
PART 1 - GENERAL**1.1 DESCRIPTION**

- A. Provide and install lighting fixtures as shown on drawings and as specified in this and all related Sections.

1.2 RELATED SECTIONS

- A. 26 06 51 Lighting Fixture Schedule

1.3 DEFINITIONS

- A. The term Architect refers to the Architect, Interior Designer, Lighting Designer or Owner's Representative individually or collectively.

1.4 GENERAL REQUIREMENTS

- A. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled and securely attached to supports.
- B. Where a catalog number and a narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.
- C. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.
- D. Type of fixtures shall be as indicated alphanumerically and as specified.
- E. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:
1. Fixture performance is equal or improved;
 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved;
 3. Cost to the Owner is reduced or equal.
 4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.5 STANDARDS

- A. The standards and regulating committees referred to in this specification and to which compliance with is required are:
1. UL Underwriters Laboratories
 2. NRTL Nationally Recognized Testing Laboratory
 3. NEC National Electric Code
 4. ANSI American National Standards Institute
 5. ASTM American Society of Testing and Materials
 6. NEMA National Electrical Manufacturers Association
 7. IEC International Electrotechnical Commission
- B. All fixtures and assembled components shall be new, of good quality, and be approved by and bear the label of UL for the applicable location and conditions (wet, damp, dry, etc.) or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.
- C. All fixtures shall meet all required local, state and/or national building, electrical and energy codes and regulations.

1.6 BIDDING

- A. Follow bidding procedures as described in Division 01 of this specification.
- B. Provide unit and alternate prices as required in Section 26 06 51 Lighting Fixture Schedule.

1.7 SUBSTITUTIONS

- A. Bidders' attention is called to the following procedure to be followed in submitting alternate fixture manufacturers than those specified:
1. Bidders wishing to obtain approval on brands other than those specified by name and/or catalog number in Section 26 06 51, Lighting Fixture Schedule, shall submit their requests not later than ten (10) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.
 2. If the bidder wishes to substitute fixtures from alternate manufacturers, his attention is called to Section 2.1, GENERAL MATERIAL REQUIREMENTS of PART 2 - PRODUCTS. In addition, he shall note that the dimensions of visible parts of many fixtures (for example, the aperture diameters of incandescent fixtures) are binding to the bidder and cannot be changed without prior approval by the Architect.
 3. Contractor shall pay professional fees (at current standard hourly rates) and reimburse expenses directly to all designers (Architect, Engineer, Lighting Designer, et. al.) for time spent reviewing substitutions proposed by the Contractor. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
 4. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Lighting Designer. The fixture samples shall be furnished and installed, at the bidder's expense, at the location selected by the Architect. In addition, the bidder shall furnish the Architect and the Lighting Designer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Lighting Designer and the Architect of record.

1.8 SUBMITTALS

- A. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
- B. For standard cataloged fixtures:
1. Submit one sample cone for each fixture type for review. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.
 2. When more than one louver panel occurs in a fixture, submit as a part of shop drawings the dimensioned layout of individual louver panels and supporting "tee" members.
- C. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit an engineered line drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.
- D. For all submittals under paragraphs A through C above, manufacturer shall provide submittals with fixture installation instruction sheets.
- E. For all submittals under paragraphs A through C above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
- F. Fixture cuts and shop drawings shall be submitted in quantities and format as described in the general conditions section the specification.

- G. The Architect shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.
- H. Mock-ups
1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture description. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.
 2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
 3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.
- I. Samples
1. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in Section 26 06 51, Lighting Fixture Schedule. When samples are called for the manufacturer shall provide two working samples complete with lamp, ballast (rated for 120 Volt operation) and 6' pig-tail with 3-prong Edison plug.
 2. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
 3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
 4. Sample fixtures may not be used on the project.

1.9 EXTRA STOCK

- A. Furnish to the Owner and store at the site where directed, extra stock of each type of lighting fixture type and lamp type installed in the Project in quantities as required by Owner, packaged in manufacturer's unopened cartons and identified as to contents by fixture type.
- B. Furnish items above with appropriate quantity of each exposed trim, fastener, bracket and other items as required for a complete installation.

1.10 WARRANTIES

- A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner. Any fixtures or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.
- B. Ballasts for fluorescent fixtures shall be covered by a five year warranty and high intensity discharge fixtures shall be covered by a two year warranty against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in-warranty ballasts.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

- A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.
- B. For weatherproof and vaportight installation, painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.

1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.
 2. Where dissimilar metal parts come in contact with each other, apply to both surfaces a coating material to prevent corrosion.
Colors shall be as specified in the Section 26 06 51, Lighting Fixture Schedule section of this specification.
- C. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.
- D. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.
- E. Outdoor fixtures shall have wire mesh corrosion resistant screens in the vent holes properly sized to prevent incursion of insects, small animals, and/or other small rodents.
- F. 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 and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).
- G. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel-and-silver-plated contacts in lampholders for the following types of lamps:
1. Mogul screw base incandescent, metal halide, and high pressure sodium.
 2. Lamps in outdoor fixtures.
 3. Tungsten-halogen lamps.
- H. Wiring channels and lampholder mountings shall be rigid and accurately made.
- I. Reflector Cones:
1. Provide 45° lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45° unless otherwise specified.
 2. Plastic materials shall not be used for reflector cones or aperture plates.
 3. Fixtures in which reflector cones are riveted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector shall not be acceptable.
 4. Cone flange shall be formed as an integral part of the cone and shall have identical color and finish as the cone, except as shown. The flange major surface shall be perpendicular to the cone axis. The width of the flange shall adequately cover the ceiling opening without light leaks. No fixture parts (housing, mounting frame, etc.) shall be visible between the ceiling surface and the edge of the cone flange. The same requirement shall be applicable to fixtures where main reflector extends down to the bottom edge of the fixture without a separate cone. In such case, the flange shall be formed as an integral part of the main reflector.
 5. Reflector cones shall be manufactured of uniform gauge, not less than 0.032" thick, high purity aluminum Alcoa 3002 alloy free of spin marks or other defects or blemishes caused during manufacturing.
 6. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 85% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
 7. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTM B136-63T.
 8. Fixtures with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
 9. Reflector cone retention devices shall not deform cone in any manner whatsoever.
Submit a certificate of compliance with Alzak finish requirements with all requests for approval.
- J. Lenses:

1. Fresnel:
 - a. Lens shall have uniform brightness throughout the entire visible area at angles from 45° to 90° from vertical, without bright spots or striations.
 - b. Lens shall have opaque risers; color shall be as specified in Section 26 06 51, Lighting Fixture Schedule.
 - c. Finish of visible regress surface of door shall be matte baked enamel paint, special color as selected by Architect.
 - d. All fixtures with fresnel lenses, unless otherwise specified, must be furnished by the same manufacturer.
 2. Glass:
 - a. Flat glass lenses shall be heat tempered borosilicate glass unless otherwise noted.
 - b. Glass finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.
 3. Acrylic:
 - a. Lenses shall be of injection molded crystal clear material 100% virgin acrylic (except as shown). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
 - b. Lenses shall fully eliminate lamp images when viewed from all directions within the 45° to 90° angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of lens does not exceed 1.50. Within the viewing angle from 0° to 45° the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.
 - c. Finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.
- K. Louvers:
1. Parabolic:
 - a. Louvers shall be continuously bound in channel formed frame, finish and color as specified or as selected.
 - b. Louver shall provide a minimum visual cut-off to the lamp of 45°.
 - c. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 85% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles.
 2. Flat Blade:
 - a. Provide flat blade louvers within formed frame, finish and color as specified.
 - b. Louvers to provide minimum of 45° degree cut-off from lamp image.
 - c. Blade thickness to minimum .125" flat steel.
- L. In adjustable fixtures, aiming and positive locking devices shall be provided.
- M. Fixtures with an adjustable lamp and using a lamp with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service or relamping.
- N. Fluorescent Fixtures:
1. Hot Cathode:
 - a. Housing:
 - 1) No. 22 minimum gauge steel, bonderized or equal rust protected, or No. 16 gauge aluminum rigid construction, suitable for continuous row mounting where indicated.
 - 2) Finish: Baked enamel paint finish unless otherwise specified, color as specified or as selected.
 - 3) Exterior Fixture Finishes:

- a) Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years. Surfaces shall be prepared, primed, and material applied in accordance with the manufacturer's requirements.
- b) Color: Colors shall be as specified under Section 26 06 51, Lighting Fixture Schedule.
- b. Reflector: Minimum 85% reflectance.
- c. Lightshields:
 - 1) Frames: Provide extruded aluminum frames with mitered corners filled and ground smooth. Provided with concealed hinges and invisible latching.
 - 2) No cross bars shall be permitted over lightshields.
- d. Lampholders:
 - 1) Lampholders shall be UL listed, and meet IEC-60400, "International Standard: Lampholders for tubular fluorescent lamps and starholders".
- e. For rapid start lamps on single ballasts, provide one (1) grounding lampholder per lamp. Lampholders operating with open circuit voltage in excess of 300 volts shall be safety type and shall open supply circuit when lamp is removed from lampholder.
 - 1) Mount lamps used in rapid start circuits 430mA and below: within 1/2" of grounded metal as long as the lamp.
 - 2) 800mA and 1500mA lamps: mount within 1" of grounded metal as long as the lamp.
- f. Fluorescent fixtures shall conform to NEMA Standards, including references to fixture dimensions and temperature ratings.
- g. Ballasts shall be electronic high power factor (greater than 90%), ballast factor (greater than 87%) and approved by UL (UL 935 listed). Ballasts shall be certified for voltage and number of lamps specified and equipped with internal thermal protectors unless otherwise specified.
 - 1) Ballasts shall have a Crest Factor of less than one and seven tenths.
 - 2) Ballasts for indoor applications shall be "Class P".
 - 3) Provide multi-lamp ballasts where possible including continuous rows of one-lamp fixtures, and one-lamp ballasts only where the fixture layout does not permit the use of multi-lamp ballasts.
 - 4) Ballast shall be a dedicated ballast to operate a specific lamp, i.e., T8 ballasts specifically for a T8 lamp.
 - 5) All ballasts shall operate at the voltage as described in Section 26 06 51, Lighting Fixture Schedule and confirmed on electrical drawings. Ballasts shall operate lamps properly through the following supply voltage ranges:
 - a) Rated voltage +/- 10%
 - b) Universal voltage of 108 to 305V on 50 or 60Hz supply
 - 6) Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
 - 7) Frequency shall be 20 Khz or greater except as noted without any discernible flicker (<3% flicker index).
 - 8) Ballast shall have input current total harmonic distortion not to exceed 10% of the fundamental harmonic (60 Hz)
 - 9) Ballast shall not contain PCB materials.
 - 10) Ballast shall provide transient immunity as recommended by ANSI C62.41-1991 location Category A2.
 - 11) Ballast shall be encapsulated to ensure maximum thermal and structural integrity.
 - 12) Ballast minimum sound ratings:
 - a) 265 mA: Class 'A'
 - b) 430 mA: Class 'A'
 - c) 800 mA: Class 'B'
 - d) 1500 mA: Class 'C'
 - 13) All fixtures installed in exterior or unheated interior spaces shall be supplied with ballasts which start lamps down to 0°F unless noted otherwise.
 - 14) Ballasts for T5, T5HO, and CFL lamps shall incorporate auto resetting lamp shutdown circuitry for end of lamp life protection thereby allowing for re-lamping without the need to cycle power.
 - 15) Program Rapid start ballasts shall be used when the lamps are to be frequently turned on/off (with cycles of less than 3 hours). Otherwise ballast shall provide instant starting sequence consistent with ANSI standard C82.11-1993.
 - 16) Ballast shall be manufactured in an ISO 9002 certified facility.
 - 17) Manufacturer shall have minimum 15 years of manufacturing experience.

- 18) Ballast, unless specified otherwise, shall be same manufacturer and model in each fixture of the same type. Acceptable ballast manufacturers unless otherwise noted are:
 - a) Advance
 - b) Universal Lighting Technologies
 - c) Osram/Sylvania
 - d) Lutron
 - h. Lighting fixtures recessed in a hung ceiling where the space above the hung ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured and wired to conform to NEC Article 300-22.
2. When specified, fluorescent luminaires shall have radio frequency interference (RFI) or electromagnetic interference filters. Filters shall either be integral or external to the ballast, but must be integral to the luminaire assembly with one filter per ballast and shall suppress electromagnetic interference in the AM radio band from 500 to 1700 kHz. Filters shall also be in the circuit serving the lighting fixture.
- O. Incandescent Fixtures:
1. Incandescent fixtures, unless otherwise specified, shall be operated at 90% of rated lamp voltage by means of a bucking transformer at the distribution panel for extended lamp life. Bucking transformers shall not be used on those circuits where dimmers are used. Refer to Electrical Engineers drawings and Specifications for manufacturer, quantity and size of bucking transformers required. (Refer to Section 26 06 51, Lighting Fixture Schedule, for lamp voltages.)
 2. Housing:
 - a. Steel, bonderized or equal rust protected or aluminum, rigid construction. Minimum gauge thickness shall be as follows:
 - 1) Interior locations: No. 20 gauge steel, No. 16 gauge aluminum.
 - 2) Exterior locations: No. 18 gauge steel, No. 14 gauge aluminum.
 - b. Finish: Baked enamel finish (except when otherwise specified).
 - 1) Concealed interior surfaces (this applies to interior hardware, lampholders, yokes, brackets, etc.): matte black.
 - 2) Concealed exterior surfaces: matte black.
 - 3) Visible surfaces: color and texture as specified below for each fixture type or as selected.
 - 4) Exterior Fixture Finishes:
 - a) Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years. Surfaces shall be prepared, primed, and material applied in accordance with the manufacturer's requirements.
 - b) Color: Colors shall be as specified under Section 26 06 51, Lighting Fixture Schedule.
 3. Reflector Cones: refer to "Reflector Cones", above.
 4. Reflectors not visible within normal viewing angles shall be highly specular as produced under the Alzak process, except when otherwise specified. Minimum reflectance shall be 85%.
 5. Provide safety devices for removable fixture elements (cones, reflectors, lenses and fixture doors, etc.). Safety devices shall support removable elements when not in normal operating position, and be detachable if necessary. This device shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.
 6. Thermal protection device shall be provided as required by code.
- P. High Intensity Discharge Fixtures:
1. Housing, where applicable:
 - a. Steel bonderized or equal rust protected, or aluminum, rigid construction. Minimum gauge thickness shall be as follows:
 - 1) Interior locations: No. 20 gauge steel, No. 16 gauge aluminum.
 - 2) Exterior locations: No. 18 gauge steel, No. 14 gauge aluminum.

- b. Finish: Baked enamel finish.
 - 1) Concealed surfaces: matte black.
 - 2) Visible surfaces: color and texture as specified below for each fixture type or as specified in Section 26 06 51, Lighting Fixture Schedule.
 - 3) Exterior Fixture Finishes:
 - a) Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years. Surfaces shall be prepared, primed, and material applied in accordance with the manufacturer's requirements.
 - b) Color: Colors shall be as specified under Section 26 06 51, Lighting Fixture Schedule.
 - c. Lampholder housing: cast aluminum with integral heat radiating fins to assure cool lamp base operation.
 - d. Fixture housing design shall provide for top and bottom relamping, unless otherwise specified.
2. Reflector: High purity (not less than 99.0%) aluminum. Specular finish shall be achieved by mechanical- and electro-polishing. Reflector shall be anodized to prevent surface corrosion or deterioration. The reflectance shall not be less than 85%.
 3. Provide safety devices for removable fixture elements (cones, reflectors, lenses, fixture doors, etc.). Safety devices shall support removable elements when not in normal operating position, and be detachable if necessary. This device shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.
 4. Magnetic Ballasts: High power factor, UL approved constant wattage auto- transformer type for voltage and lamp specified - 60 hertz.
 - a. Ballasts shall be designed in accordance with all applicable ANSI specifications including ANSI C82.4 and shall comply with UL 1029.
 - b. Ballasts shall have a normal ambient operating temperature of 104 degrees F.
 - c. The light output shall not vary more than 11% with a +/- 5% voltage variation in high reactance circuit
 - d. The light output shall not vary more than 5% with +/- 10% voltage variation in CWA circuit.
 - e. Lamp drop out voltage shall not exceed minus 25% of the rated voltage for the high reactance circuit and minus 30% for the CWA circuit.
 - f. Ballasts for indoor applications shall be encased in a housing which provides necessary wiring compartments and provisions for required electrical connectors or devices.
 - g. Ballast components shall be surrounded with a thermosetting fill to assure adequate heat dissipation and quiet operation.
 - h. Ballasts shall be provided with necessary mounting hardware and vibration dampers.
 - i. Ballasts for outdoor use shall be encased in watertight enclosures with proper outdoor wiring devices. Ballasts shall be suitable for starting lamps at temperatures between -29°C, and 41°C.
 5. Electronic Metal Halide ballasts:
 - a. Unless specified otherwise, shall be same manufacturer and model in each fixture of the same type.
 - b. Shall have an input voltage range with a variation of at least +/- 20% and +/- 1% lamp regulation resulting in greater lamp stability in areas with poor power regulation.
 - c. Output shall be "square wave" with an operating frequency of less than 200 Hz.
 - d. Shall incorporate a "Turn Off" shutdown safety feature not exceeding a response time of 3 seconds to prevent excessive ignition, undue system stress and improved long term performance of the ballast under the following conditions: no lamp, failed lamp, end of life lamp, leaker lamps and other sustained abnormal conditions such as rectification and glow mode.
 - e. Shall comply with FCC Part 18 Class A. The manufacturer shall provide documentation of compliance with non-consumer limits for EMI & RFI.
 - f. Shall have a Total Harmonic Distortion (THD) less than 10%.
 - g. Shall have a lamp Crest Factor of less than 1.3.
 - h. Shall have a Power Factor of not less than 96%.
 - i. Shall be sound rated "A".

- j. Shall be equipped with internal thermal protection to shut down the ballast when operating temperatures reach unacceptable levels.
 - k. Shall be UL and CUL "Listed or Recognized" for 120v and 277v applications and CE "Listed" for 220 to 240v 50 Hz applications.
 - l. Shall incorporate a metal case and be suitable for recessed use.
 - m. Shall be designated Type 1 – Outdoor
 - n. Shall be capable of remote mounting with a distance of not less than 10'-0".
 - o. Shall incorporate Electrolytic Capacitor(s) with minimum rating of 8,000 hours at 105 degrees C and a minimum life expectancy exceeding 64,000 hours at 75 degrees C.
 - p. Manufacturer shall offer a Five (5) year product warranty.
 - q. Manufacturer shall have a minimum of fifteen (15) experience in the manufacture of electronic power lighting products, two (2) years experience in the manufacture of Electronic Metal Halide ballasts and no less than fifty thousand (50,000) units installed worldwide.
 - r. The specified lamps shall be approved and/or warranted by the lamp manufacturer for use with the designated Electronic Metal Halide ballast.
 - s. Shall have built in circuit protection.
 - t. Shall have a designated ballast factor of 1.0.
 - u. Acceptable ballast manufacturers unless otherwise noted are:
 - 1) Aromat
 - 2) Hatch
 - 3) Metro-light
6. Lighting fixtures recessed in a hung ceiling where the space above the ceiling is used as a plenum chamber for either supply or return air for the air conditioning system shall be designed, manufactured, and wired to conform with NEC Article 300-22.
7. Provide clear glass safety lens in all Metal Halide fixtures unless otherwise noted.
- Q. Solid State Lighting / Light Emitting Diode (LED) Lamps and Luminaires:
- 1. General:
 - a. Luminaire manufacturer shall have a minimum of five (5) years experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
 - b. Unless otherwise specified, all LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
 - c. All components, peripheral devices and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system and shall operate as described in Lighting Designer's Control Narrative documents or Section 26 06 51, Lighting Fixture Schedule.
 - d. Provide submittals as described in Part 1 above.
 - e. Provide two (2) samples of each separate manufacturer and type of LED luminaire. Follow procedure for submitting samples as described in Part 1 above.
 - f. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
 - g. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated after 2007. Acceptable LED lamp manufacturers unless otherwise noted are:
 - 1) Cree, Inc.
 - 2) Philips Lighting
 - 3) Nichia Corporation
 - 4) Norlux
 - 5) Opto Technology, Inc.
 - 6) Osram Optronic Semiconductors
 - 2. Replacement and Spares:
 - a. Manufacturer shall provide written guarantee of the following:

- 1) Manufacturer will keep record of original bin for each LED module and have replacement modules from the same bin available for three (3) years after date of installation.
 - 2) Manufacturer will keep an inventory of replacement parts (source assembly, power and control components).
 - 3) Manufacturer's LED system will not become obsolete for ten (10) years: Manufacturer will provide exact replacement parts, or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.
- b. All parts of system shall replaceable in field. Manufacturer shall provide written guarantee of the following:
- 1) Manufacturer has in place a written recycling and re-use program, and will accept returned product and/or components for recycling or re-use.
 - 2) Manufacturer will properly dispose of non-recyclable components that are deemed harmful to the environment.
- c. System shall carry a full warranty for five (5) years. Manufacturer shall be responsible for cost of labor not to exceed \$50 per individual part, and cost of shipping, to replace any component of the system that fails within 2 years of installation.
3. Products and Components – Performance
- a. LED luminaires and components shall be UL listed or UL classified.
 - b. LED luminaires and components shall be CE certified.
 - c. All LED luminaires shall be subjected to the following JEDEC Reliability Tests for Lead-free Semiconductors: HTOL, RTOL, LTOL, PTMCL, TMSK, Mechanical Shock, Variable Vibration Frequency, SHR, Autoclave.
 - d. To ensure luminaire quality, luminaire shall have been tested under accelerated life test conditions including an operating temperature span of 360 degrees F, and cyclic loading up to 60G.
 - e. All products included in system shall use Mil-Std 810F, Random Vibration 7.698g as a minimum standard. In installations subject to vibration, luminaire shall be installed with vibration isolation hardware to sufficiently dampen vibrations.
 - f. All LED components shall be mercury and lead-free.
 - g. All manufacturing processes and materials shall conform to the requirements of the European Union's Restriction on the Use of Hazardous Substances in Electrical and Electronics Equipment (RoHS) Directive, 2002/95/EC.
 - h. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the lamp. Color shall match approved sample.
 - i. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products
 - j. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED "rated source life" is defined as the time when a minimum of 70% of initial lumen output remains.
 - k. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components.
 - l. Manufacturer shall supply in writing a range of permissible operating temperatures in which system will perform optimally.
 - m. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
 - n. LEDs shall be adequately protected from moisture or dust in interior applications.
 - o. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
 - p. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

- q. The LED luminaire shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
- r. RGB LED luminaires shall utilize an equal combination of high brightness red, blue and green LEDs, unless otherwise noted, to provide up to 16.7 million additive RGB colors and shall be capable of at least 8-bit control.
- s. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
- t. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
- u. All LED luminaires (100% of each lot) shall undergo a minimum twenty-four (24) hour burn-in during manufacturing, prior to shipping.
- v. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory.
- w. Power / data supply shall have the following:
 - 1) Supply outputs shall have current limiting protection.
 - 2) Supply shall provide miswiring protection.
 - 3) Supply shall have power factor correction.
 - 4) Supply shall provide connections that are conduit-ready or clamp-style connections in the case of low-voltage wiring.
 - 5) Supply shall come with a housing that meets a minimum IP20 rating for dry location installation unless located in a damp or wet location.
 - 6) Supply shall be UL listed for Class 1 or Class 2 wiring

4. LED Control and Communication – Performance

- a. LED luminaires shall be network controllable via digital control.
- b. The LED system shall use integral and differential non-linear control.
- c. Constant data transmission rates shall be employed, resulting in the output being independent of distance of cable between power supply and light source within the specified length.
- d. LED system shall have a selectable means of external control via a data network.
- e. Each LED luminaire and/or node shall have the capability to be set to a unique and individual address. Address shall be selectable through on board switches or by an external hardware or software method.
- f. The LED system shall be scalable, with every LED luminaire/address in the system capable of being controlled by a single, centralized controller.

R. Wiring:

1. Voltage Rating

- a. For voltages up to 120 volts fixture wiring shall be rated for 300 volts minimum.
- b. For voltages above 120 volts fixture wiring shall be rated for 600 volts minimum.

2. Temperature Rating - Internal to Fixture

- a. All wiring shall be code-approved for fixture wiring, and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire.
- b. Incandescent
 - 1) minimum rated between lampholder(s) and separately mounted junction box or internal transformer.
 - 2) minimum rated between internal transformer and separately mounted junction box.
 - 3) Tungsten-halogen lamp seal temperature shall not exceed 350°C at ambient of 25°C when tested per UL Bulletin 57, Par. 328-334. Submit certified heat test data by independent testing laboratory.
- c. Fluorescent
 - 1) minimum rating between lampholder(s) and internal ballast.

- 2) minimum between ballast and separate junction box, or connection within integral wireway.
 - d. High Intensity Discharge
 - 1) minimum rating between lampholder(s) and separate junction box or connections with ballast components.
 - 2) minimum rating between core and coil ballast components and separate junction box.
 - 3) minimum rating between encased and potted ballast components and separate junction box.
 3. Temperature Rating - External to Fixture
 - a. All flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.
 - b. Cord type shall be suitable for application and shall be fitted with proper strain relief and watertight entries where required by application.
 4. Splices
 - a. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulated crimped connections or insulated quick disconnects.
 - b. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.
 5. No internal wiring shall be visible at normal viewing angles, i.e., above 45° from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface.
 6. Any fixture fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.
 7. Furnish code-approved wiring in ceiling cavities forming air plenums.
- S. Lamps:
1. Hot cathode fluorescent lamps:
 - a. Shall be 3000° Kelvin, with 85 CRI or greater except as shown. Refer to Section 26 06 51, Lighting Fixture Schedule for details.
 - b. All lamps, except as specified, shall be of the same manufacturer:
 - 1) General Electric
 - 2) North American Philips
 - 3) Osram/Sylvania
 - c. T8 fluorescent lamps shall be of the "high performance" or "super" T8 type with extended lamp life and low mercury content.
 - 1) Four foot long 32 watt lamps shall have an initial lumen output of 3100 lumens, minimum.
 - 2) Four foot long lamps shall have a mean efficacy of 92 mean lumens per nominal wattage, minimum.
 - 3) Four foot long lamps shall have a rated lamp life of 24,000 hours or greater based on 3 hours per start if operated in rapid start mode.
 - 4) Mercury content in lamps shall be TCLP-compliant.
 - 5) Lamp lumen depreciation shall not be less than 92% of initial lamp lumens at 20,000 hours rated lamp life.
 - 6) Ballasts used with these lamps shall be a NEMA Premium electronic ballast, no substitutions allowed.
 2. Incandescent lamps:

- a. 120 volt, except as shown. Refer to Section 26 06 51, Lighting Fixture Schedule for details. All lamps, except as specified, shall be of the same manufacturer:
 - 1) General Electric
 - 2) North American Philips
 - 3) Osram/Sylvania
- b. Energy saving type lamps which use an electronic diode shall not be used unless otherwise specified in Section 26 06 51, Lighting Fixture Schedule.
3. High intensity discharge lamps:
 - a. Refer to Section 26 06 51, Lighting Fixture Schedule for details. All lamps, except as specified, shall be of the same manufacturer:
 - 1) General Electric
 - 2) North American Philips
 - 3) Osram/Sylvania
 - 4) Venture
- T. Pole/Luminaire Assemblies:
 1. Supply luminaires, davit arms, brackets, poles, handhole covers, base components, and all other accessories complete by specified manufacturer who will be responsible for proper fitting of all elements.
 2. Manufacturer will supply assembly to withstand 100 mph winds with a 1.3 gust factor without permanent deflection.
 3. Manufacturer shall be responsible for design of and structural integrity of complete base (i.e., concrete dimensions, rebar requirements, grounding and conduit requirements, drainage and ground compaction requirements).

PART 3 - EXECUTION

3.1 SHIPPING AND STORAGE

- A. All fixtures received at the site shall be stored in clean and dry space until fixtures are installed.
- B. Manufacturer shall clearly mark each box with fixture designation prior to shipping.
- C. Reflector cones, baffles, louvers, aperture plates, and decorative elements of fixtures shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the fixture.

3.2 LOCATION

- A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with Reflected Ceiling Plans and other reference data before ordering of fixtures and during installation.
- B. Notify Architect about field conditions at variance with Contract Documents before commencing installation.
- C. Coordinate space conditions with other trades before ordering of fixtures.
- D. Pendant mount, as approved, surface type fixtures where required to meet space conditions.
- E. Coordinate length of continuous-run fluorescent fixtures with adjacent walls, partitions, coffers and other architectural elements as required.
 1. Continuous runs shall be defined as the optimal combination of 3' and 4' lamp length as necessary to complete runs with no more than 6" of free space at either end of the run as provided by the contractor.

3.3 INSTALLATION

- A. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Fixture catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a fixture may be installed.
- B. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.
- C. Install rows of fixtures accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.
- D. Install fixtures with vent holes free of air blocking obstacles.
- E. Where plaster ceilings occur, furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location; make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.
 - 1. Fixtures shall be supported by plaster frames utilizing yokes or leveling lugs.
 - a. Fixtures and support elements shall not be mounted to or in contact with ducts or pipes.
 - b. Yoke shall have channel cross section of sufficient gauge, and shall support a fixture by means of not fewer than two (2) bolts each.
 - 2. If air diffusers are located in common continuous rows with lighting fixtures in plaster ceilings, furnish plaster frames of proper length to accommodate diffusers.
 - 3. Lighting fixtures recessed in ceilings which have a fire resistive rating of one hour or more shall be enclosed in a box which has a fire resistive rating equal to that of the ceiling.
- F. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thickness. Contractor shall be responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more than 1/16" above. Under no circumstances will the aperture ring extend below the finished ceiling surface.
- G. For fixtures with variable position lampholder assemblies Contractor shall confirm prior to installation proper lampholder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.
- H. Surface Mounted Fixtures: Support surface mounted fixtures from structural members other than ceiling tees.
- I. Pendant Mounted Fixtures:
 - 1. Pendant mounted fixtures shall be supported from structural framework of ceiling or from inserts cast into slab.
 - 2. All pendants shall have swivel aligners located at the top ends; pendants shall be 1/2" rigid steel conduit unless specifically indicated otherwise on drawings or in specifications.
 - 3. All fluorescent pendant and surface mounted fixtures shall be supported with two (2) supports per four foot section or three (3) per eight foot section unless otherwise recommended by manufacturer.
- J. Bracket Mounted Fixtures: For each bracket fixture, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the fixture rigidly in design position. Flanged part of fixture stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.
- K. Top Relamping Fixtures: Top relamping fixtures shall have the necessary top-relamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when relamping is required.
- L. Fluorescent Fixtures: Replace noisy ballasts as directed, at no cost to the Owner.
- M. High Intensity Discharge Fixtures: Replace noisy ballasts as directed, at no cost to the Owner.
- N. Solid State Lighting / Light Emitting Diode (LED) Fixtures:
 - 1. Color Changing or Programming Support
 - a. Provide installation and commissioning support to the electrical contractor as required to achieve a complete and operational system that meets the intent of the Control Narrative.
 - b. In addition to the above, provide a factory representative for up to 4 number visits not to exceed 30 hours for field calibration and programming in the presence of the Lighting Designer.

- O. Mask the trims and bottoms of all lighting fixtures if necessary to protect the fixture during construction.
- P. At the completion of construction clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers and reflector cones of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture. If the luminaires are deemed dirty by the Architect at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner.
- Q. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type.
- R. Replace all burned-out or inoperative lamps, and inoperative ballasts in all high intensity discharge and fluorescent fixtures before the building is accepted by the Owner so that all lighting fixtures will be in first-class operating condition.
- S. Re-lamp all specified H.I.D. fixtures used as construction work lights with new specified lamps. No H.I.D. lamps shall have a burning hours difference which exceeds forty (40) hours.
- T. Re-lamp all specified incandescent fixtures used as construction work lights with new specified lamps. No incandescent lamps shall have a burning hours difference which exceeds forty (40) hours.
- U. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required.

END OF SECTION