

PART 1 - GENERAL

1.1 SUMMARY

- A. This section provides general requirements for a complete and fully operational lighting system including:
 - 1. Interior lighting fixtures
 - 2. Exit signs
 - 3. Accessories
 - 4. Light fixture support

1.2 RELATED SECTIONS:

- A. Section 26 05 00 Common Work Results for Electrical
- B. Section 26 09 23 - Lighting Control Devices
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- D. Section 26 50 01 –Lighting Fixture Schedule (Datasheets) **(If not shown on Drawings)**

1.3 REFERENCES

- A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and Sections under Division 1 General Requirements.
- B. Conform to Reference Standards by date of issue current on date of Contract Documents, except where a specific date is established by code.
 - 1. ANSI/NFPA 70 National Electrical Code
 - 2. NFPA 101 Life Safety Code
 - 3. UL 57 Electrical Luminaires
 - 4. UL 924 Emergency Lighting and Power Equipment
 - 5. UL 773 Plug-In Photo controls for Use with Area Lighting
 - 6. UBC Standard Section 47.1813 Luminaires ,
 - 7. IES LM-79-08 Electrical and Photometric Measurements of Solid State Lighting
 - 8. IES LM-80 Method for Measuring Lumen Maintenance for SSL Light Sources

1.4 SYSTEM DESCRIPTION

- A. Light Fixture Datasheets and catalog numbers indicated are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware, or special requirements as specified or as required by the particular installations. Provide complete fixture to correspond with the features, accessories, number of lamps, wattage and/or size specified in the text description of each fixture type. Additional features, accessories and options specified shall also be included.
- B. Provide all frames, supplementary support structures, hangers, spacers, stems, aligner canopies, auxiliary junction boxes and other hardware as required for a complete and proper

installation. Recessed fixtures shall have frames that are compatible with the ceiling systems.

- C. Light fixture voltage shall match the voltage of the circuit serving the light fixture.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. FMG Compliance: lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- F. Luminaires, ballasts, lamps and other components and controls shall equal or exceed the requirements of all applicable state and/or municipal energy codes.
- G. Designated manufacturers are listed to define the requirements for quality and function of the specified product. Equivalent or better products of other, unnamed manufacturers may be proposed for consideration by adhering to procedures set forth in this section and in Specification Section 00 16 00 – Product Requirements.
- H. Mockups: Refer to Section 26 50 01 – Lighting Fixture Schedule (Datasheets) for fixture type(s) requiring mockups. Provide lighting fixtures for room or module mockups.
 - 1. Obtain Lighting Designer's and Architect's approval of fixtures for mockups prior to starting installation.
 - 2. Install fixtures for mockups with power and control connections.
 - 3. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 4. Remove mockups when directed. Fixtures may be reinstalled in the Work with approval of Owner.
 - 5. Mockups evaluated on the project site may become part of the complete Work with the approval of the Owner, Lighting Designer, and Architect if the mockup is undisturbed at the time of substantial completion.

1.6 SUBMITTALS

- A. Comply with requirements of specification section describing Submittal Procedures
- B. The authorized manufacturer's representative for the project area shall prepare submittals for each lighting fixture type. In addition to the fixture submittals, a list shall be provided

identifying the manufacturer representative for each fixture type. Provide manufacturers' names, addresses, and telephone numbers. Requests for prior approval shall also include this information. Submittals or requests for prior approval without this information will be rejected.

- C. Product Data shall indicate that light fixture, lamps, and ballasts fully comply with contract documents. Data shall be submitted for each type of light fixture indicated, arranged in order of fixture designation. For standard catalog fixtures provide original product catalog sheets indicating data on features, accessories, finishes, and the following:
1. Materials and dimensions of luminaires.
 2. Photometric data, in IESNA format, based on certified results of laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in the Project.
 - a. Photometric data shall be certified by a qualified independent testing agency.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 3. Emergency lighting unit battery and charger.
 4. Low voltage transformers.
 5. Fluorescent and high intensity discharge ballasts.
 6. Ballast disconnecting means.
 7. LED power supplies.
 8. Types of lamps, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
- D. Shop Drawings shall:
1. Show details of nonstandard or custom fixtures.
 2. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
 3. For custom fixtures, modified fixtures, or linear fluorescent fixtures mounted in continuous rows, submit scaled drawings prepared by the manufacturer showing all details of construction, lengths of runs, pendant and power feed locations, accessories, finishes, and lists of materials.
 4. Contractor to provide the manufacturer with accurate field dimensions where required.
 5. Wiring diagrams, power and control wiring.
- E. Wiring Diagrams shall detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.
- F. Coordination Drawings shall include reflected ceiling plans, sections, and other details drawn to scale and coordinating the following items:
1. Light fixtures
 2. Suspended ceiling components
 3. Structural members to which suspension systems for light fixtures will be attached
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets
 - b. Speakers
 - c. Sprinklers

- d. Smoke and fire detectors
 - e. Occupancy sensors
 - f. Access panels
5. Perimeter moldings.
- G. Product Certificates shall be signed by manufacturers of lighting fixtures certifying that products comply with requirements.
 - H. Dimming Ballast Compatibility Certificates shall be signed by the manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used. Product certificates signed by the product manufacturer shall be provided for each type of ballast for bi-level and dimmer controlled fixtures.
 - I. Maintenance Data shall be provided for lighting fixtures and equipment to include in emergency, operation, and maintenance manuals specified in specifications section describing Operations and Maintenance Data.
 - J. Field quality control test reports.
 - K. Special Warranties specified in this Section.
 - L. Review of luminaire submittals which indicate voltage, mounting condition, or quantities shall not be considered to be approval of said voltage, mounting condition, or quantities. Contractor shall field verify voltage and actual mounting condition and method.
 - M. Product samples, complete with housing, trim, specified lamp, and 8' cord with plug shall be submitted if requested.

1.7 SUBSTITUTIONS

- A. Comply with requirements of specification section describing Product Requirements.
- B. Lighting fixtures are based on the fixture types and manufacturers specified. If substitution of fixtures other than those specified is desired, product information must be submitted to the Lighting Designer 10-days prior to the close of the bid period. No requests for substitution will be accepted after this date.
- C. Substitution requests shall include all information required under in paragraph 1.6 - SUBMITTALS. Requests for approval shall be accompanied by a working fixture sample (including lamps, cord and plug). Provide the name of at least one installation where each proposed substitute has been installed for at least six months. Provide the name and telephone number of the Architect, Owners' Representative, and Lighting Designer or Engineer of record.
- D. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be the sole responsibility of the Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.

- E. When requesting a substitution, Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended savings to Owner to be realized by accepting proposed alternate. If requested, Contractor shall provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.
- F. If required by the Lighting Designer, the proposed substitutions must be installed at the bidder's expense in a location selected by the Architect or Lighting Designer.
- G. If the substitution request is accepted, approval will be in the form of an addendum to the specifications issued to all registered plan holders.
- H. A maximum of two substitution requests shall be reviewed for any single fixture type. If a substitution has not been approved following this process, the Contractor shall provide the specified fixture.

1.8 CUSTOM LIGHT FIXTURES

- A. All custom light fixtures require a prototype to be submitted prior to commencement of fabrication. The purpose of the prototype will be to review construction, lamp placement within the fixture, lamp type, optical assembly, finishes, etc. Modifications may be required as a result of the prototype review. These modifications and others that do not materially affect the cost of the fixture shall be incorporated at no additional cost to the Owner.

1.9 COORDINATION

- A. Coordinate layout and installation of light fixtures with ceiling system and other construction that penetrates ceilings or is supported by them including mechanical system, fire suppression, AV, and partition assemblies.
- B. Provide all frames, supplementary support structures, hangers, spacers, stems, aligner canopies, auxiliary junction boxes and other hardware as required for a complete and proper installation. Recessed fixtures shall have frames that are compatible with the ceiling systems.
- C. Coordination Meetings: Meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area. Meet at least twice with the mechanical systems installer prior to fabrication and installation of ductwork. Coordinate depth and location of all light fixtures and ductwork in all areas.

1.10 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranties for Fluorescent Ballasts: Written warranty to furnish to UWMC fluorescent ballasts that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Electronic Ballasts: three years from date of Substantial Completion.
 2. Special Warranty Period for Electromagnetic Ballasts: One year from date of Substantial Completion.
- C. Special Warranty for Fluorescent Lamps: to furnish to UWMC lamps that fail in materials or workmanship, within
1. Two years from date of Substantial Completion.
- D. Special Warranty for LED Lighting Fixtures: A warranty for luminaires, covering repair or replacement of defective electrical parts (including light source and power supplies) within specified warranty period indicated below.
1. Warranty Period: Five years from date of Substantial Completion.
- E. Exit Signs Utilizing LED Lamp Technology: Provide manufacturer's warranty including parts and labor for full replacement of defective product within specified warranty period indicated below:
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Catalog series numbers specified in Section 26 50 01 represent the type and style of fixture. The fixture size shall correspond with the wattage indicated in Section 26 50 01 – Lighting Fixture Schedule (Datasheets) or the actual length of the fixture as indicated on the drawings.
- B. Numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, type of ballast, finish trim, ceiling type, mounting hardware or special requirements as specified as required by the particular installations. Acceptable manufacturers and series numbers are listed. The manufacturer listed shall provide complete fixtures equaling or exceeding the written specifications. Verify these requirements and order fixtures as required for a complete and fully operational installation per the contract documents and per code.

2.2 GENERAL MATERIAL REQUIREMENTS

- A. Fixtures shall be free of light leaks while providing sufficient ventilation of lamps to provide the required photometric performance. Ballasts and transformers shall be adequately vented.
- B. Lampholders shall hold lamps securely against normal vibration and maintenance handling.
- C. Light fixtures containing lamps which require protective shielding shall be furnished with a tempered glass lens or approved unbreakable lens UL listed for the application.
- D. Metal Parts shall be free from burrs, sharp corners, and edges. Metal work shall be free from tool marks and dents and shall have accurate angles bent as sharply as compatible

with the gauges of the required metal. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All miters shall be in accurate alignment with abutting intersection members.

- E. Sheet Metal Components shall be steel, unless otherwise indicated. Components shall be formed and supported to prevent warping and sagging. Luminaires to be painted after fabrication. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.
- F. Fixture hardware to comply with the following material standards: 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 stainless steel or bronze.
- G. Doors, Frames, and other internal access shall be smooth operating, free from light leaks under normal operating conditions, and designed to permit relamping without use of tools.
- H. Provide supplemental safety device or arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Safety devices shall be detachable if necessary and shall not interfere with fixture performance, maintenance, or the seating of any fixture element. Safety device shall not be visible during normal fixture operation and from normal viewing angles.
- I. For all luminaires, provide a ballast disconnection means in accordance with NEC 410.130(G).
- J. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 %.
 - 2. Specular Surfaces: 90 %.
 - 3. Diffusing Specular Surfaces: 75 %.
 - 4. Laminated Silver Metallized Film: 90 %.
- K. Reflector cones shall adhere to the following criteria:
 - 1. Cones designed for vertically mounted lamps shall provide a minimum of 45 degree cutoff of lamp and lamp image. Cones designed for horizontally mounted lamps shall provide a minimum of 55 degree cutoff of lamp and lamp image. There shall be no visible lamp flashing in the cone.
 - 2. Plastic material shall not be used for reflector cones, unless otherwise specified.
 - 3. Cones shall not be permanently fastened to the housing or ceiling and shall be removable without tools. Retention devices shall not deform the cone or be visible from normal viewing angles.
 - 4. Trim shall be flush to the finished ceiling without gaps or light leaks. Where the flange trim is separate from the cone, it shall have the same finish as the reflector cone.
 - 5. Reflector cones shall be of uniform gauge, not less than 0.032" thick, high purity aluminum Alcoa 3002 alloy. Cones shall be free of spin marks or other defects.
 - 6. Manufacture cone using the Alzak process. Refer to the fixture schedule for cone color and finish (i.e. specular or diffuse) requirements. For compact fluorescent fixtures, finish shall eliminate iridescence.

- L. Lenses, Diffusers, Covers, and Globes shall be 100 % virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic, polycarbonate and acrylic shall be UV stabilized and shall have high resistance to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation.
 - 2. Lens Thickness shall be 0.125" (3 mm) unless other thickness is indicated.
 - 3. Lenses shall have uniform brightness throughout the entire visible area.
- M. Adjustable light fixtures shall have positive locking devices to fix the aiming angle. Fixtures shall be capable of being relamped without adjusting the aiming angle.
- N. Each lighting fixture that has a lamp with an oval shape beam pattern or a spread lens that defines beam orientation shall contain lamp or lens locking devices to insure that lamp or lens orientation is not disturbed during future lamp replacement or cleaning.
- O. All fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc. in the applications and mounting conditions herein specified.
- P. Fixtures recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform with NEC Article 300-22.
- Q. Provide plaster frame for recessed light fixtures mounted in other than T-bar ceilings. Verify mounting with architectural reflected ceiling plan before ordering light fixtures.
- R. Provide wire guards on all fluorescent open strip type fixtures.
- S. For weatherproof or vaportight installations, painted finishes of fixtures and accessories shall be weather resistant enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended. Exterior finishes shall have an outdoor life expectancy of not less than 20 years without any visible rust or corrosion. Where aluminum parts come into contact with bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.
- T. Fixtures for use outdoors or in areas designated as damp locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Dissimilar metals shall be separated by non-conductive material to prevent galvanic action.
- U. Welding shall be done with electrodes and/or methods recommended by the manufacturers of the metals being welded. Welds shall be continuous, except where spot welding is specifically permitted. Welds exposed to view shall be ground flush and dressed smooth. All welds on or behind surfaces which will be exposed to view shall be done so that finished surface will be free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Remove weld spatter and welding oxides from all welded surfaces.
- V. Electromagnetic-Interference Filters shall be factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate light fixtures with one filter on each ballast indicated to require a filter.

2.3 INCANDESCENT/TUNGSTEN HALOGEN FIXTURES

- A. Tungsten halogen is a type of incandescent light source and will be held to the same requirements as incandescent fixtures. Tungsten halogen lamp seal temperature shall not exceed 350 degrees Celsius with an ambient temperature of 25 degrees Celsius when tested per UL Bulletin 57, Paragraph 328-334. Submit certified heat test by independent testing laboratory when required in Section 26 50 01 – Light Fixture Datasheets.
- B. Concealed parts of fixture such as lamp holders, yokes, accessory holders, and housing shall be matte black finish.

2.4 FLUORESCENT FIXTURES

- A. Housing shall be minimum code gauge steel or rigid aluminum construction painted after fabrication with high reflectance white paint unless otherwise indicated in Section 26 50 01 - Light Fixture Datasheets.
- B. Shielding shall adhere to the following criteria:
 - 1. Eggcrate louvers shall be aluminum, continuously bound in a perimeter channel frame. Frame, louver, and support shall be painted to a finish as selected by Architect.
 - 2. Parabolic louvers shall be Alzak aluminum with a low iridescent finish, specular or semi-specular as indicated in Section 26 50 01 – Light Fixture Datasheets.
 - 3. Flat translucent diffuser shall be 100% virgin acrylic and shall have matte finish on exterior side. Diffuser shall be of sufficient density to completely obscure lamp image.
 - 4. Flat clear lenses shall be injection molded 100% virgin acrylic or clear tempered glass, thickness as specified in Section 26 50 01 – Light Fixture Datasheets.
 - 5. Clear patterned lenses shall be injection molded 100% virgin acrylic. For lenses with convex pattern of prisms or cones, specified minimum thickness refers to distance from the flat surface to the base of the pyramids or cones, or to the thickness of undisturbed material. For lenses with concave pattern, specified minimum thickness refers to overall thickness of the material. Lenses shall fully eliminate lamp image when viewed from all directions between 45-90 degrees from vertical. From 0-45 degrees the ratio of maximum brightness to minimum brightness shall not exceed 3:1. Minimum thickness shall not be less than 0.125" with a minimum weight of 8 ounces per square foot.
 - 6. Parawedge louvers shall be injection molded plastic with specular silver anti-static finish. Cell dimensions shall be ½" x ½" x ½".
- C. Doorframes shall be supplied with concealed hinges and latching. Provide mitered corners with no gaps or light leaks.
- D. Lamp mounting shall adhere to the following criteria:
 - 1. Lamps used in rapid start circuits 430 ma and below shall be mounted within ½" of grounded metal of equal length to the lamp.
 - 2. Provide one grounding lamp holder per lamp for rapid start circuits using single lamp ballasts.

2.5 FLUORESCENT LAMP BALLASTS

- A. General Requirements: Unless otherwise indicated, provide products manufactured by one of the following; Advance, General Electric (GE) or prior approved equal, with features that include the following:
1. All ballasts shall be Rapid Start or Programmed Start technology.
 2. Life: Ballasts shall provide normal rated lamp life as stated by lamp manufacturers.
 3. Electronic integrated circuit, solid-state, full-light-output, energy efficient type, compatible with lamps and lamp quantities specified.
 4. Certifications: Underwriters Laboratories (UL) listed Class P, Certified Ballast Manufacturer (CBM), Electrical Testing Laboratory (ETL).
 5. Comply with ANSI C82.11
 6. Operating voltage: shall match voltage of circuit. Confirm voltage requirements with Electrical Drawings. Ballasts shall operate lamps correctly within 10% voltage variation without damaging ballasts.
 7. Operating Frequency: 60 Hz at voltage of circuit indicated on drawings.
 8. Lamp Operating Frequency: 20 kHz or higher.
 9. Flicker: Ballasts shall operate lamps with no visible flicker.
 10. Power Factor: 0.95 or higher.
 11. Total Harmonic Distortion Rating: Less than 10%.
 12. Ballast Factor : 0.85 or higher
 13. Lamp Current Crest Factor: 1.5 or less.
 14. Sound Ratings:
 - a. A for 430 ma and 265 ma
 15. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
 16. Transient Protection: Comply with IEEE C62.41, Category A or better.
 17. Interference: Comply with 47 CFR, Chapter 1, Part 18, and Subpart C for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 18. Operating Temperatures: Ballasts shall operate in ambient temperatures up to 105 degrees Fahrenheit (40 degrees Celsius) and shall have thermal protection.
 19. Lamp end of life detection and shutdown circuit.
 20. Automatic lamp starting after lamp replacement.
 21. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation condition without modification or rewiring in the field.
 22. Utility Funding: Ballasts shall meet utility requirements for projects which are applying for utility rebates or funding.
 23. Ballasts shall be Advance Optanium Series (for T8 lamps), Advance SmartMate Series (for compact fluorescent lamps), GE UltraStart or prior-approved.
- B. Dimming Ballasts: Comply with general and fixture-related requirements above for electronic ballasts. Unless otherwise indicated, provide products manufactured by one of the following: Advance Mark 7, or prior approved, with features that include the following:
1. Provide ballasts with dimming capability (1%, 5%, 10%) as specified in Section 26 50 01 Light Fixture Datasheets
 2. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast
 3. Ballast shall maintain constant light output for a line voltage variation of +/- 10%.
 4. Ballast shall provide continuous, flicker-free dimming over the entire dimming range.

C. Low Temperature Ballasts shall be as follows:

1. Temperatures 0 Degrees Fahrenheit (Minus 17 degrees Celsius) and Higher: Electronic or electromagnetic type rated for 0 degrees Fahrenheit (minus 17 degrees Celsius) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 degrees Fahrenheit and Higher: Electromagnetic type designed for use with indicated lamp types.

2.6 LED FIXTURES

A. All Luminaires

1. Comply with IES LM79 and IES LM80 LED product testing procedures, and DOH Energy Star requirements.
2. Luminaires shall not draw power in the off state. Luminaires with integral occupancy, motion, photo-controls, or individually addressable fixtures with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.
3. Color spatial uniformity shall be within .004 of CIE 1976 diagram.
4. Color maintenance over rated life shall be within .007 of CIE 1976.
5. Indoor luminaires shall have a minimum CRI of 75.
6. Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management
7. LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver at least 70% of initial lumens, when installed in-situ, for a minimum of 35,000 hours.

B. Power Supplies and Drivers

1. Power Factor: 0.90 or higher
2. Operating temperature: minimum of -20°C or below when used in luminaires intended for outdoor use.
3. Maximum driver case temperature not to exceed driver manufacturer recommended in-situ operation.
4. Output operating frequency: $\geq 60\text{Hz}$.
5. Interference: EMI and RFI compliant with FCC 47 CFR Part 15.
6. Total Harmonic Distortion Rating: Less than 20%.
7. Meet electrical and thermal conditions as described in LM-80 Section 5.0.
8. Primary Current: Confirm primary current with Electrical Drawings.
9. Secondary Current: Confirm secondary current specified by individual luminaire manufacturers.
10. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified control components.
11. Solid-state control components to be integral or external per each specified luminaire. Remote control gear to be enclosed in Class 1, Class 2, or NEMA 3R enclosures as required.

C. Controller and Control System

1. System electronics driver / controller to use 0-10V
2. Contractor to ensure that external control equipment is compatible with LED control requirements
3. Provide connector types and wiring as appropriate for un-interrupted communication between devices, considering distance maximums, field obstructions, and

accessibility. Ensure that connection points are optically isolated for system noise reduction.

4. For stand-alone controlled LED systems see Section 26 50 01 – Architectural Light Fixture Datasheets.
5. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified power supplies and/or drivers.

2.7 WIRING

- A. All wiring shall be as required by code for fixture wiring.
- B. All flexible cord wiring between fixture components or to electrical receptacles and not in wireways shall have a minimum temperature rating of 105 degrees Celsius.
- C. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
- D. No internal wiring shall be visible at normal viewing angles.
- E. Provide #18 AWG, 3 wire flexible conduit connections (whips) for dual level switching as shown on Electrical Drawings for light fixtures recessed in accessible suspended ceiling. Provide 3-wire whips for all dual level switching. Wire count on wire whips is not shown on Drawings and shall be the responsibility of the Contractor to provide proper wire count for the lighting control as shown on Drawings.

2.8 FIXTURE SUPPORT COMPONENTS

- A. Comply with Section pertaining to General Electrical Provisions, paragraph entitled Equipment anchorage, Support, Seismic Restraint, and Bracing for fixture support and bracing.
- B. Where the ceiling is of insufficient strength to support the weight of the lighting fixtures, provide additional framing from building structure to support luminaires as required. Do not support fixtures from ceiling T-Bar system.
- C. Single-Stem Hangers shall be 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish shall be the same as the luminaire.
- D. Twin-Stem Hangers shall be two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish shall be the same as the luminaire.
- E. Rod Hangers shall be 3/16-inch minimum diameter, cadmium-plated threaded steel rod.
- F. Wires shall be ASTM A 641/A 641M, Class 3, soft temper, zinc coated steel, 12 gauge.
- G. Wires for humid spaces shall be ASTM A 580/A 580M, composition 302 or 304, annealed stainless steel, 12 gauge.
- H. Hook Hangers shall be integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

- I. Aircraft Cable Support shall use cable, anchorages, and intermediate supports recommended by fixture manufacturer.
- J. Hangers for Pendant Industrial Fixtures shall be heavy duty No. 8 jack chain with hangers, "S" hooks, mounting straps, and all required accessories for complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Mounting height indicated in drawings from finished floor to bottom of pendant light fixture or to the center of the outlet box for wall mounted light fixtures unless otherwise noted. Verify mounting heights with Architect and Lighting Designer.
- C. Mounting height may also be indicated as the length of the pendant below finished ceiling.
- D. Provide all necessary hanging or mounting devices and accessories for all fixtures. Verify the types needed for various ceiling conditions. Plaster rings shall be provided where required.
- E. Verify weight and mounting method of all fixtures prior to ordering and provide suitable support. Coordinate with General Contractor for fixtures that require additional blocking or support. Fixture mounting assemblies shall comply with all local seismic codes and regulations.
- F. Refer to architectural reflected ceiling plans for coordination of light fixture locations with mechanical and fire safety equipment. Where conflicts occur, coordinate with Architect and Lighting Designer prior to installing any of the systems.
- G. In accessible suspended ceilings, fixture wiring connection, including equipment grounding conductor, is to be through use of 72-inch flexible conduit from a rigidly supported junction box.
- H. Wire per requirements of branch circuit installation. Properly ground each fixture.
- I. Light fixtures located in recessed ceilings with a fire resistive rating of 1 hour or more shall be enclosed in an approved fire resistive rated box equal to that of the ceiling.
- J. Install fixtures with vent holes free of air blocking obstacles.
- K. Contractor shall be responsible for adjusting aperture flanges or rings on all recessed fixtures to be flush with the finished ceiling. Fixture trim shall completely conceal ceiling opening.
- L. Adjust variable position lampholders for proper lamp position prior to fixture installation.

3.2 FIXTURE SUPPORT

- A. Comply with specifications section describing General Electrical Provisions, paragraph entitled Equipment Anchorage, Support, Seismic Restraint, and Bracing for fixture support and bracing.
- B. Provide all necessary hanging or mounting devices for all fixtures, verify the type needed for various ceiling conditions. Plaster rings shall be provided where required.
- C. Ceiling Fixture Support: Where ceiling is of insufficient strength to support weight of light fixtures installed, provide additional framing from building structure to support as required.
- D. Provide two slack No. 9 safety wire hangers or threaded rods for each recessed mounted fluorescent fixture. Secure from opposite corners of each fixture and fasten to structure above, independent of ceiling system. Locate supports not more than 6 inches from fixture corners.
- E. Electrical Contractor is to provide and install locking clips for all fixtures installed in suspended ceilings. The locking clip is to be attached to the fixture with a sheet metal screw or similar device and secured to the main or supporting T-bar runner to guarantee a secure installation. Clips shall be located at or near fixture corners.
- F. Fixtures which are of a size smaller than the ceiling grid shall be located as indicated on the reflected ceiling plans. Fixtures shall be supported independently of the grid ceiling with at least two $\frac{3}{4}$ inch metal channels spanning and secured to the ceiling tees.
- G. Metal decking shall not be pierced for luminaire support.
- H. Where pendants or rods are longer than 48 inches, brace to limit luminaire swinging.
- I. Brace suspended luminaires installed near ducts or other elements so that they do not swing into obstructions.
- J. Wall mounted light fixtures shall be supported from four-square outlet box plaster ring and from wall at non-feed end with two $\frac{1}{4}$ -inch toggle bolts for gypsum board walls or $\frac{1}{4}$ -inch bolts to pre-set inserts for concrete wall.

3.3 FLUORESCENT FIXTURES

- A. Recessed Type: Support fixtures independent of the ceiling suspension system. Provide four integral tabs (one at each corner) which rotate into position and lock on ceiling tees after fixture is lifted into the ceiling cavity or provide four clips similar to Caddy #535. Provide mounting frames suitable for the ceiling type. In addition, provide slack earthquake safety wire hangers secured diagonally from opposite fixture corners to structural members above suspended ceiling. Comply with Authority Having Jurisdiction.
- B. Wall Mounted Type: Support from four-square outlet box plaster ring and from wall at non-feed end with two $\frac{1}{4}$ inch toggle bolts for gypsum board walls or $\frac{1}{4}$ inch bolts to pre-set inserts for concrete wall.

- C. Fluorescent lighting fixtures shall be switched as shown on electrical drawings. Four-lamp fixtures shown with 2-level switching shall be wired with lamps, 1, 4 and 2, 3 each on separate switch-legs for 2-level switching. Three-lamp fixtures shown with 2-level switching shall be wired with lamps, 1, 3 and 2 each on separate switch-legs for 2-level switching.
- D. If clearance above T-bar system is too restricted to "tip-in" fixture, coordinate with acoustic ceiling installer by leaving one cross T-bar off until the cross T-bar shall be secured into its proper place. Fluorescent fixtures installed in hidden-spline-type ceilings shall have supporting channels installed by Ceiling Contractor to adequately support the fixture without providing additional hangers from the structural ceiling above the suspended ceiling.
- E. Surface Mounted Type:
 - 1. Where mounted on accessible ceilings, support from structural members above ceiling by means of hanger rods through ceiling or as approved.
 - 2. Continuous Runs of Fixtures: Laser sight to insure fixtures are straight and true when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.
- F. Pendant Mounted Type:
 - 1. Provide strong back channel entire fixture length unless light fixture is designed specifically to be self-supporting.
 - 2. Where suspended below accessible ceiling, provide structural support at suspended ceiling level from structural members above ceiling. Do not run hanger rods through ceiling.
 - 3. Continuous Runs of Light Fixtures: Laser sight to insure fixtures are straight and true when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.
- G. Install lighting fixture diffusers only after construction work, painting and clean up are completed.

3.4 HIGH INTENSITY DISCHARGE FIXTURES

- A. Install as for incandescent fixture, except where special provisions are required for ballast arrangement; provide access to ballasts in all cases.
- B. Provide an earthquake chain as noted above for each fixture when fixture is supported by the ceiling suspension system. Provide two chains for units larger than 250 watts or 12" x 24" in dimension.
- C. For fixtures with remote ballasts, isolate ballast from the structure.

3.5 LED FIXTURES

- A. Adhere to manufacturers installation guidelines regarding proper thermal management.

3.6 LIGHTING CONTROL

- A. Provide branch circuiting in coordination with lighting control requirements of specification section describing Lighting Control Equipment and as indicated on Electrical Drawings.

3.7 CLEANING AND ADJUSTING

- A. Remove protective plastic covers from light fixtures and fixture diffusers only after construction work, painting and clean-up are completed. Remove, clean, and reinstall all dirty lamps, reflectors and diffusers.
- B. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer for cleaning Alzak reflectors and other surfaces.
- C. Make final adjustment of aimable light fixtures and adjustable light settings under the direction of the Lighting Designer during a scheduled period of time prior to the completion of the project, after normal business hours if required. Include all equipment and personnel expenses including overtime required for focusing.
- D. Fixtures, reflectors, and accessories which are damaged, blemished, or impregnated with fingerprints shall be replaced at the contractor's expense. All finishes shall be unmarred upon project completion.

3.8 FIELD QUALITY CONTROL

- A. Coordinate all testing procedures and schedule with the specification section describing Commissioning Agent – Demonstration and Training. All testing is to be documented with test procedures, results and initials of witnessing personnel and submitted to Commissioning Agent.
- B. Coordinate inspection and testing of Lighting Fixtures with specification section describing – Lighting Control Equipment.
- C. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- D. Replace all burned out lamps or inoperative lamps at the end of construction prior to Owner occupancy.
- E. Advance Notice: Give dates and times for field tests.
- F. Provide instruments to make and record test results.
- G. Test as follows:
 - 1. Verify proper operation, switching and phasing of each fixture after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation. Verify normal transfer to generator and retransfer to normal.
 - 3. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.
- H. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

END OF SECTION