PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general conditions, Division 26, and Basic Electrical Materials and Methods (Section 260500) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.

B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 SCOPE

A. Provide labor, materials, tools, and equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the equipment of this section, as shown on the drawings and specified herein.

B. Furnish and install complete lighting systems, wired, assembled and operable, except where specifically noted otherwise, which includes but not limited to the following:
1. Luminaires
2. Lamps and ballasts
3. Mounting hardware
4. Accessories as noted
5. Poles
6. Pole bases
7. Anchor bolts and templates
8. Spare lamps

C. The materials and equipment herein specified shall be of new and domestic manufacturer and furnished in accordance with the applicable standards.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary of the work.

1.3 SUMMARY

A. Section Includes:
1. Exterior fluorescent luminaires, lamps, and ballasts.
2. Exterior HID luminaires, lamps, and ballasts.
3. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
4. Luminaire supports.
5. Poles and accessories for support of luminaires

B. Related Requirements:
1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 260936.19 "Standalone Multipreset Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming.
3. Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.4 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. EPA: Equivalent projected area.

D. Fixture: See "Luminaire."

E. HID: High-intensity discharge.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

H. Pole: Luminaire support structure, including tower used for large-area illumination.

I. Standard: See "Pole."

1.5 SUBMITTALS

A. Shop drawings for all fixtures shall be submitted and approved before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the contractor bearing full responsibility and cost. Submit shop drawings per Section 260500 for review, include the following:
1. Luminaires
2. Lamps
3. Ballasts
4. Photometric reports
5. Point-by-point calculations specific to the project.
6. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Submit shop drawings indexed, and in accordance with luminaire identification per drawings. Each item shall be tabbed, clearly identifying the catalog ordering numbers including all optional equipment specified.

C. Luminaire shop drawings shall include the following:
1. Manufacturers report of current and original source. Photocopy of partial data sheet or drawings is not acceptable. Report shall include the following:
a. Ballast type, manufacturer and performance characteristics
b. Lamp type, manufacturer and performance characteristics
c. Finish
d. Reflector system and characteristics

e. Diffuser type and characteristics
f. Weight and dimensions
g. EPA rating
h. Standard manufacturer options
i. Luminaire series and model number
j. Luminaire efficiency
k. Candlepower data table
l. Zonal lumens table
m. IES luminaire classification
n. Maintenance and operating instructions including tools required, types of cleaners to be used and suggested replacement parts list.

2. Photometric data assembled in a standard IES photometric test report.

D. Lamp shop drawings shall include type, dimensions, manufacturer and operating characteristics, including but not limited to:
1. Operating voltage range
2. Color Rendering Index (CRI) value per IES standards
3. Color temperature (in Kelvin)
4. Mounting position
5. Starting temperature, indoor and outdoor
6. Starting/restrike time
7. Lamp life
8. Lamp efficiency
9. Warranty
10. Lamp base
11. Lumen rating

E. Ballast shop drawings shall include type, dimensions, manufacturer and operating characteristic including but not limited to:
1. Ballast operating temperature voltage
2. Total harmonic distortion
3. Ballast starting/restrike time
4. Ballast efficiency factor (BEF)
5. Ballast transformation type (i.e.: autotransformer, preheat, instant-start, rapid start, constant wattage, reactor, trigger-start)
6. UL classification (i.e.: Class "P")
7. Power factor
8. Sound rating (fluorescent only)
9. NEMA rating

F. Product Data: For each pole, accessory, and luminaire-support, arranged as indicated.
1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.

G. Shop Drawings: For each pole, accessory, and luminaire-support, arranged as indicated.
1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.

H. If requested by the Engineer, samples shall be submitted for final selection. Samples shall comply with the following:
1. Paint chips:
   a. Samples shall be provided and approved prior to any release to manufacture.
   b. Samples shall be minimum of 3"x3" and be of exact finishes.
   c. Samples shall be exact representatives of the luminaires:
      1) Priming process
      2) Painting process
      3) Baking process
      4) Finish process
      5) Luminaire material (i.e. sheet metal, aluminum, wood, etc)
   d. Samples shall be labeled with manufacturers color call-out, as well as the paint manufacturers' call-out.
2. Fixtures:
   a. Submit for approval samples called for to the Engineer when and where directed, the components marked with the name of the project, and fixture type, and part number. Fixture shall be provided with a 6' cord and plug, and specified lamp. Allow two weeks from the date of receipt for thorough examination and review by the Engineer.
   b. Fixtures under the contract shall be identical with the approved sample fixture. No fixture used as a sample shall be allowed to be installed on the project.
   c. In the event the submissions are disapproved, the fixtures shall be returned to the contractor to immediately make a new submission of fixture or fixtures meeting the contract requirements.
   d. All charges for these shipments are to be prepaid by the contractor.
   e. Samples shall be provided and approved prior to any release to manufacture.

I. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

J. Delegated-Design Submittal: For luminaire supports.
   1. Include design calculations for luminaire supports and seismic restraints.

K. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

L. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

M. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

N. Operation and Maintenance Data: For luminaires, photoelectric relay, and poles to include in operation and maintenance manuals.

O. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Diffusers and Lenses: One for every 100of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: One for every 20of each type and rating installed. Furnish at least one of each type.
   5. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   6. Pole repair materials.

1.6 FACTORY TESTING

A. Luminaire testing shall be conducted by an approved independent testing laboratory.

B. Luminaire tests shall be reported in accordance with Illuminating Engineering Society (IES) Standard Photometric Test Report.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory accredited under the NVLAP for Energy Efficient Lighting Products.

1.7 QUALITY ASSURANCE

A. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

B. Mockups: For exterior luminaires, complete with power and control connections.
   1. Obtain Architect's approval of luminaires in mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Contractor shall warranty equipment and installation free from defects in material and workmanship for a period of no less than (1) year from the date of project acceptance. This includes the fixture, its finishes and components (see ballasts below).

B. Fluorescent ballasts shall be warranted against defects in material and workmanship for a period of no less than (5) years for electronic ballasts, from the date of project acceptance regardless of the date of manufacture.

C. HID ballasts shall be warranted against defects in material and workmanship for a period of no less than (2) years from the date of project acceptance regardless of the date of manufacture.

D. Provide manufacturer’s warranty covering 5 years on drivers from date of purchase.
   1. LED dimming driver.
   2. 3-Wire (Line Voltage Controlled) Dimming Drivers
   3. Digital (Low Voltage Controlled) Dimming Drivers
   4. Forward Phase Control (neutral wire required) (Line Voltage Controlled) Dimming Drivers

E. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
   2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. Luminaires shall bear the appropriate UL label for location, mounting position and operating conditions in which it is installed.

B. Seismic Performance: Luminaires, foundation, and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.25.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

D. NRTL Compliance: Luminaires shall comply with UL 1598 and be listed and labeled for indicated class and division of hazard by an NRTL.

E. Lamp base complying with ANSI C81.61.

F. Bulb shape complying with ANSI C79.1.

G. Lateral Light Distribution Patterns: Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for luminaires

H. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

I. Luminaires, ballasts and lamps shall each be of the same manufacturer and of identical finish, appearance, and performance. Luminaires which are pre-lamped before shipment shall have identical lamp manufacturer. Mix and match of different lamp manufacturer shall not be acceptable.

J. Recessed ceiling mounted luminaires shall be provided with appropriate frame and trim type compatible with ceiling construction. Reference architectural plans for ceiling construction type and specifications.

K. Luminaires and devices shall be free of burrs, scratches, marks, and dents which may occur during transportation, storage or installation. Construction shall be finished to eliminate sharp edges exposed to installer and end-user.

L. Sheet metal construction of luminaires shall be of sufficient rigidity to prevent deformation during installation and typical use.

M. Cast parts and sections of a luminaire shall be smooth, free of blemishes, rust and scale and be irradiated, sandblasted and anodized.

N. All burned out lamps and ballasts shall be replaced by the end of contract prior to Architect, Owner Representative and Engineer final punchlist.

O. Color shall be as indicated on plans.

P. Enamel paint shall be baked on at a minimum 300 degrees F and have 86% reflectivity for a surface, which is to be reflective.

Q. Housings: Rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use.

R. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

S. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

T. Lenses and Refractors: Materials as indicated. Use heat and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

2.2 LAMPS

A. Fluorescent lamps
1. Unless specified on plans or in Lighting Fixture Schedule, the lamp color temperature shall be 4100 Kelvin (K).
2. Unless otherwise noted, lamps shall have a CRI (color rendering index) of 82 or greater.

B. HID lamps
1. Metal halide lamps shall be phosphor coated and universal burning position type unless otherwise noted. Metal halide lamps shall incorporate a quartz shroud around arc tube to prevent outer jacket rupture in the event of a non-passive arc tube failure.
2. Metal halide lamps shall be of the type with a lifetime color stability within +/- 200K. If not available for the type and wattage specified, metal halide lamps with the best color uniformity as per current industry standards shall be used.
3. Metal-Halide Lamps: ANSI C78.43, with CRI 65 and CCT 4000 K, minimum.
4. Pulse-Start Metal-Halide Lamps: CRI 65 and CCT 4000 K, minimum.
5. Ceramic Pulse-Start Metal-Halide Lamps: CRI 80 and CCT 4000 K, minimum.
6. High Pressure Sodium lamps shall be diffuse coated and universal burning position type unless otherwise noted.
7. High-Pressure Sodium Lamps: ANSI C78.42, with CRI 21, CCT 1900 K, and average rated life of 24,000 hours, minimum.
   ~~a.~~ Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
   ~~b.~~
   ~~c.~~a.

C. Compact Fluorescent

1. Unless specified on plans or in Lighting Fixture Schedule, the lamp color temperature shall be 4100 Kelvin (K).
2. Unless otherwise noted, lamps shall have a CRI (color rendering index) of 82 or greater.
3. Lamp base and fixture socket shall match pin configuration.

D. LED – Light Emitting Diode
1. LED diodes shall be of the type with lifetime color stability within +/- 200K.
2. Diodes, modules, boards, etc. shall conform to IESNA LM70 and LM80 testing and binning standards.
3. LED lifespan, per IESNA LM80, shall be a minimum of 50,000 hours.
4. Unless specified on plans or in lighting fixture schedule, the LED color temperature shall be 4100 Kelvin
5. Unless otherwise noted, lamps shall have a CRI (color rendering index) of 82 or greater.
6. Diodes, modules, and boards shall be replaceable in the field without replacement of housing or fixture.
7. Fixtures utilizing LED sources shall be UL listed and tested for proper heat dissipation.
8. Maximum inrush current of 2 amperes for 120V and 277V LED drivers.
9. Constant current drivers must provide models to:
   a. Support from 200mA to 2.1Amps (in 10mA steps) to ensure a compatible driver exists.
   b. Support LED arrays up to 40W or 50W (710mA to 1.05A in 10mA steps)
10. Constant voltage drivers must provide models to:
    a. Support from 10V to 40V (in 0.5V steps) to ensure a compatible driver exists.
    b. Support LED arrays up to 40W
11. LED drivers shall be integral to fixture.
12. LED drivers shall be dimmable from 100 percent to 0 percent of maximum light output.

E. Acceptable manufacturers
1. Fluorescent Lamps: Osram/Sylvania, 800 XP series
2. Low Pressure Sodium Lamps: Osram/Sylvania or Philips
3. Metal Halide Lamps: Osram/Sylvania, GE or Philips
4. High Pressure Sodium Lamps: Osram/Sylvania, GE or Philips
5. LED drivers: Philips

F. All lamps shall be burned once installed in the fixtures for 100 hours, prior to switching.

2.3 BALLASTS

A. General
1. Ballasts shall be UL listed when installed in luminaire.
2. Ballasts shall be grounded appropriately as governed by CEC Article 410.36(V).
3. Ballasts shall be located within the luminaire for which it is operating unless specifically indicated on plans as remote ballast type.
4. Ballasts shall contain no PCB's in any indoor or outdoor installation unless otherwise noted.

5. Ballasts shall be rated weatherproof type where there is moisture present.
6. A permanent waterproof seal shall be factory provided where the wiring enters the ballast compartment of an outdoor luminaire installation.

B. Solid State Ballasts (Electronic)
1. Electronic ballasts shall meet or exceed ANSI, IEEE, and FCC standards for lamp starting and operation, electro-magnetic interference, radio frequency interference suppression and line transient protection.
2. Electronic ballasts shall not interfere with other electrical equipment normal operation.
3. Electronic ballasts shall operate at a frequency of 20 to 35 kHz with no detectable flicker and be high power factor (97% or higher).
4. Electronic ballasts that operate more than one lamp shall be able to maintain full output of the companion lamp(s) after failure of any combination of lamp(s).
5. Electronic ballasts shall not be affected by lamp failure nor hinder the normal life of operating lamp.
6. Electronic ballast normal case operating temperature shall not exceed 70 degree C.
7. Rapid-start electronic ballasts shall provide soft/stable start of rapid-start lamps and maintain full cathode heat during operation.
8. Electronic ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and bear all applicable UL listings on housing.
9. Exterior ballast shall be rated for cold weather conditions.
10. Designed for type and quantity of lamps served.
11. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
12. Sound Rating: Class A.
13. THD Rating: Less than 10 percent.
14. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
15. Lamp Current Crest Factor: 1.7 or less.
16. BF: 0.88 or higher.
17. Power Factor: 0.95 or higher.
18. Electronic Programmed-Start Ballasts for T8, T5, and T5HO Lamps: Comply with ANSI C82.11 and the following:
    a. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
    b. Automatic lamp starting after lamp replacement.
19. Ballasts for Bi-Level Controlled Luminaires: Electronic type.
    a. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level operation and off.
        1) High-Level Operation: 100 percent of rated lamp lumens.
        2) Low-Level Operation: 30 percent of rated lamp lumens.
    b. Ballast shall provide equal current to each lamp in each operating mode.
    c. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

C. Low-Pressure Sodium Ballasts

1. Low-pressure sodium ballasts shall bear all applicable UL listings on housing.
2. Low-pressure sodium ballasts shall be auto-leakage transformer type.

D. HID Ballasts
1. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
   a. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
   b. Rated Ambient Operating Temperature: 130 deg F.
   c. Lamp end-of-life detection and shutdown circuit.
   d. Sound Rating: Class A.
   e. Total Harmonic Distortion Rating: Less than 20 percent.
   f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   g. Lamp Current Crest Factor: 1.5 or less.
   h. Power Factor: 0.90 or higher.
   i. Protection: Class P thermal cutout.
   j. Instant-Restrike Device: Integral with ballast or solid-state potted module, factory installed within luminaire and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   k. Minimum Starting Temperature: Minus 40 deg F.
2. High pressure sodium ballasts shall be Regulating type with voltage regulation of □10% allowable and shall meet ANSI trapezoid limitations for voltage characteristics over the life of the lamp.
3. HID ballasts shall be fused with manufacturer recommended size and type.
4. HID ballasts shall bear all applicable UL listings on housing.

E. Acceptable Manufacturers
1. Solid state ballasts (electronic): Osram Sylvania or “Quicktronic”.
2. Low-pressure sodium ballasts: Magnetek, Advance Transformer Co. or approved equal.
3. Metal halide ballasts: Magnetek, Advance Transformer Co. or approved equal.
4. High-pressure sodium ballasts: Magnetek, Advance Transformer Co. or approved equal.

2.4 LUMINAIRES

A. General
1. Escutcheon plates, coverplates, and finish trim hardware shall meet flush with ceiling, floor, wall or other surfaces to which they may be mounted.
2. Luminaire construction shall allow initial installation of recessed luminaires without the presence of finish trim, diffusers or lens.
3. Lamp sockets and reflector assemblies shall be securely fastened to luminaire housing to prevent rotation, adjustment or rocking of hardware during lamping or future relamping.
4. Luminaire lenses shall be securely retained in a fashion so that relamping or accessing to luminaire will not dislodge lens.
5. Luminaires lenses and diffusers shall be free from chromatic or spherical imperfections and have thermal characteristics capable of withstanding installed lamp temperatures.

6. Pendant type luminaires shall be mounted to provide balanced construction with the use of swivel hanger. Swivel hanger shall be provided standard or ordered as accessory unless specified otherwise.
7. Bracket type luminaires shall be specifically designed for type installation which is indicated.
8. Luminaires shall be factory tested, prewired and preassembled unless otherwise specified or intended.
9. Luminaires located in direct exposure to the weather to include rain, sleet and snow shall be marked "Suitable for Wet Locations" with UL label. Luminaires located outdoors but not in direct exposure to rain shall be market "Suitable for Damp Locations" minimum rated.
10. Where ceiling space is not accessible, luminaire housing shall provide access to luminaire junction box to comply with CEC section 410.24(B).
11. Luminaires shall contain an integral ballast disconnect compliant with CEC section 410.130(G).
12. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
    a. Label shall include the following lamp characteristics:
        1) "USE ONLY," including specific lamp type.
        2) Lamp diameter, shape, size, wattage, and coating.
        3) CCT and CRI for all luminaires.
13. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
14. Luminaires mounted less than 25’-0” shall contain integral occupancy sensors to facilitate bi-level lighting based upon the presence of pedestrians or vehicles per Title 24 requirements.

B. Fluorescent Luminaires
1. Recessed fluorescent luminaires shall be constructed to limit ballast housing surface temperature in luminaire to 90 degrees C with the following factors:
    a. Voltage: 277V +5%
    b. Room Ambient Temp: 25 degrees C + 5%
    c. Plenum Ambient Temp: 55 degrees C +5%
    d. Ceiling Material R Factor: 20
2. Medium BiPin type lamp socket shall be fastened securely to housing via brackets or straps to eliminate excessive flexing or pressure during normal lamp installation. Socket should be replaceable without removing entire housing.
3. Medium BiPin type lamp sockets without a housing shall be secured with (2) appropriate screws or bolts to prevent misalignment.
4. Fluorescent pin type sockets shall utilize corrosion-resistant "edge-wipe" type contacts.
5. Steel metal fluorescent luminaire housing shall be constructed of die formed, heavy duty, cold rolled steel. Housing shall be welded using lab seam construction and corners mitered and free of burrs, cracks, gouges, scratches.
6. Aluminum fluorescent luminaire housing shall be extruded or die formed in sections, which will positively interconnect to provide a rigid unit when assembled.

7. Steel metal construction of fluorescent luminaires housing shall be ribbed, section or paneled to provide internal structure.
8. Parabolic baffle optic control for fluorescent luminaires shall be semi-specular anodized, of low iridescent and constructed of sheet aluminum. Baffle shall be constructed to ensure rigidity and parabolic contours through interlocking cell assembly.
9. Prismatic lenses shall be of virgin acrylic plastic pattern 12 (0.125 inches thick pre-stressed to span 48-inches) unless specified otherwise on plans.
10. Fluorescent luminaires mounted in accessible ceiling areas shall utilize a plug together modular wiring system. The system shall be installed with all required fittings, plugs, and cord drops for a complete and operating system.
11. Compact fluorescent luminaire shall incorporate an End of Life (EOL) protection device.

C. Low Pressure Sodium Luminaires
1. Low pressure sodium luminaires shall comply with HID luminaire requirements where applicable.

D. HID Luminaires
1. HID luminaires shall be provided with porcelain, screw type mogul sockets UL listed for 1500W or higher at 600 volts where applicable.
2. High-pressure sodium luminaires shall operate ballasts and lamps with lamp in open and short circuit conditions for 6 months without significant ballast life loss.
3. High-pressure sodium luminaires shall operate within 2% of their labeled wattage with a +/-10% variance of input rated voltage. Power factor shall maintain minimum of 85% through life.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 10 gauge.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

2.6 STEEL POLES

A. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.

B. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.
1. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

D. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. Powder Coat: Comply with AAMA 2604.
      a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
      b. Color: As selected by Architect from manufacturer's full range.

2.7 POLE LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, accessories, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 110 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system;

D. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

E. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

F. Mountings, Fasteners, and Accessories: Corrosion-resistant items compatible with support components.
   1. Materials: Will not cause galvanic action at contract points.
   2. Mountings: Correctly position luminaire to provide indicated light distribution.
   3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
   4. Anchor-Bolt Template: Plywood or steel.
   5. Poles located on top of parking structures shall feature hinged bases allowing the pole to be lowered for relamping.

2.8 LUMINAIRE TYPES

A. See Fixture Schedule on electrical drawing.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Any discrepancies with specified luminaire and its proposed use or environment shall be brought to the Engineer's attention as soon as possible.
   1. At project close-out, a list of damaged fixtures received by the contractor shall be provided to the Electrical Engineer for evaluation of fixture manufacturers shipping and packaging methods.

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Examine walls, roofs, canopy ceiling, and overhang ceilings for suitable conditions where luminaires will be installed.

E. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.4 INSTALLATION

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Luminaires shall be installed complete with all accessories, glassware, canopies, sockets, reflectors, optics, wiring devices and supplied with new lamps of the type and wattage indicated on plans or in this specification unless specifically noted otherwise.

D. Concrete Foundations: Construct according to details and drawings.
   1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete.
   1. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

F. Install poles as follows:
   1. Use web fabric slings (not chain or cable) to raise and set poles.
   2. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
   3. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
      a. Fire Hydrants and Water Piping: 60 inches.
      b. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
      c. Trees: 15 feet from tree trunk.
   4. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   5. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
      a. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
      b. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
      c. Install base covers unless otherwise indicated.
      d. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
   6. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.
   7. Secure poles level, plum, and square.
   8. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.

G. All luminaires (where applicable) shall be supported in accordance with ASTM E-580 recommended guidelines for seismic restraint, as well as the latest version of the Uniform Building Code related to lateral and vertical bracing, including but not limited to:
   1. Recessed luminaires shall have a minimum of two (2) #12 gauge wires attached to structure above, independent of ceiling support system.
   2. All lighting fixtures shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100 percent of the lighting fixture weight acting in any direction.

3. Pendant-hung lighting fixtures shall be supported directly from the structure above with #9 gauge wire or approved alternate support without using the ceiling suspension system for direct support.

H. Mount luminaires in mechanical yards, areas and rooms to clear any mechanical equipment, conduit and clearances. Coordinate mounting with mechanical plans.

I. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

J. Coordinate layout and installation of luminaires with other construction.

K. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

L. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.
1. In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

M. Bollard Luminare installation:
1. Align units for optimum directional alignment of light distribution.
2. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

N. Individual Ground-Mounted Luminaire installation:
1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

O. Junction box and ballast compartment shall be accessible from below when housing is installed in final position. Wiring shall be secured from damage when accessed for relamping.

P. Fire rated gypsum board enclosures shall be constructed around all recessed luminaires that penetrate fire rated areas.

Q. Actual locations of luminaires and dimensions shall be referenced to architectural drawings. Electrical plans shall not be used to scale for construction purposes. Any discrepancies shall be brought to the engineer's attention prior to installation.

R. Provide additional junction boxes as required where conductor exceeds factory provided junction box limitations.

S. Installation shall be appropriately coordinated with all disciplines to insure proper ventilation and heat dissipation as required per manufacturer.

T. Where luminaires are served from two sources, a barrier shall be provided to separate emergency source from normal source with notation indicating separate sources.

U. All wall mounted fixtures shall be mounted to a supporting wall bracing material in addition to the junction box. The bracing shall be installed behind the finished wall surface and be secured to structural elements in the wall. The bracing shall be capable of supporting the weight of the fixture and comply with manufacturer's requirements and recommendations.

V. Pendant luminaires shall be mounted in a uniform mounting height and in straight continuous rows. Final coordination with mechanical equipment and plumbing fixtures shall be made in the field to ensure consistent spacing and locations.

W. Luminaire Attachment: Fasten to indicated structural supports.

X. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

Y. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

Z. All exterior wall mounted fixtures shall be sealed watertight between the fixture housing or the canopy and the wall (or structure). Clear silicone caulking (or matching color), shall be used.

AA. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 CONNECTIONS

A. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
   2. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 DELIVERY, STORAGE, AND HANDLING OF POLES

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

B. Package poles for shipping according to ASTM B 660.

C. Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

D. Retain factory-applied pole wrappings on poles until just before pole installation. Handle poles with web fabric straps.

3.7 FIELD TESTING

A. Upon completion of installation, an operation test shall be conducted to show that all equipment operates in accordance with the requirement of this specification.

B. All applicable tests shall be conducted in the presence of an Owner Representative and copies of any reports shall be provided.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

E. Reports shall indicate when and where the test was conducted and who was present.

F. Upon completion of installations, luminaires requiring positioning shall be adjusted and aimed at final position.

3.8 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.9 CLEANING AND REPAIR

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. After complete lighting installation and before project completion, all damaged or faulty lenses or louvers in luminaires shall be replaced by the Electrical Contractor, at no additional cost to the Owner.

C. All anodized or highly visual or optically sensitive reflectors shall be cleaned of all fingerprints and smudges for a clean installation per manufacturer's recommendations.

D. All luminaires with paint scratches, dents or deformations due to installation or shipping shall be repaired, touched up or replaced as required or deemed necessary by the Electrical Engineer at no additional cost to the Owner.

E. Upon final installation of individual luminaires, dirt and debris shall be removed from luminaire enclosures.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION