

SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section provides general requirements for a complete and fully operational Exterior Lighting System including:

- 1. Exterior Luminaires
- 2. Accessories
- 3. Luminaire supports
- 4. Poles
- 5. LED Arrays
- 6. Controls
- 7. Standard Fixture Schedule

- B. Related Sections:

- 1. Section 26 5100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
- 2. Section 26 0519 "Low Voltage Electrical Power Conductors and Cables" for wire and cabling.

1.3 SYSTEM DESCRIPTION

- A. Catalog numbers indicated in the Luminaire Schedule are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of LED, driver, finish trim, mounting hardware or special requirements as specified or as required by the particular installations. Provide complete luminaire to correspond with the features, accessories, number of LED's, wattage and/or size specified in the text description of each luminaire type. Additional features, accessories and options specified shall be included.

- B. Luminaire voltage shall match the voltage of the circuit serving same.

1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.

- D. Luminaire: Complete lighting fixture, LED arrays, including driver housing.
- E. Pole: Luminaire support structure, including tower used for large area illumination.
- F. Standard: Same definition as "Pole" above.

1.5 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 - 1. Basic wind speed of calculating wind load for poles 50 feet (15 M) high or less is 90 mph.
 - a. Wind Importance Factor: 1.3.
 - b. Minimum Design Life: 25 years.
 - c. Wind induced vibration.

1.6 SUBMITTALS

- A. The authorized manufacturer's representative for the Project area shall prepare Submittals for each luminaire type. In addition to the luminaire Submittals, a list shall be provided identifying the manufacturer representative for each luminaire 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.
- B. Product Data shall indicate that luminaire, LED arrays, and drivers fully comply with Contract Documents. Data shall be submitted for each type of luminaire indicated, arranged in order of luminaire designation. For standard catalog luminaires 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 luminaire type, outfitted with LED arrays, drivers and accessories identical to those indicated for the luminaire as applied in the Project.
 - a. Photometric data shall be certified by a qualified independent testing agency.
 - b. Foot-candle map including existing fixtures' contributions
 - 3. Low voltage transformers.
 - 4. LED power supplies.
 - 5. Types of LED's, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
 - 6. Wireless controls: nodes, gateways, modems, and server.
- C. Shop Drawings shall:

1. Show details of nonstandard or custom luminaires.
 2. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
 3. This Contractor shall provide the manufacturer with accurate field dimensions where required.
 4. Include wiring diagrams, power and control wiring.
- D. Wiring Diagrams shall detail wiring for luminaires and differentiate between manufacturer-installed and field-installed wiring.
- E. Product Certificates shall be signed by manufacturers of luminaires certifying that products comply with requirements.
- F. Maintenance Data shall be provided for luminaires and equipment to include in emergency, operation, and maintenance manuals Specified in Specifications Section describing Operations and Maintenance Data.
- G. Field quality control test reports.
- H. Special Warranties Specified in this Section.
- I. 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. This Contractor shall field verify voltage and actual mounting condition and method.
- J. Product samples complete with housing, trim, specified lumen package, and 8' cord with plug for 120 V shall be submitted if requested.
- K. Pole and Support Component Certificates: Signed by Manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a Professional Engineer.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.
1. Provide a list of all driver types used on Project; use ANSI and manufacturers' codes.
 2. Submit site map showing dimensioned locations all exterior lighting fixtures and poles with tags consistent with the University's standard naming convention. Also show stubbed-out spare conduits, in-ground junction boxes, and underground sleeves. Indicate dimensioned locations of sleeve ends, conduits, and junction boxes from a permanent building or landscape feature. Circuit numbers for all loads shall be shown. Electronic files of site lighting maps be provided at Substantial Completion and submitted to the Electric Shop.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Glass, Plastic Diffusers and Lenses: 10% or one dozen (whichever is less) of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: 5% of each type and rating installed. Furnish at least one of each type.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Package poles for shipping according to ASTM B 660.
- B. 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.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle with web fabric straps.

1.10 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. 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.
- C. Comply with IESNA TM-15-11 and Addendum A for Backlight, Uplight, and Glare (BUG) ratings.
- D. Comply with ANSI C7.3777.208 Standards for chromaticity of SSL products.
- E. Comply with NFPA 70.
- F. All luminaires shall bear a UL or ETL label.
- G. Comply with IEEE C2, "National Electrical Safety Code."
- H. Comply with most current edition of the Northwestern University Design Standards.
- I. Designated manufacturers are listed in the Luminaire Schedule to define the requirements for quality and function of the specified product.

1.11 COORDINATION

- A. Coordinate layout and installation of luminaires with plantings, paving, site walls, other site work elements, and existing luminaires.
- B. Coordination Meetings: This Contractor shall meet at least twice with the sitework installer(s) and NU Chief Electrician (or his designee). Hold first meeting before submittal of shop drawings to coordinate each luminaire mounting condition and location. During second meeting, coordinate layout with other site components. Coordinate depth and location of all luminaire pole bases in all areas.

1.12 WARRANTY

- A. Comply with Division 1 requirements.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products 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 specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Fixture, including the LEDs, drivers and electrical components: Ten years from date of Beneficial Occupancy.
 - 2. Warranty Period for housing paint and finish: Ten years from date of Beneficial Occupancy.
 - 3. Warranty Period for Color Retention: Ten years from date of Beneficial Occupancy.
 - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less ten years from date of Beneficial Occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings and/or the Schedule at the end of this document.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to Authorities Having Jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Comply with IESNA TM-15-07 Luminaire Classification System for Outdoor Luminaires.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit easy replacement of drivers. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- I. Light Shields: Baffles made of metal or similar sturdy material, field installable and adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Optical assemblies: where specified, full cutoff with zero uplight, "dark sky" compliant. LED assemblies shall comply with IESNA BUG rating system.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 90 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses in luminaire doors.
- M. Luminaires utilizing internal refractors are not allowed.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Finish: premium 5 stage TGIC polyester powder coat paint minimum 2.5 mils thick, applied to factory-assembled and -tested luminaires before shipping. Where indicated, match the finish process and color of pole or support materials.
 - a. Color: See Luminaire Schedule.
- O. Decorative Fixtures:
 - 1. Shall have minimum 74 lumens per watt.
- P. Outdoor Wall Mounted Area Luminaires
 - 1. Shall have minimum 90 lumens per watt.
 - 2. No more than 48% of the total luminaire output shall be within the forward 60-80° zone.
 - 3. No more than 3% of the total luminaire output shall be in the forward 80-90° zone.
 - 4. No light at or above horizontal 90-180° zone.
- Q. Canopy Luminaires
 - 1. Shall have minimum 100 lumens per watt.
 - 2. At least 30% of total luminaire output shall be within the 40-60° zone.
 - 3. No more than 20% of total luminaire output shall be above the 80° zone.

2.3 LED DRIVERS AND ARRAYS

- A. UL 1598 listing.
- B. LED arrays shall have LED's that produce minimum 80 lumens/watt @ 525mA.

1. Lumen Depreciation Data: maintain greater than 95% lumen maintenance at 60,000 hours per IES TM-21.
 2. LED color: neutral white, 4000 deg K, minimum CRI of 70, or as scheduled on the drawings.
- C. LED arrays shall have an IP66 enclosure rating.
- D. Driver + LED Life Rating not less than 100,000 hours.
- E. Power supply / driver shall be field replaceable by means quick-disconnect connectors and easy access mounting hardware.
- F. Drives shall accept 120 – 277 volts or 480 volts, 60 Hz.
- G. Power Factor > 0.9@ full load.
- H. THD < 20% @ full load.
- I. Surge protection: 10kA/10kV per ANSI/IEEE C136.2-2014
- J. The housing shall have an integral thermal management system with extruded aluminum radiation fins and lateral airways for passive cooling, no devices using moving parts are permitted.
- K. Minimum starting temperature: minus 30 deg C, 40 deg C ambient.
- L. Comply with IES LM-79-08 and LM-90-08 Approved Methods.
- M. Comply with In-Situ testing for more reliable results.
- N. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.

2.4 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Compatible with 7 – pin socket.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 1. Adjustable window slide for adjusting on-off set points.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
 - C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 3. Anchor-Bolt Template: Plywood or steel.
 - D. Handhole: Minimum clear opening of 2-1/2 by 5 inches with cover secured by stainless-steel captive screws.
 - E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Concrete Sections.

2.6 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Aluminum Alloy 6063-T6, unless noted otherwise, and access handhole in pole wall.
 1. Shape: Refer to Luminaire Schedule or shall match existing site poles.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation.
- B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, and then bolted together with stainless-steel bolts.
 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 2. Finish: Match pole and luminaire material and finish.
- E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Finish designations prefixed by "AA", comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Finish: Premium five (5) stage TGIC polyester powder coat paint.
 - a. Color: As selected by Architect from manufacturer's full range or to match existing adjacent poles.

2.7 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- B. Fusing: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by driver manufacturer. Fuseholders shall be completely waterproof and shall grip the fuse in the load side section when opened. The circuit shall be fused in the base of the pole and accessible through the handhole.
- C. Banner Arms: Use shall be approved by NU Chief Electrician. Coordinate with manufacturer for maximum banner size limitations to avoid banner arm or pole failure. Banner arms shall be break-away type designed to fail before over stressing the pole.
- D. Wind Mitigation Devices: Provide in areas of consistent, high, uneven winds.
- E. Duplex Receptacle: In central areas of congregation, provide a NEMA 5-20R Duplex Receptacle in a weatherproof assembly complying with Section 26 2726 "Wiring Devices" for ground-fault circuit-interrupter (GFCI) type.
 - 1. Recessed, nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, color to match pole, with cord opening, that when mounted results in NEMA 250, Type 3R enclosure mounted 36" above finished grade. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
 - 2. Where noted, provide minimum 1800-W transformer, 120V secondary, protected by replaceable fuses, mounted behind access cover.
- F. Outdoor Wireless Controls: Where noted, provide wireless controls for remote monitoring, control, energy measurement and GPS mapping of pole mounted exterior luminaires.
 - 1. Products: "Light-Grid™" Outdoor Wireless Control System by General Electric.
 - 2. Basic Description: system consists of the following components:
 - a. Node
 - b. Gateway
 - c. Modem
 - d. Central Management System server
 - 3. Functional Performance: Gateway shall receive real time data from each Node. Transmitted messages shall include voltage, current, power factor, wattage, and hours of operation. Gateway shall automatically transmit the status of each luminaire along with a unique code that identifies the transmitting station to the Central Management System (CMS) via modem.
 - 4. Provide network communications for the system according to manufacturer's written requirements. Coordinate remote communication module package with the University's SCADA system for successful transmission and remote readout of monitoring data and luminaire control.
 - 5. Furnish each luminaire with a 7-pin twist lock receptacle for connection to controls. Provide weather tight shorting cap when controls not in use.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. 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.
 - 1. Provide house side shields where necessary to control spill light.

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Concrete Sections.
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
 - 2. Install base covers unless otherwise indicated.
 - 3. 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.
- E. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD AND INDIVIDUAL GROUND MOUNTED LUMINAIRES

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard 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 Division 3 Concrete Sections.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 0533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
 - 3. Provide a continuous grounding conductor in all exterior lighting circuits.

3.6 CONNECTIONS

- A. **[Outdoor Wireless Control Systems: Provide all communications wiring between remote metering and control modules and the University's SCADA system. Verify that each luminaires' address for communication packages corresponds to data network requirements.]**

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Replace all burned out or inoperative LED arrays at the end of Construction prior to University occupancy.
- C. Advance Notice: Give dates and times for field tests.
- D. Provide instruments to make and record test results.
- E. Test as follows:
 - 1. Verify proper operation, switching and phasing of each luminaire 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.
- F. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- G. Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

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1. Verify operation of photoelectric controls.
2. **[Verify operation of wireless controls, test send and receive data/commands between luminaires and CMS.]**

H. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - b. IESNA LM-72, "Directional Positioning of Photometric Data."

- I. 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. Submit Electronic files of site lighting maps to the Electric Shop.

Northwestern University Standard Fixture Schedule

Type	Description	Volt	Lamp	Fixture Watts	Manufacturer	Series
S1	Standard Walkway Fixture. Post-top contemporary lantern fixture. Globe: one piece satin clear polycarbonate. Guard: 356 cast aluminum, one piece, with four arms. Cast AL heat sink. IES Type III optics. 90% PF electronic driver. Tenon mounted GE motion response sensor, black finish.	M-volt Universal auto adjusting	48 White LED Module 4000 K	81	Philips - Lumec	L80 – 020 - 80W48LED4K – T – PC – CS - LE3 – 277 – DMG – SF80 – RCD7 - BKTX
S1 Pole	Four inch round extruded 6061-T6 AL pole with 4-1/2" x 10" maintenance opening 25-1/4" from the bottom of the anchor plate with receptacle –in-door option, duplex 15A-120V GFI receptacle with lockable W-I-U cast AL door. Black textured polyester powder coat finish.	—	—	—	Philips - Lumec	RA61U – 12 – FS1 – GFI – M - BKTX

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