

SECTION 02926 - HIGHWAY ILLUMINATION MATERIALS

(Follow all instructions and make all edits with "Track Changes" turned on. If there are no instructions [purple text] above a subsection, paragraph, sentence, or bullet, then include it in the Project. Delete all purple text before preparing the final document. All other modifications to this Section will require ODOT Technical Resource and State Specifications Engineer approval.)

Replace Section 02926 of the Standard Specifications except for the Section number and title with the following:

Description

02926.00 Scope - In addition to all applicable portions of AASHTO Roadway Lighting Design Guide (2018) and Recommended Practice for Lighting Roadway and Parking Facilities (ANSI/IES, RP - 8, 2025), this Section includes the requirements for Highway illumination installations.

Materials

02926.01 Materials - Furnish and install hardware with hot-dip galvanized or Type 304 or 316 stainless steel screws, bolts, nuts and washers. Furnish bolts and screws with square or hex heads. Allen head fasteners are not allowed.

Cabinets and Control Devices

02926.40 Cabinets - Construct all cabinets from 12-gauge Type 304 stainless steel, or 10-gauge sheet steel and hot-dip galvanize after fabrication according to 02530.70. Furnish weatherproof post mount cabinets, rated as NEMA type 3R, and constructed as shown.

With 3 phase electrical system or main circuit breaker of 200 amp or higher, install pad-mount cabinet as shown. Furnish a NEMA type 3R, with hinged double door, 3-point lockable vault handles and stainless steel hardware. Cabinet size is 48 inches x 63 inches x 18 inches deep, or as shown.

Complete the internal wiring of cabinets by a UL listed facility. Furnish cabinets according to one or more of the following standards where appropriate:

- UL 50, Cabinets and Boxes
- UL 67, Panelboards
- UL 869A, Service Equipment

Use a welded conduit hub to make conduit entrances into cabinets. Furnish hubs of the size required and securely weld to the cabinet before galvanizing. Malleable iron screw on hubs may be used as approved.

Furnish power service cabinets with live parts exposed having a dead-front panel installed with cutouts for operating handles. Furnish a minimum of two holding latches on each dead-front panel to maintain rigidity of the panel.

Construct the dead-front panels of stainless steel or code-gauge galvanized steel and treat all cut galvanized steel edges with zinc-rich paint. Prime galvanized steel dead-front panels with vinyl wash primer and finish with exterior polyurethane enamel. The finish color of galvanized steel is aluminum.

In all outdoor locations, mounting pans are required when circuit breakers, contactors, relays, switches, transformers or other types of electrical Equipment are to be mounted inside the cabinet.

Label circuit breakers and Equipment with an engraved permanent label on the dead-front panel to indicate the circuit controlled.

Furnish each cabinet with a latching device for a standard Agency padlock.

Make the meter base from 16-gauge galvanized sheet steel (G90), and powder coated inside and out after fabrication, or from 16-gauge Type 304 stainless steel sheet.

02926.41 Circuit Control Devices:

(a) General - Install circuit breakers, the copper neutral block, and contactors as shown.

(b) Circuit Breakers - Furnish circuit breakers having the voltage rating and number of poles shown or specified with an interrupting rating meeting or exceeding short circuit rating of the specified electrical system.

Furnish circuit breakers that are UL 489 conformed, thermal magnetic molded case circuit breakers and bolt on type with individually insulated and protected terminals, suitable for surface mounting in the cabinet on a false back or bracket.

Furnish 100 A frame breakers that are Class 13a for single pole breakers and Class 18a for multiple pole breakers. Furnish 225 A frame breakers that are Class 20a in Federal Specification W-C-375B, table "Classification of ratings".

Install overcurrent protection and relay Equipment, as shown or specified, with Materials and installation according to the NEC.

(c) Multiple Light Contactors - Furnish contactors that are lighting type specifically rated for high intensity discharge type lamp loads, electrically held and have a 600 V rating. Furnish multiple light contactors that are unenclosed single phase, two- or three-pole, open type lighting contactors of the rating shown or specified. Construct contactors for surface mounting on a false back or bracket within a weatherproof cabinet. Ensure the contactor coil operates on 120 V for 240 V circuits and 240 V, 208 V, and 277 V for 480 V circuits.

(d) Test Switch - Furnish and install a 277 V AC rated test switch in the control cabinets if shown. Furnish a heavy-duty single pole switch or circuit breaker rated at 15 A. Install the test switch in the control cabinet as a Roadway lighting test switch. Wire the switch to shunt the photoelectric relay power contactor and energize the lighting circuit contactors.

(e) Photoelectric Relay - Attach the photoelectric relay to a three-pole locking receptacle by a twisting motion.

Furnish a photoelectric relay with a built-in surge protective device for protection from induced high voltage and follow through currents. Furnish a relay meeting or exceeding the requirements of ANSI C136.10. Furnish factory set turn-on lights that are 1.4 footcandle $\pm$ 0.2 footcandle at 120 V AC. When operated at 240 V AC, turn-on is not allowed to change more than plus or minus 0.3 footcandle from the 120 V value. Maximum off to on ratio is 1.5:1.

Furnish a cadmium-sulfide photocell encapsulated for humidity protection, or a silicon junction type photo-transistor for the photoelectric relay.

Normal operation is for dual voltage operation of 105 V - 285 V, 60 Hz.

The allowed power consumption of the relay is less than 1 W. At the designated voltage, ensure the photoelectric relay is capable of controlling a minimum HID or LED luminaire load of 1000 W. Minimum operating temperature range is from -40 °F to 150 °F.

Prevent false turn-offs by transient light conditions by furnishing a time-delay control circuit. Provide a fail safe circuit for the lighting load to remain on or become energized if any functional failure of the photoelectric control circuit occurs.

(f) Electrical Splice Materials - Furnish electrical splice materials meeting the following requirements:

- **Split bolt** - Made of silicon bronze to securely join the wires both mechanically and electrically.
- **Heat-shrink tubing** - Split-resistant and adhesive-lined tube made of polyolefin complying with UL 224 or UL 486D, temperature range -67 °F to 230 °F, with 600 V rated inner melting wall or liner to provide void-free encapsulated insulation.
- **Insulating rubber tape** - Electrical grade, nondrying, rubber based, elastic type complying with ASTM D4388.
- **Insulating vinyl plastic tape** - Low temperature (0 °F) resistant, vinyl chloride plastic, electrical insulating tape with pressure-sensitive adhesive. Comply with ASTM D3005.

Lamps, Ballasts, and Luminaires

02926.50 Illumination Lamps - Furnish all high-pressure sodium lamps according to ANSI standards. Furnish all lamps of the same size and type, on a single project, from the same manufacturer's lot number.

Furnish all lamp bases having a brass mogul base mounting with dating system.

Furnish lamps that have an average minimum initial lumen rating (after 100 burning hours) and an average minimum lamp life (based on 10 hours per start) as follows:

		Minimum	Lamp	Minimum
Lamp		Initial	Lumens	Average
Watts	ANSI Code	Vertical	Horizontal	Lamp Life
High-Pressure Sodium - Clear				
70	S62ME-70	6,300	6,300	24,000
100	S54SB-100	9,500	9,500	24,000
250	S50VA-250/S	29,000	29,000	24,000
400	S51WA-400	50,000	50,000	24,000
1,000	S52XB-1000	140,000	140,000	24,000

02926.52 Ballasts - Furnish high-pressure sodium ballasts that are magnetic regulator (lag type regulator) with primary and secondary windings electrically isolated from each other.

Unless otherwise shown or specified, the ballast is an integral part of the luminaire unit. Furnish prewired, built-in type mounted in the luminaire.

Provide a manufacturer's nameplate on the ballast housing. Include the manufacturer's name, model number, serial number, hook-up diagram, power supply data, lamp type and operating wattage on the nameplate.

Furnish ballast that operate the lamp within the limits specified below throughout the rated life of the lamp:

- Does not vary the lamp wattage more than the allowable range shown in the table below over the line voltage variation shown.
- Does not vary the lamp wattage more than plus or minus 5 percent of nominal when the lamp is at its rated nominal voltage (high-pressure sodium lamps only).
- The minimum efficiency of the ballast (nominal lamp watts/line watts) is not less than shown below.
- The ballast does not allow the lamp arc to extinguish when a line voltage dip as shown below occurs for several seconds.
- The power factor does not drop below 90 percent for the line voltage variation shown below.
- The line starting current does not exceed normal line operating current.
- The ballast starts and operates the lamp in ambient temperatures down to -20 °F.
- The lamp current crest factor does not exceed 1.8 for line voltage variation shown below.
- The ballast conforms to all ANSI Standards.
- The ballast has capacity to operate dual-arc tube lamps as well as standard lamps without modification of the luminaire.

Submit for review ballast electrical data and lamp operating volt-watt traces for nominal and ± 10 percent rated line voltage for each type of high-pressure sodium lamp ballast.

Lamp	Lamp	Line	Allowable	Allowable	
Type	Wattage	Voltage	Lamp Watt	Minimum	Line
	Range	Variation	Variation	Efficiency	Voltage Dip
HPS	70 - 100	± 10%	± 10%	70%	40 - 50%
HPS	150 - 400	± 10%	± 10%	78%	40 - 50%
HPS	1,000	± 10%	± 10%	92%	40 - 50%

Unless otherwise shown or specified, operate ballasts on 240 V or 480 V. When 120 V operation is specified, furnish a multi-voltage type ballast with taps to allow the ballast to be connected to 120 V, 208 V, 240 V, or 277 V.

02926.53 High-Intensity Discharge Luminaires:

(a) General - Furnish conventional Roadway luminaires for horizontal slip fitter end mounting.

Furnish luminaires with a cast-aluminum housing and attach to 2-inch pipe tenons on mast arms. Ensure the luminaire attachment fitting provides for a minimum of plus or minus 3-degree adjustment of the luminaire in the vertical direction. Furnish reflectors for all luminaires that are snap-on or easily removed design manufactured of polished aluminum or molded from prismatic formed borosilicate glass. Mount the refractor in a door frame assembly hinged to the luminaire and secured in the closed position by means of an automatic latch or a draw latch. The refractor and doorframe assembly, when closed, exert pressure against a gasket. Furnish gaskets composed of material capable of withstanding the temperatures encountered and that are securely held in place. Furnish glassware that is of the refractor type with prisms.

Stamp or label reflectors and refractors provided with the luminaire with a part number. Indicate the reflector and refractor part number used on the luminaire photometric submittal (isocandela diagrams).

Secure luminaire components to the luminaire frame with corrosion-resistant mounting hardware. Furnish a weather tight housing, complete with integral ballast.

If sand-cast, leave the aluminum housing in its natural finish. If die-cast, give the housing a coat of aluminum paint.

Form refractors from heat-resistant, high-impact, molded borosilicate glass.

Furnish lamp sockets that are adjustable to obtain the light distribution shown or specified.

Seal socket opening with a heat-resistant filter or filtering gasket to prevent the entry of dirt, insects or moisture into the optical system.

Furnish a sufficiently rigid socket mounting mechanism that upon application of a 2-pound load in any direction on the light source center, the light source center does not deflect more than 1/16 inch.

(b) Classification of Luminaire Light Distribution - Furnish the following distribution types as shown or specified. Ensure the classifications listed conform to ANSI definitions.

(1) Vertical Light Distributions - Divide vertical light distributions into three groups: short (S), medium (M), and long (L). Classification of the three groups depends on the maximum candle power point within a grid area according to the ANSI/IES RP-8 (2018) publication.

(2) Lateral Light Distributions - Lateral light distribution patterns have the following designations:

_____	Type I
_____	Type II
_____	Type III
_____	Type IV
_____	Type V

Ensure the type designations listed above conform to ANSI definitions.

(3) Distribution Above Maximum Candle Power - Use this classification to control the candle power in the upper portion of the beam above the maximum candle power. Use the following three classifications:

_____	Cutoff
_____	Semi cutoff
_____	Noncutoff

Ensure the classifications listed above conform to ANSI definitions.

02926.54 LED Luminaires:

(a) General Performance Requirements:

(1) General - Furnish each LED luminaire as a complete lighting unit manufactured according to ANSI C136.37 2011 and utilizing high power LEDs as the light source.

Assemble and pre-wire all internal components using modular electrical connections. Install wiring, grounding, and terminal blocks according to ANSI C136.37. Furnish luminaires that accept a designated voltage range of 50 to 60 Hz and operate normally with an input voltage that is within 10 percent of the specified voltage.

(2) Finished Surface - Furnish LED luminaires with a gray or silver housing with the surface UL listed for wet locations (UL 1598). After 1000 hours of salt chamber exposure, according to ASTM B117, provide a luminaire surface that exceeds a rating of 6 for rust creepage for scribed specimens according to ASTM D1654.

(3) Thermal Management - Furnish luminaires that start and operate in the ambient temperature range specified. Furnish heat sink fins with a mechanical design that facilitate hose down cleaning and discourage debris accumulation.

Clearly indicate in submittals liquids or moving parts (such as fans), consistent with product testing, and subject to approval by the Engineer.

(4) LED Driver Requirements - Furnish LED driver meeting the following minimum requirements:

- Rated to operate in -40 °C to 40 °C ambient temperature
- Total harmonic distortion (THD) to be less than 20 percent
- Have minimum power factor of 90 percent
- Comply with requirements of UL, CSA, and FCC regulations in 47 CFR Part 15
- Rated for outdoor operation and have an ANSI/IEC rating of IP66

Furnish a dimmable driver for each high-mast, Highway/street lighting luminaire, including ornamental lighting and intersection lighting on signal systems, with two leads to accept standard 0 10 V (DC), except on the luminaires of 100 watts or less. Furnish a dimming control compatible with IEC 60929 with a circuit that defaults to 100 percent power if the control leads are open or the analog control signal is lost. Identify all conductors and terminals.

(5) Electrical Parts and Safety Testing - For each luminaire, except ornamental, underdeck, and wall mount luminaires, furnish an ANSI C136.41compliant, 7 pin receptacle that is fully prewire for the LED driver's control. For 0 10 V dimmable LED drivers, connect control wires to the receptacle pads as specified in ANSI C136.41.

When the photo control is required, furnish and install a specified photo control unit with the specified driver on each LED luminaire. If the photo control is not required, install a shorting cap on each luminaire, as directed by the Engineer.

Furnish luminaires according to ANSI C136.2 for electrical immunity, using the combination wave test level of 6 kV/3 kA. Furnish luminaires that comply with interference criteria for Class A digital devices according to FCC regulations in 47 CFR Part 15.

(6) Identification and Labeling - Furnish luminaires with internal and external labels according to ANSI C136.15 and ANSI C136.22.

(7) Surge Protection - Furnish a surge protection device (SPD) to protect LED drivers and LED lighting arrays from electrical transients that is recognized according to UL1449 and rated for 10 kV/5 kA combination wave surges according to ANSI/IEEE C62.41.2. Furnish a SPD that complies with FCC regulations in 47 CFR Part 15, Subpart B for the emission of electronic noise.

(8) Maximum Power Consumption - For the control of trespassing light and glare, the following maximum power consumption values are allowed on ODOT standard pole mounting for State Highways:

<u>Mounting Height</u> <u>(ft.)</u>	<u>Maximum Wattage in</u> <u>LED Luminaire</u>
<u>25.0 to < 30.0</u>	<u>100</u>

30.0 to < 35.0, or when replacing 150-watt HPS	120
35.0 to < 40.0, or when replacing 200/250-watt HPS	200
40.0 to 55.0, or when replacing 310/400-watt HPS	300
Each LED luminaire in high mast tower	500

(b) LED Luminaire Types - For each type of LED luminaire shown, furnish luminaires according to the general performance requirements in 02926.54(a) and the following:

(1) LED Luminaires on Traffic Signal Supports - When furnishing an LED luminaire model that is not specified as approved, meet the following general requirements:

Minimum luminaire efficacy: 115 lumens/watt (LPW)
 Nominal input power: 110 - 136 watts
 Nominal input voltage: 240 volts
 Minimum lumen output: 14,000 lumens
 Minimum lumen maintenance at 50,000 hrs.: 86% of initial lumens
 Nominal CCT (Correlated color temp.): 3000 or 4000 $\pm$ 250 °K
 Color Rendering Index (CRI)..... $\geq$ 70
 BUG rating: B3-U0-G3
 Nominal type of output pattern: Type 3 Medium
 Maximum luminaire weight: 30 lb.
 EPA: 0.5 – 0.9 sq. ft.
 Mounting method: 2 inch tenon as shown
 Vibration: 3G vibration test
 Thermal: -40 – 40 °C operation
 Photo control receptacle: ANSI C136.41, 7-pin
 LED driver: 0-10 V dimmable

(2) LED Luminaires on Freeway Interchange Lighting Systems - When furnishing an LED luminaire model that is not specified as approved, meet the following general requirements:

Minimum luminaire efficacy: 117 lumens/watt (LPW)
 Nominal input power: 180 - 214 watts
 Nominal input voltage: 240 volts
 Minimum lumen output: 24,000 lumens
 Minimum lumen maintenance at 50000 hrs.: 86% of initial lumens
 Nominal CCT (Correlated color temp.): 3000 or 4000 $\pm$ 250 °K
 Color Rendering Index (CRI): $\geq$ 70
 BUG rating: B3-U0-G3
 Nominal type of output pattern: Type 3 Medium
 Maximum luminaire weight: 30 lb.
 Maximum EPA: 1.0 sq. ft.

Mounting method:..... 2 inch tenon, as shown
Vibration: 3G vibration test certified (ANSI C136.31)
Thermal: -40 – 40 °C operation
Photo control receptacle:..... ANSI C136.41, 7-pin
LED driver:..... 0-10 V dimmable

(c) Submittals - Before beginning LED luminaire installation, submit the following according to 00150.37 for review by the Engineer:

- Four copies of LED luminaire manufacturer's data sheets, including light source, drivers, surge protection device, and installation instructions.
- For the dimmable LED driver specified, diagrams illustrating light output and input power as a function of control signal.
- IES LM-79 luminaire photometric reports produced by the test laboratory, that satisfy LED Lighting Facts accreditation requirements. Include the name of the laboratory, report number, date, luminaire catalog number, luminaire description, and backlight uplight glare (BUG) ratings.
- Submit lumen maintenance calculations and supporting data according to LED lighting facts guidance. Submit computer generated photometric analysis and calculation of maintained light levels according to IES RP 8, Roadway lighting. use a light loss factor (LLF) of 0.8 or less, according to the individual luminaire test report data. Do not use the Mesopic multipliers of effective luminance factors for calculation.
- IES format electronic file containing luminous intensity data associated with submitted LM 79 reports and used for point-by-point calculations.

Within 21 Calendar Days after receipt of submittals, the Engineer will review the submittals and designate them in writing as “approved”, “approved as noted”, or “returned for correction”. Do not begin LED luminaire installation before receiving written approval of submittals from the Engineer.