ITEM 686
ROAD ILLUMINATION ASSEMBLIES
(ON TRAFFIC SIGNAL POLES)

686.1 Description. This Item governs the materials, composition and quality of Light Emitting Diode (LED) luminaires used as equivalents to the 400-W, high-pressure sodium (HPS), "cobra-head" style roadway illumination light fixtures (luminaires) in conjunction with traffic signal projects as shown on the drawings. The term "assembly", as used herein, shall constitute the complete assemblage of parts, equipment and miscellaneous items, except foundation, erected as provided in the drawings and in accordance with these Standard Specifications, forming a complete and independent lighting unit.

All materials furnished, assembled, fabricated or installed under this Item shall be of the latest design and in strict accordance with the details shown on drawings. Materials and equipment shall comply with the applicable provisions of the National Electrical Code and National Electrical Manufacturers Association Standards.

Poles and mast arms shall be designed to carry the luminaire described herein, and shall meet the applicable requirements of the Standard Traffic drawings.

686.2 Material Requirements.


Rate luminaire for operating at ambient temperature between -40 and 40°C.

Provide external label per ANSI C136.15.

Provide internal label per ANSI C136.22.

Do not place fuses in pole-mounted luminaires. Provide wall- or underpass-mounted luminaires with internal 10-amp, time-delay fuses and fuse holders.

Provide internal label or marking with date code of when fixture was manufactured.

Request approval from the County before making any changes to construction, materials, or components in the luminaire. Do not make changes to the luminaire until approved by the County.
B. Housing. Provide luminaire housing, lens frame, and door constructed from 96% copper-free aluminum. Provide for luminaire mounting to a 2-in. pipe arm, capable of adjustments ± 5° from level. Meet ANSI 136.31, 3.0 G vibration requirements.

Equip luminaire with a three-prong ANSI C136.10 rotatable photocell receptacle and shorting cap.

Paint luminaires light gray with initial gloss in the range of 30–60% (semi-gloss) when installing on galvanized poles. For all other poles, paint luminaires to match the color of the pole as directed. Use a thermoset powder-coat paint system. For pre-qualification, document that the coating meets the following:

- Exceeds a rating of six per ASTM D 1654 after 1000 hr. of testing in accordance with ASTM B 117; and
- Exhibits no greater than 30% reduction of gloss per ASTM D 523, after 500 hr. of QUV testing at ASTM G 154 Cycle 6. Cycle 6 uses UVA-340.

Fabricate exposed hardware, nuts, bolts, washers, and metal parts from stainless steel or aluminum of adequate thickness as approved.

Attach a level indicator to the fixture housing. Ensure that indicator is sensitive to 1° changes in position at any point within 5° of the level position. Ensure that indicator is clearly visible from the ground up to a 50-ft. mounting height. Ensure that indication of level corresponds to level position of fixture.

Ensure weight of the luminaire is less than 60 lb. and the effective projected area is less than 1.6 sq. ft.

Provide a barrier-type terminal block secured to housing for power connection to luminaire in accordance with ANSI 136.14 and ANSI 136.37. Provide lugs with screws for wire sizes up to 6 AWG. Identify each terminal position.

C. LED Drivers. Provide luminaire with replaceable LED driver that will operate at 120 V, 240 V, or 480 V line voltages as shown in the plans. For pre-qualification, provide summary of reliability testing performed for LED driver(s). Provide LED drivers meeting the following specifications:

- Rated case temperature suitable for operation in the luminaire at ambient temperature of -40 to +40°C;
- Power factor (PF) of at least 0.90 at full input power at the specified voltage;

- Rated life expectancy of 100,000 hr. at rated operating temperature inside the luminaire;

- Reduced output power to LEDs if maximum allowable case temperature is exceeded;

- Tolerates sustained open circuit and short circuit output conditions without damage; and

- Potted or rated IP 66 if exposed to the environment.

D. LED Optical Assembly. Provide LED optical assembly with nominal color temperature of 4000K. For verification testing, CCT within the range of 3710K–4260K is allowable.

Provide LED optical assembly with a minimum CRI of 70.

Provide a passive thermal management system. Do not use fans or other mechanical cooling systems.

E. Surge Protective Devices. Provide luminaire with a surge protective device (SPD), in addition to driver’s internal protection, to withstand repetitive noise transients from utility line switching, nearby lightning strikes, and other interference. Provide SPD that will protect the luminaire from common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 10 kA (minimum). Provide SPD tested in accordance with ANSI/IEEE C62.45 per ANSI/IEEE C62.41.2 Scenario I Location Category C-High for Line-Ground, Line-Neutral, and Neutral-Ground. Provide SPD listed or recognized by a NRTL to UL 1449, 3rd edition. Test luminaires at a test lab accredited by American Association for Laboratory Accreditation (A2LA) for Electrical Fast Transient (EFT) and Surge Immunity. Provide test reports for 120 V, 240 V and 480 V luminaires, showing the fixture can survive the following tests.

1. Testing. Perform Electrical Immunity Tests 1, 2 and 3, as defined by their Test Specifications, on an entire powered and connected luminaire, including any control modules housed within the luminaire but excluding any control modules mounted externally, such as a NEMA socket connected photo-control. Place a shorting cap across any such exterior connector.
Connect the luminaire to an AC power source with a configuration appropriate for nominal operation. The AC power source must have a minimum available short-circuit current of 200 A. Test the luminaire at the manufacturer-specified nominal input voltage or at the highest input voltage in the input voltage range.

Superimpose electrical immunity test waveforms on the input AC power line at a point within 6 in. (15 cm) of entry into the luminaire using appropriate high-voltage probes and a series coupler/decoupler network (CDN) appropriate for each coupling mode, as defined by ANSI/IEEE C62.45-2002. The test area for all tests must be in accordance with ANSI/IEEE C62.45-2002, as appropriate.

Prior to electrical immunity testing, perform a set of diagnostic measurements, and record the results to note the pre-test function of the luminaire after it has reached thermal equilibrium. These measurements should include at a minimum:

- For all luminaires, Real Power, Input RMS Current, Power Factor, and THD at full power/light output; and
- For luminaires specified as dimmable, Real Power, Input RMS Current, Power Factor, and THD at a minimum of 4 additional dimmed levels, including the rated minimum dimmed level.

Apply tests in sequential order (Test 1, followed by Test 2, followed by Test 3). If a failure occurs during Test 3, then re-apply Test 3 to a secondary luminaire of identical construction.

Following the completion of Tests 1, 2, and 3, repeat the same set of diagnostic measurements performed pre-test for all tested luminaires, and record the results to note the post-test function of the luminaire(s).

A luminaire must function normally and show no evidence of failure following the completion of Tests 1, 2, and 3 (for a single tested luminaire), or the completion of Tests 1 and 2 on a primary luminaire and Test 3 on a secondary luminaire. Abnormal behavior during testing is acceptable.

Following the completion of testing, the existence of any of the conditions listed below constitutes a luminaire failure.

- A hard power reset is required to return to normal operation;
• A noticeable reduction in full light output is observed (e.g., one or more LEDs fails to produce light or becomes unstable);

• Any of the post-test diagnostic measurements exceeds by \(\pm 10\%\) the corresponding pre-test diagnostic measurement; and

• The luminaire or any component in the luminaire (including but not limited to an electrical connector, a driver, a protection component, or module) has ignited or shows evidence of melting or other heat-induced damage. Evidence of cracking, splitting, rupturing, or smoke damage on any component is acceptable.

2. Test Specifications.

NOTE: L1 is typically “HOT”, L2 is typically “NEUTRAL” and PE = Protective Earth.

a. Test 1—Ring Wave. Subject the luminaire to repetitive strikes of a “C Low Ring Wave” as defined in IEEE C62.41.2-2002, Scenario 1, Location Category C. Apply the test strikes as specified in Table 1. Prior to testing, calibrate the ring wave generator to simultaneously meet both the specified short circuit current peak and open circuit voltage peak minimum requirements. Note that this may require raising the generator charging voltage above the specified level to obtain the specified current peak. Use calibrated current probes/transformers designed for measuring high-frequency currents to measure test waveform currents.

Compare test waveform current shapes and peaks for all strikes to ensure uniformity throughout each set of test strikes (coupling mode and polarity/phase angle), and calculate and record the average peak current. If any individual peak current in a set exceeds the average by \(\pm 10\%\), check the test setup and repeat the test strikes.
Table 1
0.5 μS–100kHz Ring Wave Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Level/Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Circuit Current Peak</td>
<td>0.5 kA</td>
</tr>
<tr>
<td>Open Circuit Voltage Peak</td>
<td>6 kV</td>
</tr>
<tr>
<td>Source Impedance</td>
<td>12 Ω</td>
</tr>
<tr>
<td>Coupling Modes</td>
<td>L1 to PE, L2 to PE, L1 to L2</td>
</tr>
<tr>
<td>Polarity and Phase Angle</td>
<td>Positive at 90° and Negative at 270°</td>
</tr>
<tr>
<td>Test Strikes</td>
<td>5 for each Coupling Mode and Polarity/Phase Angle combination</td>
</tr>
<tr>
<td>Time between Strikes</td>
<td>1 minute</td>
</tr>
<tr>
<td>Total Number of Strikes</td>
<td>= 5 strikes × 3 coupling modes × 2 polarity/phase angles = 30 total strikes</td>
</tr>
</tbody>
</table>

b. Test 2—Combination Wave. Subject the luminaire to repetitive strikes of a “C High Combination Wave” as defined in IEEE C62.41.2-2002, Scenario 1, Location Category C. Apply the test strikes as specified in Table 2. Prior to testing, calibrate the combination wave generator to simultaneously meet both the specified short circuit current peak and open circuit voltage peak minimum requirements. Note that this may require raising the generator charging voltage above the specified level to obtain the specified current peak. Use calibrated current probes/transformers designed for measuring high-frequency currents to measure test waveform currents.

Compare test waveform current shapes and peaks for all strikes to ensure uniformity throughout each set of test strikes (coupling mode and polarity/phase angle), and calculate and record the average peak current. If any individual peak current in a set exceeds the average by ± 10%, check the test setup and repeat the test strikes.
Table 2
1.2/50μS–8/20 μS Combination Wave Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Level/ Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2/50 μS Open Circuit Voltage Peak</td>
<td>Low: 6 kV</td>
</tr>
<tr>
<td></td>
<td>High: 10 kV</td>
</tr>
<tr>
<td>8/20 μS Short Circuit Current Peak</td>
<td>Low: 3 kA</td>
</tr>
<tr>
<td></td>
<td>High: 10 kA</td>
</tr>
<tr>
<td>Source Impedance</td>
<td>2 Ω</td>
</tr>
<tr>
<td>Coupling Modes</td>
<td>L1 to PE, L2 to PE, L1 to L2</td>
</tr>
<tr>
<td>Polarity and Phase Angle</td>
<td>Positive at 90° and Negative at 270°</td>
</tr>
<tr>
<td>Test Strikes</td>
<td>5 for each Coupling Mode and Polarity/Phase Angle combination</td>
</tr>
<tr>
<td>Time Between Strikes</td>
<td>1 minute</td>
</tr>
<tr>
<td>Total Number of Strikes</td>
<td>= 5 strikes × 3 coupling modes × 2 polarities = 30 total strikes</td>
</tr>
</tbody>
</table>

c. Test 3—Electrical Fast Transient (EFT). Subject the luminaire to “Electrical Fast Transient Bursts,” as defined in IEEE C62.41.2 - 2002. The test area must be in accordance with IEEE C62.45-2002. Apply the bursts as specified in Table 3. Direct coupling is required; the use of a coupling clamp is not allowed.

Table 3
Electrical Fast Transient (EFT) Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Level/ Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Circuit Voltage Peak</td>
<td>3 kV</td>
</tr>
<tr>
<td>Burst Repetition Rate</td>
<td>2.5 kHz</td>
</tr>
<tr>
<td>Burst Duration</td>
<td>15 mS</td>
</tr>
<tr>
<td>Burst Period</td>
<td>300 mS</td>
</tr>
<tr>
<td>Coupling Modes</td>
<td>L1 to PE, L2 to PE, L1 to L2</td>
</tr>
<tr>
<td>Polarity</td>
<td>Positive and Negative</td>
</tr>
<tr>
<td>Test Duration</td>
<td>1 minute for each Coupling Mode and Polarity combination</td>
</tr>
<tr>
<td>Total Test Duration</td>
<td>= 1 minute × 3 coupling modes × 2 polarities = 6 minutes</td>
</tr>
</tbody>
</table>
F. Warranty. The manufacturer will replace failed luminaires, when non-operable
due to defect in material or workmanship, within ten years of installation with
a luminaire that meets all specifications, delivered to the project location.
Photocells are subject to the warranties of their respective manufacturers.

The warranty must cover maintained integrity and functionality of:

- Luminaire housing, wiring, and connections;
- LED light source(s)—negligible light output from more than 10% of the
  LED packages constitutes luminaire failure; and
- LED driver(s).

The warranty period will begin 90 days after date of manufacture as shown
on internal label.

Provide documentation of warranty service procedures, including forms,
manufacturer contact information, and shipping addresses.

G. Calculation of Light Loss Factor (LLF). For pre-qualification, submit
calculations per IES TM-21 predicting lumen maintenance at the luminaire
level using In Situ Temperature Measurement Testing (ISTMT) and LM-80
data. Meet all of the conditions below.

- The LED light source(s) have been tested according to LM-80. Provide
  verification from the LED or luminaire manufacturer that the LM-80 report
  corresponds to the LEDs in the luminaire being tested.
- The LED drive current specified by the luminaire manufacturer is less than
  or equal to the appropriate drive current specified in the LM-80 test report.
- The LED light source(s) manufacturer prescribes/indicates a temperature
  measurement point (TS) on the light source(s).
- For the hottest LED light source in the luminaire, the temperature
  measured at the TS during ISTMT is less than or equal to the appropriate
  temperature specified in the LM-80 test report for the corresponding drive
  current or higher, within the manufacturer’s specified operating current
  range.

The ISTMT laboratory must meet at least one of the following requirements:

- Be approved by OSHA as a Nationally Recognized Testing Laboratory
  (NRTL) or recognized as a participant in UL’s Client Data Test Program;
• Be approved through an OSHA NRTL data acceptance program or OSHA Satellite Notification and Acceptance Program (SNAP); or

• Be accredited for ANSI/UL 1598 or CSA C22.2 No. 250.0-08, including Sections 19.7 and 19.10–16, by an accreditation organization that is an ILAC-MRA Signatory.

Conduct the ISTMT using the same configuration of luminaires submitted, or another luminaire from the same product family having:

• The same or lower nominal CCT;

• The same or higher nominal drive current;

• The same or greater number of LED light source(s);

• The same or lower percentage driver loading and efficiency; and

• The same or smaller size luminaire housing.

Install luminaire as defined by ANSI/UL 1598 (hardwired luminaires).

Include in the ISTMT report:

• Photos of thermocouple locations and luminaire in testing position;

• Ambient test temperature;

• LED temperature;

• Maximum LED current; and

• Full description of luminaire used in test.

Calculate LLF for each fixture configuration using the submitted ISTMT data, LM-80 data, and Energy Star TM-21 calculator.

• Provide documentation of in situ temperature at 25°C ambient for the luminaire rating submitted for approval;

• Calculate the lumen depreciation at 70,000 hr. at the documented in situ temperature at 25°C ambient using the Energy Star TM-21 calculator;

• LLF = Manufacturer's documented lamp lumen depreciation (LLD) factor per TM-21 calculations at 25°C at 70,000 hr. × 0.90 Luminaire Dirt Depreciation; and
- Total light loss factor is not to exceed 30% system depreciation (0.70) over 70,000 hr.

Calculated LLF will be used for design purposes and to determine if luminaire meets the performance specification.

H. Performance Requirements. For each type of luminaire specified, submit a photometric file in LM-63 format (i.e., filename.ies) and test report of the luminaire generated from LM-79 tests of an actual luminaire in a NVLAP-accredited test lab. Document that the luminaire was tested according to IES LM-79. The Department will verify the performance of the luminaire in a computer simulation using the following criteria in AGI32 Roadway Optimizer.

1. 400 Watt HPS Equivalent:
   a. Layout.
      - LLF as calculated in Section 11011.8.G;
      - Fixtures mounted level perpendicular to the roadway at 50-ft. mounting height with 8-ft. arms, on one side of the roadway;
      - Fixtures spaced at 270 ft.;
      - Setback 15 ft. from outside edges of main lanes;
      - Grid points spaced according to IESNA RP-8 for a roadway with four 12-ft. lanes.
   b. Test Criteria for Passing.
      - Minimum > 0.20 footcandle;
      - Average > 0.60 footcandle;
      - Average/minimum ratio < 3.0:1;
      - IESNA TM-15-11 BUG rating with an Uplight value of U0.

686.3 Submittal. Shop drawings shall be submitted directly to the Harris County Engineering Department, Traffic Signal Maintenance Section. Harris County Engineering Department, Traffic Signal Maintenance Section will review the general design features of the Road Illumination Assemblies.
686.4 Construction Methods.

A. General. The installation as a whole shall be carried out in conformance with the requirements stated herein and as shown on the drawings, and shall present a neat and workmanlike finished appearance.

B. Installing Fixtures. The installation of all luminaires shall conform to the recommendations of the manufacturer and, unless otherwise specified, shall be mounted in a level position.

C. Wire and Cable Installation. All conductor cables shall be installed in continuous lengths, without splices, from terminal to terminal. Terminals for lighting shall be located in the luminaire housing and the controller cabinet only, or as indicated on the drawings.

686.5 Measurement and Payment. Road Illumination Assemblies shall be paid for by each assembly installed, including all mounting hardware required.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specification

Item 680 "Steel Mast Arm & Steel Strain Pole Assemblies"

END OF ITEM 686