



**MnDOT Specification  
Light Emitting Diode (LED) Luminaire  
For Roadway Lighting  
Asymmetrical High Mast  
12/12/2017**

**1. LISTING REQUIREMENTS**

- 1.1. The luminaire shall be listed by a National Recognized Testing Laboratory (NRTL) as defined by the U.S. Department of Labor. The testing laboratory must be listed by OSHA in its scope of recognition for the applicable tests being conducted as required by this specification. A list of recognized testing labs for products sold in the United States may be found on the U.S. Department of Labor's web site:  
<http://www.osha.gov/>
- 1.2. The luminaire shall be listed and labeled by a NRTL as being in compliance with UL 1598 and suitable for use in wet locations
- 1.3. Light source and drivers shall be RoHS compliant.
- 1.4. Shall have an International Electrotechnical Commission (IEC) 529 Ingress Protection (IP) rating of IP 66 or greater for the optical assemblies of the luminaire.
- 1.5. Shall be in compliance with Electro Magnetic Interference (EMI) requirements as defined by FCC Title 47 CFR, Chapter 1, Subchapter A, Part 15, Subparts A and B.
- 1.6. Shall be tested according to the most current version of Illuminating Engineering Society of North America (IESNA) LM-79.
- 1.7. Shall have lumen maintenance measured in accordance with the most current version of Illuminating Engineering Society of North America (IESNA) LM-80.
- 1.8. Shall have long term lumen maintenance documented according to the most current version of Illuminating Engineering Society of North America (IESNA) TM-21.
- 1.9. Shall have LM-79, LM-80 and In-situ temperature testing conducted by U.S. Department of Energy Lighting Facts Program LED Lighting Facts approved testing laboratories.  
  
<http://www.lightingfacts.com/approvedlabs>
- 1.10. Shall meet the light level performance requirements as listed in Section 5, "Optical Requirements" of this specification.

## **2. HOUSING:**

- 2.1. Shall have an aluminum housing.
- 2.2. Shall be painted for corrosion resistance. Color shall be gray.
- 2.3. All hardware on the exterior of the housing including cover and latch shall be stainless steel, zinc or steel with zinc alloy electroplate and chromate top coat .
- 2.4. Shall be easy to open when properly mounted.
- 2.5. Shall be easy to open when sitting on its top side when placed on the ground.
- 2.6. Shall have readily accessible internal parts.
- 2.7. Shall have a 4-bolt slip fitter type mounting on nominal 2 inch (2 3/8 OD) tenons.
  - 2.7.1. Slip fitter mount shall allow 3 1/2 inches of the pole tenon to be inserted in the luminaire mounting assembly.
  - 2.7.2. The 4 bolt slip fitter type mounting assembly shall be internal to the luminaire housing.
  - 2.7.3. The mounting assembly shall permit any necessary adjustment to orient the luminaire with the roadway for proper light distribution.
  - 2.7.4. Mounting that requires drilling of the luminaire ring tenon is not acceptable.
- 2.8. Shall not weigh more than 65 pounds when fully assembled.
- 2.9. Shall have an effective projected area (EPA) of no more than 2.00 square feet (when viewed from either side or either end).
- 2.10. Shall be compliant with American National Standard (ANSI) IEEE C136.31, Table 2 Roadway Lighting Equipment -Luminaire Vibration for both normal applications and bridge and overpass applications.
- 2.11. Shall have area on the top of the housing to allow for a level to be used for proper orientation of the luminaire.
- 2.12. Shall have a 7 pin photocontrol receptacle in full compliance with ANSI C136.41-2013 “For Roadway and Area Lighting Equipment-Dimming Control an External Locking Type Photocontrol and Ballast or Driver”
  - 2.12.1. Shall be rotatable up to 359 degrees.
    - 2.12.1.1. Housing shall provide a stop to prevent the internal twisting of wire assemblies resulting in potential electrical shorts.
    - 2.12.1.2. Rotation of the receptacle in 90° increments is an acceptable alternative.
  - 2.12.2. Shall be fully wired.

2.12.3. Shall have a rain tight twist lock shorting cap.

2.12.3.1. Shall allow the luminaire to turn on and off using a single photocell at the lighting service cabinet when a shorting cap is installed in the luminaire.

2.12.4. Shall allow a simple replacement of the shorting cap with a smart photocontrol to enable dimming and performance monitoring of the luminaire.

2.13. Housing shall be designed to allow water shedding.

2.14. Shall have optional external light shields for controlling light distribution.

2.15. Passive cooling method shall be employed to manage thermal output of LED light engine and power supply.

2.16. Shall have a label on the inside of the luminaire that states operating voltage and current range.

2.16.1. The label must be clearly visible on the inside of the housing.

### **3. ELECTRICAL REQUIREMENTS:**

3.1. Shall fully operate in a temperature range -40° C to 40° C (-40° F to 104° F).

3.2. Shall consume an AC line input power of 350 watts maximum.

3.3. Shall have an integral power supply (electronic driver).

3.4. Shall have a power supply (electronic driver) that will operate within the following voltage range:

(120 to 277 VAC (rms))  $\pm 10\%$  at 60 hertz  $\pm 3\text{Hz}$ .

3.5. Shall have a power supply (electronic driver) that has a power factor of .90 or greater at full load.

3.6. Shall have a power supply (electronic driver) that has total harmonic distortion of 20% or less at full load.

3.7. Shall have a power supply (electronic driver) that has 0 to 10 volt dimming.

3.7.1. Shall be in compliance with IEC 60929, Annex E, "Control Interface for Controllable Ballasts".

3.7.1.1. Open circuit (floating) dimming (violet & gray) conductors will force 0% dimming. The driver will provide 100% current on the outputs.

3.7.1.2. 1 VDC applied to the dimming circuit will provide 10% current out of the driver.

3.7.1.3. 10 VDC applied to the dimming circuit will provide 100% current out of the driver.

3.7.2. See Section 2 photocontrol receptacle for additional information.

- 3.8. Shall have power supply (electronic driver) with a rated life of 100,000 hours with a luminaire operated at an ambient temperature of 25° C (77°F).
- 3.9. Shall have a power supply (electronic driver) that has thermal overload protection.
- 3.10. Shall have a power supply (electronic driver) that is self-limited short circuit protected and over load protected.
- 3.11. Shall have a power supply (electronic driver) that is NRTL certified for use in dry or damp locations when installed inside an electrical enclosure.
- 3.12. Shall have a power supply (electronic driver) that is terminated with quick disconnect wire harnesses for easy maintenance. Wire nut termination is not acceptable.
- 3.13. Shall have a terminal block for terminating pole wiring to the Luminaire. The terminal block shall be a 3 station, tunnel lug terminal board that will accommodate 6 AWG thru 18 AWG wire.
- 3.14. The luminaire shall meet the performance requirements specified in the most current version of ANSI C136.2 for electrical immunity, using the enhanced combination wave test level.
  - 3.14.1. Manufacturer shall indicate in submittals whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire
  - 3.14.2. Shall be a 3 wire device providing protection from Line to Ground, Line to Neutral and Neutral to Ground.
  - 3.14.3. The transient suppressor is not required to be RoHS compliant.
  - 3.14.4. The transient suppressor shall be a NRTL listed or recognized and labeled in accordance with the most current edition of UL 1449.
- 3.15. Fusing shall not be used to achieve required suppression levels.

#### **4. LED PERFORMANCE REQUIREMENTS:**

- 4.1. Shall meet the chromaticity requirements as follows:

The standard color for the LED luminaire shall be white. The colors shall conform to the following color regions based on the 1931 CIE Chromaticity Diagram.

##### **Nominal Correlated Color Temperature**

CCT = 4000K

Manufacturer-Rated Nominal	Allowable LM-79 Chromaticity Values	
	Measured CCT (K)	Measured Duv
4000	3710 to 4260	-0.005 to 0.007

Adapted from NEMA C78.377

##### **Color Rendering Index**

Shall have a minimum Color Rendering Index (CRI) of 70

- 4.2. Intensity and Chromaticity as stated above must be confirmed by an independent test lab or shown on the LM 79 test report.

## **5. OPTICAL REQUIREMENTS:**

- 5.1. Shall have a completely sealed optical system.
- 5.1.1. Shall have a (IEC) (IP) rating of 66 or greater.
- 5.2. Shall have an Illuminating Engineering Society of North America (IESNA) TM-15 Backlight- Uplight- Glare (BUG) rating for the initial value (LLF=1.0) as follows:
- 5.2.1. Backlight rating shall not exceed 3
- 5.2.2. Uplight rating shall not exceed 0
- 5.2.3. Glare rating shall not exceed 4
- 5.3. Shall have a light distribution pattern at the road surface that has an evenly dispersed appearance.
- 5.3.1. Luminaire shall have a bilaterally symmetrical distribution.
- 5.4. Shall not have a perceptible light level flicker to the unaided eye over the voltage range as specified in section 3.
- 5.5. Shall meet the required light levels, documented using AGI 32 or Visual Lighting Design Software, based on the following criteria:
- 5.5.1. Shall utilize a Light Loss Factor (LLF) as defined below:
- 5.5.1.1. Calculations shall be for maintained values (Light Loss Factor (LLF) < 1.0.) where:  
$$LLF = LLD \times LDD$$
- 5.5.1.2. Lamp Lumen Depreciation Factor (LLD) shall be the specified percentage of LED lumen maintenance at 70,000 hours at 25C° C (77°F) from the TM-21 report.
- 5.5.1.3. Luminaire Dirt Depreciation (LDD) = .9
- 5.5.2. Mesopic multipliers (i.e. effective luminance factors) shall not be used. All values shall assume photopic visual adaptation.
- 5.5.3. The TM-21 Report must show the drive current used for the submitted luminaire. The report can show a larger drive current to represent a worst case scenario.
- 5.5.4. The Lumen Maintenance Life  $L_{70}$  from the TM-21 Report must not be below 70% at 70,000 hours at 25C° C (77°F).
- 5.6. Shall meet all light level requirements as defined in this section:
- 5.6.1. Shall have the following light level values when using the layout, pole locations, pole heights,

luminaire count, and calculation zones provided in the Visual or AGI32 Lighting Design files that can be obtained by contacting Phil Stohr at 651-234-7090.

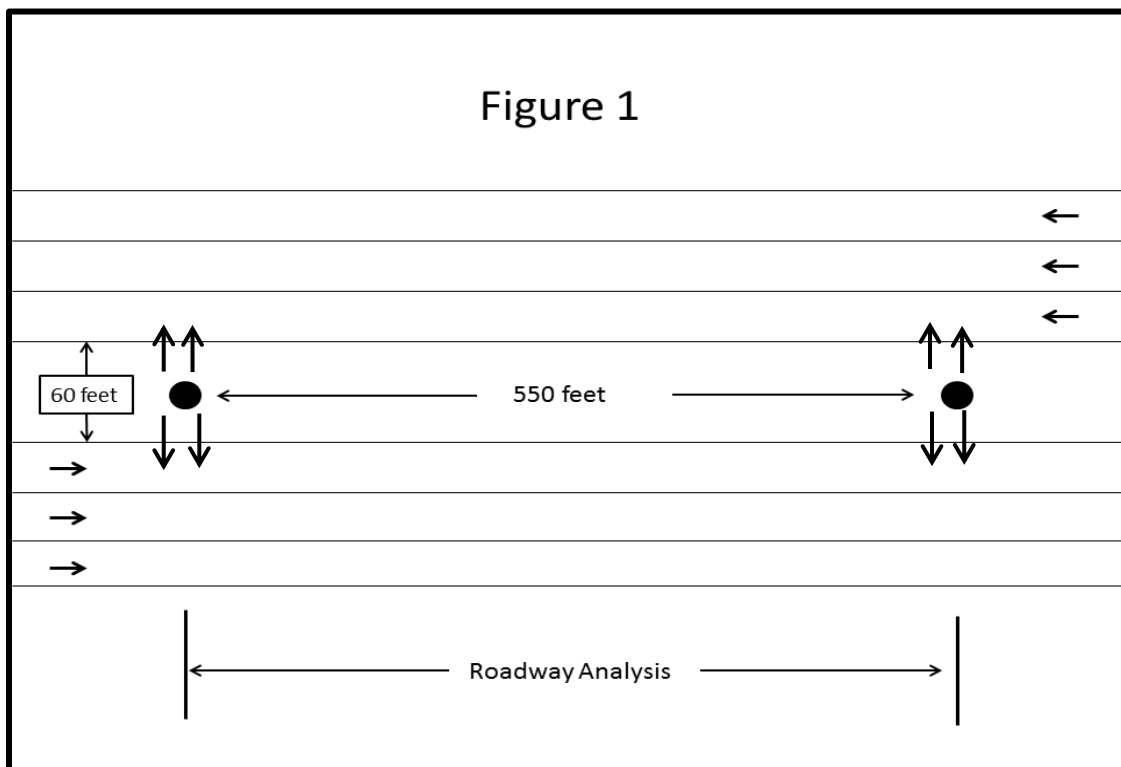
- 5.6.1.1. Shall have a minimum average maintained illuminance of 0.6 footcandles.
- 5.6.1.2. Shall have an average to minimum uniformity not to exceed 4.00:1
- 5.6.1.3. Illuminance levels for symmetrical and asymmetrical submittals shall be similar. i.e. if symmetrical luminaire light level is 1.2 fc then asymmetrical light level must be in the same range. It will not be accepted if it is at a 0.6 fc.
- 5.6.2. Shall have a maximum allowed veiling luminance ratio ( $L_{V(max)} / (L_{(avg)})$ ) of  $\leq 0.34:1$  using the following criteria as shown in figure 1 (figure is used for veiling luminance calculation only):

Two 100 foot towers spaced 550 feet apart.

4 luminaires on each pole

Located in a center median which is 60 feet wide.

3 driving lanes each 12 feet wide on both sides of the tower in opposite directions.



- 5.7. Shall provide independent test laboratories IES photometric files, which will be used to verify light levels.
- 5.8. Product submittal shall be accompanied by IES TM-21 compliant test reports from a CALiPER qualified or NVLAP accredited testing laboratory for the specific model being submitted.

## **6. LUMEN MAINTENANCE:**

6.1. Lumen maintenance calculations and support test data:

6.1.1. Shall be in accordance with LED Lighting Facts guidance.

6.1.2. Exception: calculations shall be based on minimum of 70% of initial output at 70,000 hours of operation.

6.2. Submit completed ENERGY STAR TM-21 Calculator as an electronic Excel file.

## **7. WARRANTY:**

7.1. The entire luminaire assembly including material, workmanship, photometrics, labor, power supply and LED modules shall have a minimum 10 year warranty from the date of installation.

7.1.1. If more than 10% of the individual LEDs fail within the warranty period the luminaire shall be repaired or replaced.

7.1.2. The department will remove the unit from the field and ship it to the manufacturer for repair or replacement.

7.2. Shall have a 10 year warranty on the paint finish.

## **8. MINIMUM REQUIRED SUBMITTALS:**

8.1. Luminaire specification sheet.

8.2. LED driver specification sheet.

8.3. LM-79 Luminaire photometric report.

8.4. The vendor shall submit LM-79 in-situ test data to confirm thermal operating temperatures of the luminaire.

8.4.1. Supplied in-situ test data must include thermal measurements from the worst case (hottest) thermal test point on the electronic driver (power supply).

8.5. LM-80 Lumen maintenance report.

8.6. TM-21 calculations as defined in section 6.

8.7. Backlight-Uplight-Glare (BUG) rating of the luminaire.

8.8. Computer generated point by point photometric analysis using unaltered Visual or AGI32 lighting file provided.

8.9. A complete certified test lab report that shows the electrical transient suppression meets the requirements as set forth in this specification.

8.10. Written product warranty.

8.11. Independent test lab IES photometric reports.

8.11.1. Including IES electronic file.

8.12. IES chromaticity data from an LED Lighting Facts approved testing laboratory.

8.13. Instructions for installation and maintenance.

8.14. Manufacturer shall have an approved symmetrical and asymmetrical luminaire to be placed on MnDOT's Approved/Qualified Products List (MnDOT APL).

8.15. As part of the submittal process when a manufacturer submits a luminaire for inclusion on the MnDOT APL a Microsoft Word version of the MnDOT LED luminaire specification will be provided to the manufacturer. On each line of the provided MnDOT LED luminaire specification the manufacturer shall identify in writing where and on which manufacturer submitted documents the item in the MnDOT specification is shown to be in compliance.

8.16. After approval of submittals manufacturer shall supply MnDOT with 4 luminaires to be installed by MnDOT for final review. Luminaires will become the property of MnDOT.

## **9. MnDOT ACCEPTANCE TESTING:**

9.1. Luminaire will be reviewed against each item listed on this specification. If the luminaire is not in compliance with each item on this specification it will not be placed on the MnDOT APL.

9.2. Shall be installed by MnDOT on a tower to verify light levels and light distribution.

9.3. The Minnesota Department of Transportation will verify light levels using the independent test laboratories photometrics.

9.4. The Minnesota Department of Transportation reserves the right to perform random sample testing on all shipments at its own expense. Random sample testing will be completed within 60 days, and as soon as possible, after delivery. MnDOT shall determine the sampling parameters to be used for the random testing. If the units tested fail random testing the units will be removed from the MnDOT APL.

9.5. Once the luminaire has been placed on the MnDOT APL no substitution of materials shall be allowed unless the manufacturer has received written permission in advance from MnDOT allowing the substitution.

9.6. MnDOT shall be notified of any change to the catalog number. This notification shall include the reason for the change in catalog number.  
Failure to meet this requirement may cause the luminaire to be eliminated from the MnDOT APL.