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# SURFACE VEHICLE RECOMMENDED PRACTICE

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## L.E.D. LIGHTING DEVICES

***Foreword*—**This Document has also changed to comply with the new SAE Technical Standards Board format. Definitions have changed to Section 3. All other section numbers have changed accordingly.

***1. Scope*—**This SAE Recommended Practice applies to functions of motor vehicle signalling and marking lighting devices which use light emitting diodes (L.E.D.'s) as light sources. This report provides test methods, requirements, and guidelines applicable to the special characteristics of L.E.D. lighting devices. These are in addition to those required for devices designed with incandescent light sources. This report is intended to be a guide to standard practice and is subject to change to reflect additional experience and technical advances.

***2. References***

**2.1 Applicable Publications—**The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J387—Terminology—Motor Vehicle Lighting
SAE J575—Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less than 2032 mm in Overall Width
SAE J576—Plastic Materials for Use in Optical Parts Such as Lenses and Reflex Reflectors of Motor Vehicle Lighting Devices
SAE J578—Color Specification
SAE J1330—Photometry Laboratory Accuracy Guidelines

***3. Definitions***

**3.1 Semiconductor—**A material whose resistivity lies in the broad range between conductors and insulators.

**3.2 L.E.D.—**An indivisible, discrete light source unit containing a semiconductor junction in which visible light is non-thermally produced when a forward current flows as a result of applied voltage.

**3.3 L.E.D. Lighting Device—**A lighting device in which light is produced by an array of L.E.D. light source units.

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**3.4 Incandescent Light Source—**A light source in which the generation of light is caused by heating a body to a high temperature. Generally this heating is obtained by passing an electric current through a wire filament. The resistance of the filament to the current causes the filament to heat up and emit radiant energy, some of which is in the visible range. Ordinary automotive bulbs have incandescent light sources.

**3.5 L.E.D. Light Source Center—**For a single L.E.D. light source unit, the point that is located at the geometric center of the junction where the luminescence takes place.

**3.6 L.E.D. Lighting Device Light Center—**The geometric center of all the single L.E.D. light source centers within the L.E.D. array(s) used to illuminate the device function, or the geometric center of the illuminated area if the light output is produced indirectly.

**3.7 Optically Combined L.E.D. Light Source—**The definition of "Optically Combined" in SAE J387, shall also apply to a lamp using L.E.D light sources by substituting "L.E.D." for the term "filament" in the definition.

***4. Tests—***The following section describes individual tests which need not be performed in any particular sequence. Testing may be expedited by performing two or more tests simultaneously on separate samples.

**4.1** SAE J575 is a part of this document. Unless otherwise specified, the following tests are applicable with modifications as indicated.

4.1.1 VIBRATION TEST—The evaluation of the sample at the completion of the test shall also include a functional lighting check. If a partial outage is observed, a photometry test (see 4.1.5) shall be performed and the results recorded.

4.1.2 MOISTURE TEST

4.1.3 DUST TEST—If dust is found, the change in the maximum photometric luminous intensity of the sample shall be determined by using the photometric measurement procedures in 4.1.5.

4.1.4 CORROSION TEST

4.1.5 PHOTOMETRY TEST—Due to the near monochromatic nature of the color emitted by most L.E.D. light sources, the color response of the photometer detector shall be accurately calibrated in the spectral range of the L.E.D. device being measured. The photometric output (luminous intensity) of a L.E.D. lighting device typically decreases as the temperature of the L.E.D. light sources increases. In addition to the test procedures in SAE J575, the following shall apply:

*4.1.5.1 Test Voltage*—The device shall be operated at its design voltage, as specified by the manufacturer of the L.E.D. lighting device, during all photometry tests.

*4.1.5.2 Photometric Measurement Times*—For measurements to photometric requirements, first allow the test device to stabilize at laboratory ambient temperature (23 °C ± 5 °C) unenergized. After all the device components are at laboratory ambient temperature, energize the applicable test device function and record the H-V photometric value at 1 min after the initial on-time. Also record the following at the specified on-times for the lamp function being tested:

a. Steady-burning Lamp Functions (such as tail and sidemarker)—Continue to energize the test device until either 30 min has elapsed or internal heat saturation has occurred, whichever occurs first. Record the photometric values at H-V and all required test points, including maximums.
b. Intermittent Operating Lamp Functions (such as stop and turn signals)—Continue to energize the test device and record the H-V photometric value at 10 min on-time. Also continue to energize the test device until either 30 min has elapsed or internal heat saturation has occurred, whichever occurs first. Record the photometric values at H-V and all required test points, including maximums.

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Calculate the luminous intensity value of the maximum and any other applicable test points after 1 min of operation by applying the ratio between the 1 min and 30 min H-V measurements. For intermittent operating lamp functions, also calculate the luminous intensity value of all required test points after 10 min of operation by applying the ratio between the 10 min and 30 min H-V measurements.

NOTE—Other test methods which yield equivalent results may be used. Examples include eliminating the ratio calculation and directly measuring the maximum photometric value at 1 min (for a typical L.E.D. device where photometric values decrease with on-time) or directly measuring values at the specified on-time when the photometric measurement equipment can record near simultaneous readings at all test points. Readings at shorter on-times may also be used when the photometric output versus time performance of the device is known.

4.1.6 WARPAGE TEST ON DEVICES WITH PLASTIC COMPONENTS—Not required.

**4.2 Color Test—**SAE J578 is a part of this document.

**4.3 Thermal Cycle Test**

4.3.1 SCOPE—This test evaluates the ability of the sample device to resist optical, electrical, or physical malfunctions due to exposures to repeated changes from hot to cold temperature extremes. Devices installed in vehicle locations that could produce temperatures outside the test range specified may necessitate special test requirements.

4.3.2 TEST EQUIPMENT—A thermal cycle chamber capable of providing the temperature extremes and rates of change of temperature in the temperature-time profile specified in Figure 1.

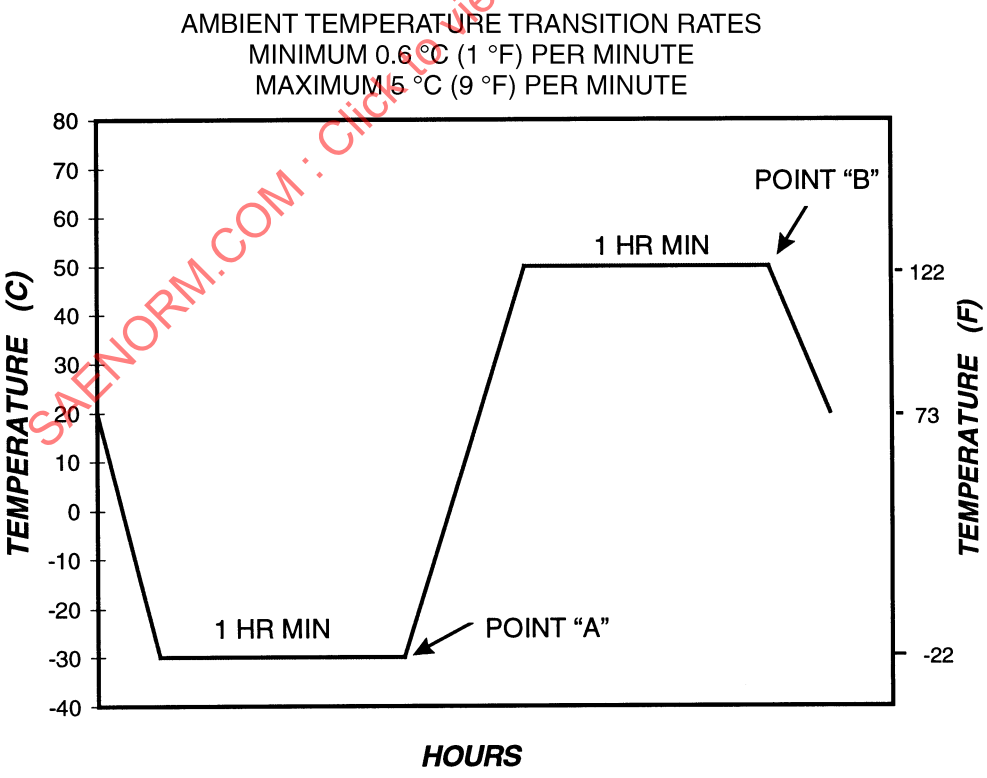


FIGURE 1—THERMAL CYCLE PROFILE

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4.3.3 TEST PROCEDURE—The sample device, mounted on a test fixture shall be subjected to thermal cycles as follows:

*4.3.3.1* *Thermal Cycle*—The device shall be tested to the thermal cycle profile shown in Figure 1.

*4.3.3.2* *Device Operation*—The device shall be energized at design voltage commencing at point "A" of Figure 1 and de-energized at point "B" of each cycle. When energized, the lighting function(s) shall be cycled as specified by the cycle times in SAE J575, Warpage Test.

*4.3.3.3* *Test Duration*—The test shall consist of 8 complete cycles of the thermal cycle profile shown in Figure 1.

*4.3.3.4* *Sample Evaluation*—During the final thermal cycle, the sample lighting function(s) shall be continuously checked for permanent or intermittent outages while energized from Point "A" (cold temperature) to Point "B" (hot temperature) in Figure 1 and the results recorded. If partial outage occurred, a photometry test (see 4.1.5) with the remaining functional L.E.D. segments lighted shall be performed and the results recorded. Upon completion of the thermal cycle exposure, the sample device shall be visually examined for any cracking, rupture, or warpage of parts and the results recorded. If any of the previous changes are observed that could result in failure of the other tests contained in Section 4, those test(s) shall be performed on the same sample used for the thermal cycle test and the results recorded.

**4.4 Plastic Materials—**Plastic materials used in optical parts shall be tested in accordance with the procedures in SAE J576.

## *5. Requirements*

**5.1 Performance Requirements—**A L.E.D. lighting device when tested in accordance with the test procedures specified in Section 4, shall meet the following requirements.

5.1.1 VIBRATION—SAE J575. In addition, the following requirements also apply:

*5.1.1.1* After completion of test procedure 4.1.1, all L.E.D. light sources contained within the device shall function or the device shall comply with the photometric requirements in 5.1.5 of this document.

5.1.2 MOISTURE—SAE J575.

5.1.3 DUST—SAE J575.

5.1.4 CORROSION—SAE J575.

5.1.5 PHOTOMETRY—SAE J575. The photometric performance requirements in the applicable SAE technical report for the lighting function being tested shall also apply. The luminous intensity values for 1 min (as determined in 4.1.5.2) and after the following specified time of operation, shall both comply with the photometric maximum and minimum test point requirements.

a. Steady-burning Lamp Functions—30 min (as determined in 4.1.5.2)
b. Intermittent Operating Lamp Functions—10 min (as determined in 4.1.5.2)

The following requirements shall also apply:

*5.1.5.1* *Lighted Sections*—Applicable photometric requirements specified in other SAE technical reports which are based on the number of lighted sections shall instead be applied based on the total projected luminous area for the function being tested. That area shall be equivalent to the number of lighted sections in Table 1:

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**TABLE 1—NUMBER OF LIGHTED SECTIONS**

| Total Projected Luminous Area | Equivalent Number of Lighted Sections |
|---|---|
| Less than 225 $cm^2$ | 1 |
| 225 to 450 $cm^2$ | 2 |
| Greater than 450 $cm^2$ | 3 |

5.1.6 WARPAGE—SAE J575. Not required.

**5.2 Color—**The color of light shall be as specified in SAE J578 and in the SAE report of the applicable device function.

**5.3 Thermal Cycle—**After completion of the thermal cycle test procedure in 4.3.3, there shall be no observed cracking, rupture, displacement, or warpage of parts of the test device which would result in failure of other tests contained in 5.1 of this document. There shall also be no loss of function of any L.E.D. light sources while energized during the last thermal cycle which could result in failure of the photometry requirements of 5.1.5 of this document.

**5.4 Plastic Materials—**Plastic materials used in optical parts in the device, including the individual L.E.D. light source units, shall meet the requirements of SAE J576 when exposed directly, or when covered by another lens material, depending on the actual use in the device.

**5.5 Design Requirements**

5.5.1 REVERSE VOLTAGE—Some L.E.D. light sources may be damaged by the application of a voltage of reverse polarity. Protection shall be provided to prevent any damage when the voltage polarity to the lighting device is reversed.

***6. Guidelines***

**6.1 Photometric Design Guidelines—**Any photometric design guidelines in the applicable SAE technical report for the lighting function being tested shall also apply. The luminous intensity values for 1 min (as determined in 4.1.5.2) and after the following specified time of operation apply to both the photometric maximum and minimum photometric design guidelines.

a. Steady-burning Lamp Functions—30 min (as determined in 4.1.5.2)
b. Intermittent Operating Lamp Functions—10 min (as determined in 4.1.5.2)

Requirements using the number of lighted sections shall apply as specified in 5.1.5.1 of this document.

**6.2 Installation Guidelines—**The following guidelines are provided because of the special characteristics of L.E.D. lighting devices:

6.2.1 The luminous intensity of L.E.D. lighting devices typically varies with applied voltage. The electrical system of a vehicle should, under normal operating conditions, provide design voltage to the device as closely as practicable bearing in mind the inherent variability of such systems.

6.2.2 The luminous intensity of a L.E.D. lighting device typically decreases as the temperature of the L.E.D. light sources increases. Installation of lamps on vehicles should be considered to minimize the effect of accumulating excessive temperatures in the device.

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6.2.3 While L.E.D. light sources typically have a very long energized life, outage of a segment of a L.E.D. light source array may occur when one of the L.E.D. light sources within the array segment malfunctions. The user should be cautioned that the luminous intensity of the device may be reduced by such an outage.

## *7. Notes*

**7.1** As a matter of additional information, attention is called to SAE J387 and SAE J1330.

**7.2** **Marginal Indicia —**The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE SIGNALLING AND MARKING DEVICES STANDARDS COMMITTEE
AND APPROVED BY THE SAE LIGHTING COORDINATING COMMITTEE

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**SAE J1889 Revised JUN1999**

**Rationale—**The changes are as follows;

Section numbering was changed beginning with Section 3 to correspond to current SAE format guidelines.

Section 1: The words “functions of” were added to clarify that the scope of this document is limited to only the functions in a lighting device which have L.E.D. light sources.

Section 3: Definitions were slightly modified for consistency with term usage in the document.

Section 3.7: Definition of an optically combined L.E.D. light source was added to clarify the definition in SAE J387 which was written for incandescent filament light sources. L.E.D. light sources may be operated at different current levels or with pulse width modulation so that the same array could perform two functions such as stop and tail. Separate filaments are typically used with incandescent light sources. Both amber and red L.E.D. light sources could also be combined in one compartment to provide different lamp functions.

Section 4.1.5.2: Since it is not considered practical to impose routine laboratory photometric measurement requirements at temperatures other than normal laboratory ambient, the purpose of the special photometry test procedure for L.E.D. lamps is to:

1. Obtain reasonable inter-lab correlation by conducting measurements during relatively stable photometric output periods at laboratory room ambient temperatures, and

2. Obtain measurements for minimum values after some period of operation so that the self-heating of the L.E.D. device produces values which simulate initial-on photometric values at elevated ambient temperatures.

For intermittent operating lamp functions, the operating time for photometric measurements was revised from 30 min to 10 min to provide a more reasonable and less design restrictive requirement. This change was implemented so that smaller L.E.D. stop and signal lamp designs (such as truck rear lamps and some turn signal lamps that have photometric output versus time profiles that do not stabilize as fast or at a higher relative value as some larger lamps) would not be unduly penalized with a requirement which can produce unreasonable equivalent test temperatures when compared to common vehicle ambient operating temperatures. Room temperature on-time versus relative photometric output data for various current production stop and signal lamps showed variations dependent on many design factors, but had the following general characteristics which support the use of a shorter photometry operating time:

a. When stop lamps were cycled 5 min on and 5 min off for 30 min or turn signal lamps were flashed for 30 min, the resulting decline in the photometric values at the end of the 30 min never approached the value obtained after a room temperature steady-burn for 5 min. The photometric values also never dropped below the 10 min steady-burn value at any time during the 30 min cycling.

b. Many intermittent type devices when steady-burned at room temperature, had relative photometric output drops of 0.80 of initial-on values, but had less than a further 5% change between 10 and 30 min. All had at least a 0.90 relative output after 10 min of operation and some had values of 0.80 or lower and continued further declines to relative levels below 0.60.

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