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Superseding J595 JAN1990

**(R) Directional Flashing Optical Warning Devices for
Authorized Emergency, Maintenance, and Service Vehicles****1. Scope**

This document provides design guidelines, test procedure references, and performance requirements for directional, single color, flashing optical warning devices used on authorized emergency, maintenance and service vehicles. It is intended to apply to, but not limited to, surface land vehicles.

1.1 Rationale

1. Multiple flash patterns and cyclic patterns have been added. End users have increasingly been requesting non-repetitive flash patterns to prevent complacency.
2. Source definition has been changed to include multiple source components with some restrictions. Light pulse and flash definitions have been added.
3. The specified minimum size lighted area has been eliminated. Recent demonstrations have shown that observers were unable to see any difference in the performance of flashing warning devices having the same optical power but substantially different lighted area.
4. Optical Power has been defined.
5. Class 1, 2 and 3 ratings have been established. Lighting identification code restrictions have been added. Multiple flash patterns that are user adjustable must be rated as the lowest performance mode.
6. Test Voltage – In conformance with other optical warning device reports, the test voltage is changed to 12.8 V for 12 volt systems and 25.6 V for 24 volt systems instead of "the voltage recommended by the manufacturer", and requirements added for 36 volt systems.
7. Environmental tests have been added – these include low temperature, high temperature and 200 hour durability flash rate maintenances.
8. Photometric performance has now been established as meeting the original peak intensity and meeting a specified "optical power". Advances in laboratory instrumentation have made it practical and cost effective to directly measure the optical power generated by any optical warning device. The direct measurement or calculation of peak intensity also is readily done with current technology.
9. Establishment of new performance requirements for use of the color blue. The use of blue as a signal color for emergency vehicles has steadily increased until now approximately one half of such vehicles employ blue either alone or in combination with red or white. It is apparent that the operators of emergency vehicles have determined that the spectacular performance of blue at night outweighs the very poor performance of this color during the day. Blue requirements shall be the same as red.

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10. Eliminated the requirement that the device or system use a J945 or J1054 compliant flasher. Devices not supplied with flasher shall be tested using a 1.20 Hz / 50% duty cycle flasher.
11. The flash rate range was increased from 1-2 Hz to 1-4 Hz. Increasing the flash rate without a corresponding increase in photometric energy lowers the flash energy. However, if the flash rate is increased and the photometric energy is maintained above the minimum requirement, the conspicuity of the signal is improved. From a practical stand point, higher flash rates reduce the travel distance between signal flashes and promote earlier recognition of a hazardous condition. This document increases the allowable flash rate maximum to 4 Hz, so long as the flash energy content of the signal is not reduced below the required tabulated values. It is important to note that the energy to operate such devices may have to increase with the flash rate. This also harmonizes with ECE Regulation 65.
12. Miscellaneous Editorial Changes – The word "device" is used to indicate the assembly of components which is tested. The previous edition used both the words "lamp" and "device" for this purpose as well as referring to light sources as "lamps."
13. The color green was discussed and deemed not applicable.

2. References

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of the publication shall apply.

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, (www.sae.org).

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 Reflectors of Motor Vehicle Lighting Devices

SAE J578—Color Specification

SAE J759—Lighting Identification Code

SAE J1889—L.E.D. Lighting Devices

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, (www.sae.org).

SAE J1690—Signal Flashers

SAE J2498—Minimum Performance of the Warning Light System Used on Emergency Vehicles

3. Definitions

3.1 Directional Flashing Optical Warning Device

A flashing optical warning device, in which the light source produces flashes of light, which is directionally aimed and will project a signal over a minimum area from 20° right to 20° left in a horizontal plane and from 10° up to 10° down in a vertical plane. The flashes of light may be a repetitive signal or a non-repetitive signal. If a non-repetitive signal is used it shall be a block of repetitive signals that have been characterized.

3.2 Light Source

Any single, independently mounted, light emitting component in the lighting system. A light source may consist of a single optical element or a fixed array of any number of optical elements whose geometric positioning relative to each other is fixed by the manufacturer of the light source and not intended to be modified. To be considered a single source the elements must be adjacent, and operate simultaneously in all modes if it is vehicle operator adjustable.

3.3 Optical Element

Any discrete light emitter such as, but not limited to, an incandescent filament, HID or individual light emitting diode.

3.4 Primary Optical Warning Device

A device or group of devices that are intended to provide the primary visual optical warning signal as called out in each service class. Unless prohibited by law or regulation, a Class 1 device may be used in place of Class 2 device and a Class 1 or 2 device in place of Class 3 device.

3.5 Secondary Optical Warning Device

A device or group of devices of lower performance that can be used to provide supplemental optical warning to that provided by the primary optical warning device or devices.

3.6 Class 1 Optical Warning Device

A primary optical warning device for use on authorized emergency vehicles responding to emergency situations. These devices are utilized to capture the attention of motorists and pedestrians and warn of a potentially hazardous activity or situation.

3.7 Class 2 Optical Warning Device

A primary optical warning device for use on authorized maintenance or service vehicles to warn of traffic hazards such as a lane blockage or a slow moving vehicle.

3.8 Class 3 Optical Warning Device

A primary optical warning device for use on vehicles authorized to display an optical warning device for identification only.

3.9 Light Pulse

A single, visually continuous emission of optical energy. High frequency modulation is permitted.

3.10 Flash

A flash is a light pulse or a train of light pulses, where a dark interval of at least 160ms separates the light pulse or the last pulse of the train of light pulses from the next pulse or the first pulse of the next train of light pulses. To be considered a train of light pulses, each pulse in the train must begin within 100ms after the end of the preceding light pulse. Dark interval luminous intensity shall not exceed 2% of the maximum luminous intensity of a flash.

3.11 Optical Power

The integration of the luminous intensity of the flashing light source for a time of 60 seconds (11dt). Units are Candela·Seconds/Minute.

4. Lighting Identification Code, Markings, and Notices

4.1 In accordance with SAE J759, the optical warning device may be identified by the codes:

"W-1", Class 1

"W-2", Class 2

"W-3", Class 3

A device may only have one class rating if it is vehicle operator adjustable. The rating shall be based on the mode with the lowest performance level.

5. Tests

All tests are to be made at $12.8\text{ V} \pm 0.1\text{ V}$ for 12 V systems, $25.6\text{ V} \pm 0.2\text{ V}$ for 24 V systems and $38.4\text{ V} \pm 0.3\text{ V}$ for 36 V systems. Tests are to be made using the wiring supplied by the device manufacturer or wire of the minimum size recommended by the device manufacturer. The voltage shall be measured at 300 mm from the point at which the wiring exits the device.

5.1 SAE J575 is a part of this report. The following tests are applicable with the modifications as indicated.

5.1.1 VIBRATION TEST

5.1.2 MOISTURE TEST

5.1.3 DUST TEST

The change in intensity may be measured at HV.

5.1.4 CORROSION TEST

5.1.5 WARPAGE TEST FOR PLASTIC COMPONENT

The device shall be operated in the mode with the highest optical power.

5.2 Photometry

In addition to the test procedures in SAE J575, the photometric performance shall be determined by measuring optical power and through direct measurement or calculation, the peak intensity of each flash. Photometry shall be performed with the light source flashing.

5.2.1 All light sources shall operate until the output is stable prior to testing.

5.2.2 Photometric measurements shall be made with the device mounted in its normal operating position and all measurements shall be made with the light source of the device at least 18 meters from the photometer sensor.

The device shall be mounted so that the horizontal plane through the photometer axis passes through the center of the light source. The vertical axis through the center of the light source shall be perpendicular to this horizontal plane. If the light source is composed of an array of optical elements, the geometric center of the array shall be used.

5.2.3 An integrating photometer shall be used to determine the optical power projected over 60 seconds. Any measurement period not less than 20 seconds may be used. These measurements shall then be corrected to obtain the optical power in units of Cd·Sec/min. If the flasher or power supply/flasher has more than one flash pattern, the optical power shall be measured and recorded for each pattern.

5.3 Flash Rate

Any device, incorporating an integral flasher, an external flasher or a combined power supply and flasher supplied by the manufacturer of the device, shall be tested with this flasher.

5.3.1 If a flasher is required and no flasher is supplied by the manufacturer of the device, the device shall be tested using a flasher having a flash rate of $1.20 \text{ Hz} \pm 0.14 \text{ Hz}$ with a $50\% \pm 2\%$ current on time.

5.3.2 The characteristics, including peak intensities, flash rate, period, number of pulses per flash, on times (electrical), off times (electrical) & pulse separations, shall be measured and recorded. If the flasher or power supply/flasher has more than one flash pattern, the characteristics shall be measured and recorded for each pattern.

5.4 Color Test

SAE J578 is a part of this report. The device shall meet color requirements in each mode and at all times. Incandescent devices may be measured while in a steady-state mode at design voltage.

5.5 Additional Tests

5.5.1 HIGH TEMPERATURE FLASH RATE TEST

The device shall be subjected to an ambient temperature of $50\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for a period of 6 hours. The device shall be off (not operating) during the first hour and shall operate continuously for the next 5 hours of the test. The flash rate shall be measured starting 3 minutes after the device is activated and at the conclusion of the test. If the device has multiple flash patterns then the pattern with the highest optical power shall be used. The start time shall be measured at time of activation.

5.5.2 LOW TEMPERATURE FLASH RATE TEST

The device shall be subjected to an ambient temperature of $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for a period of 6 hours. The device shall be off (not operating) during the first 5 hours and shall operate continuously for the last hour of the test. The flash rate shall be measured starting 3 minutes after the device is activated and at the conclusion of the test. If the device has multiple flash patterns then the pattern with the lowest optical power shall be used. The start time shall be measured at time of activation.

5.5.3 DURABILITY FLASH RATE TEST

The device shall be operated continuously for 200 hours at an ambient temperature of $25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ in cycles consisting of 50 minutes on and 10 minutes off. The flash rate shall be measured starting 3 minutes after the device is activated and at the conclusion of the test. If the device has multiple flash patterns then the pattern with the highest optical power shall be used.

5.6 Materials Test

SAE J576 is a part of this report.

6. Performance Requirements

6.1 Performance Requirements

A device, when tested in accordance with the test procedures specified in Section 5, shall meet the following requirements of SAE J575.

6.1.1 VIBRATION

6.1.2 MOISTURE

6.1.3 DUST

On completion of the test, the test device shall be considered to have met all the requirements of the dust test when complying with either of the following requirements:

No dust shall be found on the interior surface of the test device, or
The maximum or HV luminous intensity measured after the dust exposure test shall be at least 90% of the initial maximum or HV luminous intensity measured before the test.

6.1.4 CORROSION

6.1.5 WARPAGE

6.2 Photometry

All device flash patterns shall meet the optical power requirements contained in Tables 1A and 1B, and their footnotes. The summation of the optical power measurements at the specified test points in a zone shall be at least the value shown. Additionally, the peak intensity of all device flash patterns shall meet the photometric requirements contained in Tables 2A and 2B, and their footnotes. The summation of the peak luminous intensity measurements at the specified test points in a zone shall be at least the value shown.

A device may only have one class rating.

6.3 Flash Rate

The flash rate for devices shall be at least 1 Hz and not more than 4 Hz at all times.

6.4 Color

The color of light emitted shall be white, yellow, red, or signal blue as specified in SAE J578

6.5 Additional Requirements

6.5.1 HIGH TEMPERATURE FLASH RATE TEST

There shall be no evidence of operating conditions which would result in failure to comply with Section 6 of this document. Operation of the device shall begin and continue within 5 seconds of the beginning of each operating cycle. The measured flash rates shall not vary by more than 20% from the ambient flash rate.

6.5.2 LOW TEMPERATURE FLASH RATE TEST

There shall be no evidence of operating conditions which would result in failure to comply with Section 6 of this document. Operation of the device shall begin and continue within 5 seconds of the beginning of each operating cycle. The measured flash rates shall not vary by more than 20% from the ambient flash rate.

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6.5.3 DURABILITY FLASH RATE TEST

There shall be no evidence of operating conditions which would result in failure to comply with Section 6 of the document. The final measured flash rates shall not vary by more than 20% from the initial.

6.6 Material Requirements

Plastic materials used in optical parts shall meet the requirements of SAE J576.

TABLE 1A—PHOTOMETRIC DESIGN GUIDELINES
Optical Power (Candela*Seconds/Minute)

		Class 1			Class 2			Class 3		
		White	Yellow	Red/Blue	White	Yellow	Red/Blue	White	Yellow	Red/Blue
10U	5L	1920	960	480	480	240	120	192	96	48
	V	4800	2400	1200	1200	600	300	480	240	120
	5R	1920	960	480	480	240	120	192	96	48
	20L	1920	960	480	480	240	120	192	96	48
	10L	4800	2400	1200	1200	600	300	480	240	120
	5L	9600	4800	2400	2400	1200	600	960	480	240
5U	V	14400	7200	3600	3600	1800	900	1440	720	360
	5R	9600	4800	2400	2400	1200	600	960	480	240
	10R	4800	2400	1200	1200	600	300	480	240	120
20R	20R	1920	960	480	480	240	120	192	96	48
	20L	2880	1440	720	720	360	180	288	144	72
	10L	7200	3600	1800	1800	900	450	720	360	180
H	5L	19200	9600	4800	4800	2400	1200	1920	960	480
	V	28800	14400	7200	7200	3600	1800	2880	1440	720
	5R	19200	9600	4800	4800	2400	1200	1920	960	480
10R	10R	7200	3600	1800	1800	900	450	720	360	180
	20R	2880	1440	720	720	360	180	288	144	72
	20L	1920	960	480	480	240	120	192	96	48
5D	10L	4800	2400	1200	1200	600	300	480	240	120
	5L	9600	4800	2400	2400	1200	600	960	480	240
	V	14400	7200	3600	3600	1800	900	1440	720	360
10D	5R	9600	4800	2400	2400	1200	600	960	480	240
	10R	4800	2400	1200	1200	600	300	480	240	120
	20R	1920	960	480	480	240	120	192	96	48
10D	5L	1920	960	480	480	240	120	192	96	48
	V	4800	2400	1200	1200	600	300	480	240	120
	5R	1920	960	480	480	240	120	192	96	48

TABLE 1B—PHOTOMETRIC DESIGN REQUIREMENTS
Optical Power (Candela-Seconds/Minute)

Zones	Class 1			Class 2			Class 3		
	White	Yellow	Red/Blue	White	Yellow	Red/Blue	White	Yellow	Red/Blue
1 5U/10L 5U/20L H/20L 5D/20L 5D/10L	14400	7200	3600	3600	1800	900	1440	720	360
2 10U/5L 10U/V 10U/5R	7680	3840	1920	1920	960	480	768	384	192
3 5U/5L H/10L 5D/5L	24000	12000	6000	6000	3000	1500	2400	1200	600
4 5U/V H/5L HV H/5R 5D/V	86400	43200	21600	21600	10800	5400	8640	4320	2160
5 5U/5R H/10R 5D/5R	24000	12000	6000	6000	3000	1500	2400	1200	600
6 10D/5L 10D/V 10D/5R	7680	3840	1920	1920	960	480	768	384	192
7 5U/10R 5U/20R H/20R 5D/20R 5D/10R	14400	7200	3600	3600	1800	900	1440	720	360

NOTE—A minimum of 60% of the photometric design guideline must be met at all points.

An adjustment in device orientation from the design position may be made in determining compliance to the performance photometric requirements, provided such adjustment does not exceed 1 deg in any direction. All zone totals must comply after reaim.