SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

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Lighting and Marking of Earthmoving Work Machines

RATIONALE

Construction Machines replaced with Work Machines to reflect the title change of SAE J1116.

Added references SAE J1330, SAE J2121, and SAE J2895 as these documents contain requirements that apply to the lighting and marking of earthmoving work machines.

Added Section 4, Environmental Tests.

Section 3 revised for clarity, adding specific names for flood and trapezoid beams.

Table 1 enhanced by adding 30-degree left and right requirements.

This SAE Standard differs technically from ISO 12509 in scope and application.

1. SCOPE

This SAE Standard establishes minimum requirements for lighting and marking earthmoving work machinery as defined in SAE J1116. It may be used as guidance for other types of machinery.

Earthmoving work machines are normally operated off-highway. Therefore, this SAE document is not intended to be used as a basis for regulations by those having authority over on-highway motor vehicles.

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 issue of SAE publications shall apply.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
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Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

For more information on this standard, visit
https://www.sae.org/standards/content/J1029_202405/

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J585 Tail Lamp (Rear Position Lamp) for Use on Motor Vehicles Less than, Equal to, or Greater than 2032 mm in Overall Width

SAE J586 Stop Lamps for Use on Motor Vehicles Less than 2032 mm in Overall Width

SAE J594 Reflex Reflectors

SAE J1116 Categories of Off-Road Self-Propelled Work Machines

SAE J1330 Photometry Laboratory Accuracy Guidelines

SAE J2121 Requirements for Composite Lighting Assemblies Used on Construction and Industrial Machinery

SAE J2895 LED Work Lighting Devices

2.2 Related Publications

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

2.2.1 ANSI/ASABE Publications

Available from either ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, Tel: 269-429-0300, www.asabe.org, or from ANSI at https://webstore.ansi.org/.

ANSI/ASAE S279 Lighting and Marking of Agricultural Equipment on Highways

2.2.2 ISO Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ISO 3450 Earth-moving machinery - Braking systems of rubber tyred machines - Systems and performance requirements and test procedures

ISO 12509 Earth-moving machinery and rough-terrain trucks - Lighting, signaling and marking lights, and reflex-reflectors

3. REQUIREMENTS

3.1 Forward Lighting

3.1.1 General

This section specifies the lighting requirements for illuminating the area directly ahead of the machine when operated in its normal direction of travel. Maximum level surface speed is used for the calculation of stopping distance, which specifies the area that must be illuminated.

3.1.2 Number and Type of Lamps

At least two general service front lamps, trapezoid-beam type or flood-beam type, shall be used. They shall be so located as to be visible from the entire length of a line segment located 15 m in front of the machine and extending 7 m to either side of the machine centerline.

3.1.3 Maximum Stopping Distance

Forward lighting shall provide adequate illumination for a distance that exceeds the machine stopping distance. Adequate forward visibility with various work tool attachments shall be considered when positioning the front lamps on the machine. Stopping distance from the machine maximum level surface speed shall include the distance traveled during the operator reaction time interval (added to the braking distance). The distance traveled during a 1.5-second operator reaction time interval can be computed by Equation 1. For braking distance, refer to ISO 3450.

$$\text{Distance (m)} = 0.4167 \times \text{km/h} \quad \text{(Eq. 1)}$$

3.1.4 Photometric Requirements

Minimum light output requirements for forward lighting at different stopping distances are listed in Table 1. Front lamps shall be vertically aimed so that the portion of highest intensity of the beam intercepts the terrain at the distance ahead of the machine, which equals the stopping distance from the maximum machine level surface speed. Horizontal aiming shall provide required illumination on the longitudinal axis in front of the machine and gradually decreasing illumination to no less than 20% of the required values on 30-degree angles to the left and right. All photometry tests shall be performed in accordance with SAE J1330.

Table 1 - Photometric requirements

Maximum Stopping Distance Meters	Minimum Light Output in Candelas on Longitude Axis	Minimum Light Output in Candelas on 30 degrees Left and Right from the Axis
Up to 30	2493	499
Up to 45	5609	1122
Up to 60	9972	1994
Up to 75	15581	3116
Up to 90	22437	4488
Up to 105	30539	6108
Up to 120	39888	7978
Up to 135	50483	10097
Up to 150	62325	12465

Note 1: This table was derived from the formula: [Stopping Distance (m)]^2 x 2.77 (lux) = Light intensity (cd)
Note 2: Light intensity between 30 degrees left and right should gradually increase toward the center projection of the machine.
Note 3: For machines frequently turning at sharper angles than 30 degrees, the aiming may be adjusted to wider horizontal angles.
Note 4: Light meter orientation: horizontal toward the vehicle.

In general, the candela of two lamps will be nearly equal to the sum of the candela of the two lamps if both are carefully aimed to intercept the terrain at the same distance. The lamps may also be aimed at two different points to provide the required angular coverage. Additional lamps may be used if the required coverage is not accomplished with two lamps. When two types of lamps are used to provide low and high beam performance with provision for switching between them, the low beams are normally aimed for a distance closer to the machine than the high beams. When this scheme is used, only the high beam candela portion should be considered to satisfy the value of Table 1.

3.1.5 When lamps are used as dedicated high beams (aimed for optimum distance vision), provision for switching between high and low beams is recommended to restrict glare to acceptable limits.

3.2 Work Area Lighting

3.2.1 General

The following guidelines should be used by the manufacturer, distributor, and end user to select lamps for proper illumination of the work area and the intended machine work application.

3.2.2 Flood Beam

Flood lamps are recommended for general illumination of the work tool area of the machines.

3.2.3 Trapezoid Beam

General service trapezoid beam lamps are recommended for general illumination of areas a short distance from the machine. Typical usage includes: rubber-tired loader and backhoe loader, grader, and tractor front lamp.

3.2.4 Special Case for Rear-Facing White Lamps

On machines capable of reversing speed equal to or greater than 90% of forward maximum level surface speed and intended to be routinely driven in reverse, the rear work area lighting shall include lamps that meet the general requirements in 3.1.3, 3.1.4, and 3.1.5. Those lamps shall be activated by a separate switch to allow activation only when appropriate.

3.3 Rear Lighting (Red)

3.3.1 General

This section specifies the types of red lighting to be used to identify rubber-tired machines from the rear when at their normal job site. Lighting equipment should have performance equal to or greater than that specified by SAE J586 for stop lamps and SAE J585 for tail lamps.

3.3.2 Types of Machines

Rubber-tired machines including loaders, dumpers, graders, tractor-scrapers, backhoe loaders, and tractors should use one of the following options:

- Two tail lamps and two stop lamps
- Two combined tail/stop lamps

3.3.3 Exemption

Skid steer loaders are exempted from the stop lamp requirement.

3.3.4 Refer to ISO12509 for further guidance.

3.4 Rear and Side Marking

3.4.1 General

This section specifies the marking of all machines with reflectors when at their normal job site. In this document, reflectors are defined as reflex reflectors (refer to SAE J594) or reflective material that shall be visible at night from all distances within 182 to 30 m, when directly in front of lawful lower beams of headlamps. Refer to ISO12509 for further guidance.

3.4.2 Rubber-Tired and Track Machines

Two red reflectors shall be mounted on the rear of the machine, as low in height as practical and spaced as far apart from the centerline of the machine as practical. They shall be spaced no further than 3 m from the outer edge of the machine.

3.4.3 Rubber-Tired Machines Over 3-M Long

Two yellow reflectors shall be mounted on each side of the machine. One reflector shall be mounted as far forward as practical, but no more than 3 m from the front of the machine and as low as practical, but no less than 0.4 m above the ground. The second shall be mounted as far rearward as practical and as low as practical, but no less than 0.4 m above the ground. Refer to ISO 12509. Additional reflectors shall be required if the distance between any two reflectors exceeds 3 m.

For machines under 3-m long, a single yellow reflector on each side is acceptable.

High-mounted reflectors may be used in addition to the required low-mounted reflectors.

4. ENVIRONMENTAL TESTS

4.1 Operating Ambient Temperature

All the lamps shall operate throughout the temperature range of -40 to 85 °C. No permanent deformation or cracking is acceptable throughout this range over the design life of the assembly.

4.2 Maximum Operating Temperature

If contact with the lens or housing is likely due to the lamp mounting location, consideration shall be given to the surface temperatures and the protection that may be required.

4.3 Operating Voltage

Operating voltage shall be specified for the lamp by the manufacturer. When a test requires the lamp to be operating, the power supply voltage shall be at the nominal value specified by the manufacturer, with 2% tolerance. Refer to SAE J2895, Table 1 for system voltage values.

4.4 Initial H-V Light Output Test

The following tests may be performed on separate samples for each test. An initial light output test on H-V axis shall be performed for each sample.

4.5 Thermal Endurance Test

Expose the lamp assembly to the specified maximum ambient temperature (85° C) for the time required to reach thermal stability, then turn on the supply voltage and operate the lamp for 100 hours. Steady burning lamps shall work constantly, flashing lamps shall work at their normal flashing duty, and stop lamps shll work at 30-second on, 60-second off duty. The lamp assembly shall remain functional throughout the test. At the end of 100 hours, turn off the supply voltage. The lamp shall be cooled to ambient tempereature and tested for light output and integrity. The light output after the test shall be at least 80% of its pretest light output.

4.6 Vibration Test

The light assembly shall be fastened to the table of the vibration test machine, mounted on its standard supplied support, and the test shall be conducted as specified in Section 8 of SAE J2121.

Upon completion of the test, there shall be no observed rotation, displacement, cracking, or rupture of parts of the device, which could result in failure of any other tests contained in this document. Looseness of parts, as evidenced by rattling heard as the assembly is shaken, shall also constitute a failure. Cracking or rupture of parts of the device affecting its mounting shall also institute a failure. The light output after the test shall be at least 80% of the initial light output prior to the vibration test. The incandescent light source may be replaced after the test, but the initial LED light source shall remain.