SAE International™ SURFACE VEHICLE STANDARD

SAE J2121 REAF. DEC2002

Issued 1995-04
Reaffirmed 2002-12

Superseding J2121 APR1995

Requirements for Composite Lighting Assemblies used on Construction and Industrial Machinery

1. ***Scope***—This SAE Standard provides general design performance requirements and related test procedures for composite lighting unit assemblies, other than signaling and marking devices, used on construction and industrial machines as defined in SAE J1116.

1.1 **Purpose**—To provide general guidelines and design parameters for lighting assemblies used on construction and industrial machinery.

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 SAE publications shall apply.

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

SAE J180—Electrical Charging Systems for Off-Highway Work Machines
SAE J1116—Categories of Off-Road Work Machines

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117-90—Standard Test Method of Salt Spray (Fog) Testing

3. ***Definitions***

3.1 **Composite Lighting Assembly**—A lighting device comprised of lens, reflector and holding mechanism, housing, and a replaceable light source.

3.2 **Design Beam Pattern**—The beam distribution which establishes 90% of the light output. It is defined typically by angular degrees horizontal by angular degrees vertical.

3.3 **Design Voltage**—That voltage assigned by the burner manufacturer to establish the specifications for current, light output, and life.

3.4 **Test Fixture**—A fixture which simulates the mounting interface of the lighting unit to a machine. It may be used for the icing and pressure water test.

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3.5 Design Life—The rated quiescent life of a burner or light source in hours, at design voltage. The B_{10} Stand Life.

3.6 Application Voltage—The voltage, generated and distributed by the machine electrical system, that is applied to the lamp terminals.

4. Light Source Requirements

4.1 Life—Acceptable life is often determined by the application requirements. These are primarily shock, vibration, voltage transients, and steady-state voltage. The design life of the light source shall be mutually agreed upon between lamp manufacturer and machine manufacturer.

4.2 Steady-State Voltage—The control of steady-state voltage can be very important in the application of a light assembly (especially tungsten lamps).

For tungsten lamps, the re-rating rules are:

a. Rerated Light Power = $(V/V_D)^{3.5}$ x light power at V_D
b. Rerated Life = $(V_D/V)^{12}$ x life at V_D
c. Rerated Current = $(V/V_D)^{0.55}$ x current at V_D

where:

V = Application voltage
V_D = Design voltage

In order to maximize the life and effectiveness of a lamp, the application voltage should be identical to the design voltage. The application voltage is the result of the following:

a. Alternator output voltage which is dictated by the requirements to re-charge the battery.
b. Voltage drops resulting from the various control devices such as switches, circuit breakers, etc., in the lamp circuit.
c. Voltage drop in the electrical cables and ground return of the lamp circuit.

The application voltage is typically adjusted by selecting the lamp circuit cable to provide the appropriate resistance and voltage drop.

Quiescent life tests shall be performed at the nominal design voltage level within 0.1 V. The voltage shall be measured at the light assembly electrical interface.

4.3 Voltage Transients—As shown in Table 1, voltage transients take on many forms depending on their source. Transients can cause immediate failure or significantly shorten the life of the lamp. The system design shall take into account these transients to eliminate or reduce their effect on the life of the light assemblies.

TABLE 1—TRANSIENT VOLTAGES

Cause	Effect
Voltage Regulator Failure	50% over Voltage
Jump Starts	100% over Voltage
Alternator Load Dump (Disconnect Battery)	12V System: $(14+100\ e^{-t/.2})$ V 24V System: $(28+200\ e^{-t/.2})$ V (t=time in seconds)
Inductive Load Transients	$\pm 200\ e^{-t/.2}$ V (t=time in seconds)
Mutual Coupling in Harness	$\pm 200\ e^{-t/.001}$ V (t=time in seconds)
Accessory Noise	1.5 vpk (50 Hz to 10 kHz)
Radio Frequency Interference	R F Energy
Machine Welding	100% over Voltage

5. ***Operating Ambient Temperature—***The light assembly 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.

6. ***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.

7. ***Shock and Vibration—***Shock and vibration are common in off-road equipment and the following situations are typical: Operating over rough terrain, running into immovable objects, and using the mounted tools as hammers. The shock levels induced and the resulting structural vibrations have a negative effect upon light filament life. Light mounting methods and locations should be selected to reduce shock and vibration effects. Both level and frequency are important to the overall life of the light. Lower voltage filaments are more rugged and are better able to withstand shock and vibration.

   The test criteria to evaluate the ability of the light assembly to withstand shock and vibration shall be determined and agreed upon by the lamp manufacturer and the machine manufacturer. The test criteria shall define the frequency range, acceleration, length of test in each axis, sweep rate, and the power cycle in order to establish a quantitative value of lamp life for the application.

8. ***Dust—***The light assembly shall be sealed to dust and the following dust test shall be used. An initial light power test to measure peak candlepower shall be performed. An enclosure, with a minimal inside dimension of 1 m shall contain 15 kg of AC fine dust (as referenced in SAE J180). The light assemblies shall be mounted not closer than 150 mm from any wall in the normal operating orientation toward the bottom of the enclosure. Every 15 min the dust shall be agitated by a fan blower for enough time to completely and uniformly diffuse the dust throughout the enclosure. The dust is then allowed to settle.

   This test is to continue for 500 h. After the dust test, each assembly exterior is to be cleaned and the peak candlepower determined. The light assembly shall be operable within 90% of its initial value to pass this test.

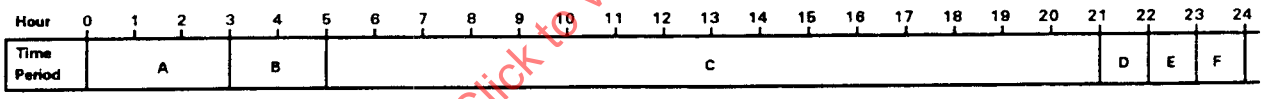
9. Moisture Sealing

9.1 Pressure Washer—The light assembly, as installed, shall not accept water internally from a high-pressure washer when operated at 140 bar with a solid cone angle and orifice of 2 mm. The nozzle shall pass not closer than 300 mm from the front surface of the light during washing while the light is mounted into its test fixture in its proper orientation.

9.2 Rain and Shine—The light assembly, as installed, shall be subjected to 100 cycles of rain and shine operation. Each cycle shall consist of 1 h of simulated precipitation of 5.0 mm/h of water from one or more solid cone nozzles followed by 1 h where the test sample lamp is energized at rated voltage. After the 100 cycle test, the samples shall be examined. Moisture ingression or corrosion that results in degradation in performance shall constitute a failure.

10. Fluid Compatibility—The light assembly shall remain functional and shall not degrade when it comes into contact with chemicals commonly used in off-road machinery. The assembly will be brushed with engine oil, hydraulic and transmission oils, #1 diesel fuel, brake fluid, ethylene glycol, and phosphatizing agents at room temperature. The samples shall be completely brushed eight times with each fluid with a 1 h interval between each brushing. The samples will be allowed to stand 16 h minimum in this condition. At the completion of this period, rinse, air dry, and then test the light assemblies with criteria being 90% of its initial peak light output and no discoloration or degradation.

11. Icing—The light assembly shall show no damage when allowed to ice over. The test procedure for each 24 h cycle is shown in Figure 1. The light assembly may be mounted into its test fixture for this test. The light assembly and test fixture shall be turned upward to aid in distributing the water over the exterior surface. The light assemblies shall be subjected to ten of these 24 h cycles. Any assemblies found with cracks, open seams, or other damage shall be cause for failure of this test.



Time Period	Procedure
A	For 3 s every 15 min the surface of the light assembly shall be sprayed with a fine mist of water cooled to 0 to 3 °C while the light assembly is cooled from room temperature to –5 °C.
B	Spray mist shall continue with the light assembly temperature maintained at –5 °C.
C	Test fixtures shall be cooled from –5 to –40 °C over a 16 h period without any further spraying.
D	Light assembly shall be energized for 1 h and then removed from the cold chamber.
E	Light assembly shall be energized for 1 h while at room temperature.
F	Light assembly shall be rinsed, dried, and reviewed for any damage along the surfaces and seams of the light assembly.

FIGURE 1—ICING TEST PROCEDURE

12. Illumination Performance—The light output or performance is a function of the intended design and application. The illumination effects in any given application are very subjective and need to be quantified by measurable features. Measurable parameters of this performance are beam pattern intensities, measured in candela, and beam distribution as displayed in an iso-candela curve or contour plot.

General desirable qualities of all beam pattern distributions are smooth, even lighting gradients throughout the entire beam pattern. This will eliminate hot spots, voids, and stria which can cause false cuing or poor acuity to the operator of a machine using this light pattern.

To allow for the optimum flexibility in providing lighting pattern that perform specific illumination objectives, an agreement between the supplier and customer should be reached as to the desired characteristics of the lighting pattern and method of measurement. Two methods of depicting lamp output are shown in Figure 2 (vertical plane) and Figure 3 (horizontal or ground plane).

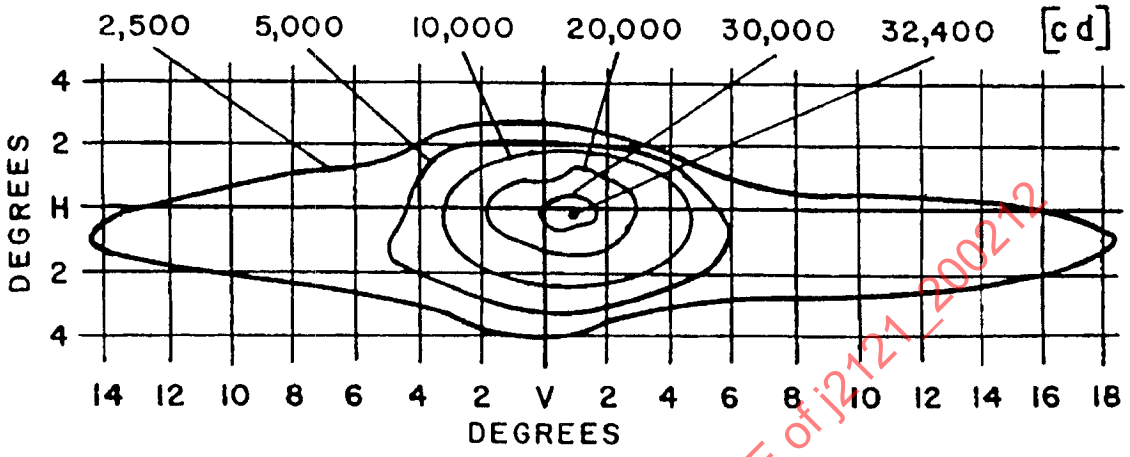


FIGURE 2—ISO-CANDELA CURVE

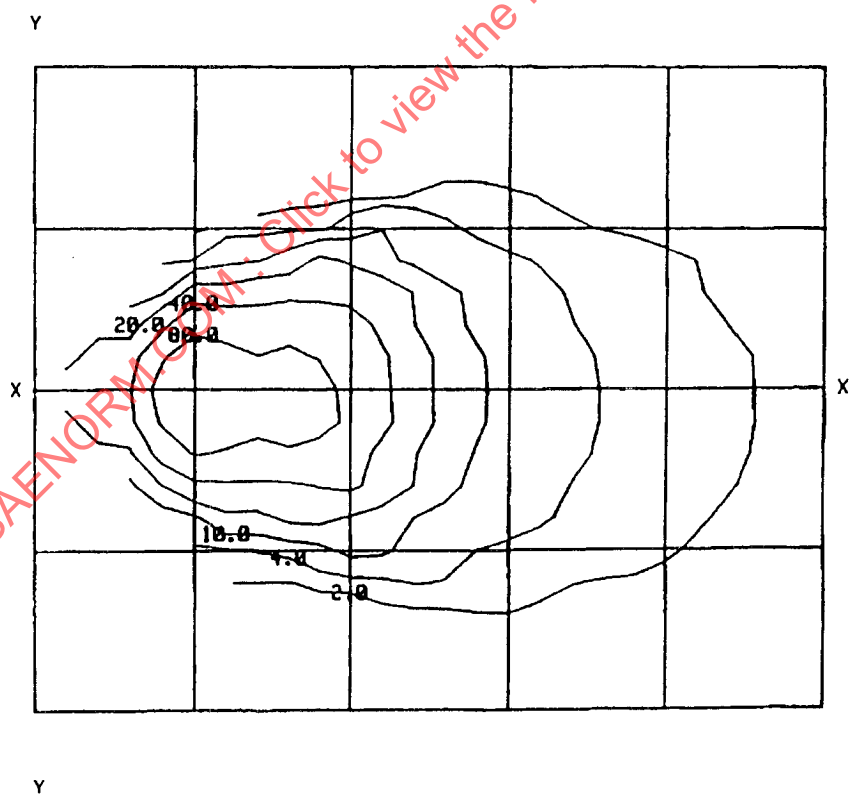


FIGURE 3—ISO-LUX CURVE