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Performance Requirements for Replaceable Bulb Motor Vehicle Headlamps				

RATIONALE

Revisions to this document were made to improve the readability and to revise the photometric tables for modern beam pattern requirements. Specific changes are detailed below:

- Section 6.15.5.1.4 was changed to make the information easier to read and easier to find the test method to be used.
- Section 7.4 added to include a design guideline for the high beam hot spot.
- Photometry tables updates for modern beam patterns.

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1. SCOPE

This SAE Recommended Practice is intended as a guide toward standard practice and is subject to change to keep pace with experience and technical advances. This document establishes performance requirements, material requirements, design requirements, and design guidelines for headlamps.

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.

2.1.1 SAE Publications

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

SAE J387	Terminology – Motor Vehicle Lighting
SAE J575	Tests for Motor Vehicle Lighting Devices and Components
SAE J576	Plastic Materials for Use in Optical Parts Such as Lenses and Reflectors of Motor Vehicle Lighting Devices
SAE J578	Color Specification
SAE J599	Lighting Inspection Code
SAE J600	Headlamp Testing Machines
SAE J602	Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units
SAE J759	Lighting Identification Code
SAE J2442	Harmonized Installation Provision for Installation of Lamps and Retro-Reflecting Devices
SAE J2595	Performance Requirements for Sealed Beam Motor Vehicle Headlamps

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 Federal Publications

Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

FMVSS 108

2.2.2 ASTM Publications

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 308-85 Standard Method for Computing the Color of Objects by Using the CIE System

3. DEFINITIONS

3.1 Headlamp

A lighting device providing a high and/or a low beam designed to provide illumination forward of the vehicle.

3.2 Replaceable Bulb (Bulb)

A light source with related envelope and mounting base which is removable from the headlamp for the purpose of replacement.

3.3 Mechanically Aimable Headlamp

A headlamp having three pads on the lens, forming an aiming plane or an aiming ring, the aiming plane or aiming ring being used for laboratory photometric testing and for inspecting the aim of the headlamp when installed on the vehicle.

3.4 Aiming Plane

A plane defined by the surface of the three aiming pads on the headlamp lens or by the forward surface of an aiming ring.

3.5 Headlamp Optical Axis

The line formed by the intersection of a horizontal and a vertical plane through the light source parallel to the longitudinal axis of the vehicle. If the optical axis of the headlamp is not at the geometric center of the lens, then the location will be indicated by the manufacturer on the headlamp.

3.6 H-V Axis

A line from the center of the principal filament formed by the intersection of the horizontal (H) and vertical (V) planes which intersect the filament and are perpendicular to the test screen.

3.7 Seasoning

Process of energizing the filament of a bulb at design voltage for a period of time equal to 1% of design life or 10 h, whichever is shorter.

3.8 Design Voltage

The voltage used for design purposes.

3.9 Test Voltage

The specified voltage and tolerance to be used when conducting a test.

3.10 Rated Voltage

The nominal circuit or vehicle electrical system voltage classification. (Example: 12 V headlamp.)

3.11 Headlamp Test Fixture

Device specifically designed to support a headlamp in the test position during laboratory testing. Mounting hardware and components shall be representative of those necessary to operate the headlamp in its normal manner.

3.12 Aiming Screws

Screws with self-locking features used for adjusting horizontal and/or vertical aim and to retain the headlamp unit in the proper position.

3.13 Vehicle Headlamp Aiming Device (VHAD)

An aiming device incorporated in the headlamp system which allows for inspection and adjustment of headlamp aim without the use of aim measuring equipment external to the vehicle.

3.14 High Beam

A beam intended primarily for distant illumination and for use when not meeting or following other vehicles.

3.15 Low Beam

A beam intended to illuminate the road ahead of the vehicle when meeting or following another vehicle.

3.16 High Beam Filament

Filament coil designed to provide high beam function.

3.17 Low Beam Filament

Filament coil designed to provide low beam function.

3.18 Design Life

An operational time objective in hours of a light source at the test voltage.

3.19 Aiming Reference Plane

A plane which is perpendicular to the longitudinal axis of the vehicle and tangent to the forward most aiming pad on the headlamp or, where such a plane would intersect the surface of the lens between the aiming pads, a plane which is perpendicular to the longitudinal axis of the vehicle and is located forward of and as close to the lens as possible without causing interference.

3.20 Direct Reading Indicator

A device that is mounted in its entirety on a headlamp or headlamp aiming or headlamp mounting equipment, is part of a VHAD, and provides information about headlamp aim in analog or digital format.

3.21 Remote Reading Indicator

A device that is not mounted in its entirety on a headlamp or headlamp aiming or headlamp mounting equipment, but otherwise meets the definition of a direct reading indicator.

3.22 Visually/Optically Aimable Headlamp

A headlamp which is designed to be visually/optically aimable.

3.23 Cutoff

A visual/optical aiming cue in the low beam that marks a separation between areas of higher and lower luminance.

4. LIGHTING IDENTIFICATION CODE, MARKINGS AND NOTICES

4.1 SAE J759 Lighting Identification Code

Headlamps meeting the requirements of this document shall be identified by the code "HR" in accordance with SAE J759.

4.2 Headlamp Marking Requirements

Headlamps shall be permanently marked with the following markings:

4.2.1 Name and/or trademark of the manufacturer, importer, or vehicle manufacturer shall be visible when installed on the vehicle.

4.2.2 Design voltage and part number or trade number shall appear on the headlamp.

4.2.3 If markings are molded on the surface of the lens, the face of letters, numbers, or other symbols molded on the surface of the lens shall not be raised more than 0.5 mm (0.020 in).

4.2.4 The letters, numbers, or other symbols shall be not less than 3 mm in height.

4.3 Headlamp Aim-Type Code

4.3.1 Mechanical Aim Headlamp

4.3.1.1 The lens shall have three aiming pads which meet the requirements of Figures 1 to 4, which detail the dimensional specifications for the location of aiming pads on replaceable bulb headlamps. The aiming pads need not be centered at the geometric center of the lens, or on the optical axis. Except as provided in 4.3.1.2, a whole number, which represents the distance in tenths of an inch (i.e. 0.3 inch = 3) from the aiming reference plane to the respective aiming pads which are not in contact with that plane, shall be inscribed adjacent to each respective aiming pad on the lens. The height of these numbers shall be not less than 0.157 in (4 mm). If there is interference between the plane and the area of the lens between the aiming pads, the whole number represents the distance to a secondary plane. The secondary plane shall be located parallel to the aiming reference plane and as close to the lens as possible without causing interference.

4.3.1.2 If the forward aiming pad is the lower inboard aiming pad, then the dimensions may be placed anywhere on the lens. The dimension for the outboard aiming pad (Dimension F in Figure 4) shall be followed by the letter "H" and the dimension for the center aiming pad shall be followed by the letter "V." The dimensions shall be expressed in tenths of an inch.

4.3.2 Visual/Optical Aim Headlamp

4.3.2.1 Vertically Aimed Headlamp

4.3.2.1.1 Headlamps intended to be aimed vertically using the left side of the low beam pattern shall be marked "VOL."

4.3.2.1.2 Headlamps intended to be aimed vertically using the right side of the low beam pattern shall be marked "VOR."

4.3.2.2 Vertically and Horizontally Aimed Headlamp (Reference 6.15.5.1.4)

4.3.2.2.1 Headlamps intended to be aimed horizontally using a 0.2D scan and be aimed vertically via the right side of the low beam pattern shall be marked "VORH1."

4.3.2.2.2 Headlamps intended to be aimed horizontally using a 0.2D scan and be aimed vertically via the left side of the low beam pattern shall be marked "VOLH1."

4.3.2.2.3 Headlamps intended to be aimed horizontally using a 3-line scan shall be aimed vertically via the left side of the low beam pattern and shall be marked "VOLH2."

4.3.2.3 High Beam Headlamp

4.3.2.3.1 Headlamps intended to be aimed via the high beam pattern shall be marked "VO."

4.3.3 VHAD Aim Headlamp

VHAD aim headlamps do not require any aim-type code markings.

4.4 Replacement Component Marking

Replaceable lens headlamps shall have the manufacturer's name and/or trademark identification permanently marked on the lens and housing. In addition, a replacement component shall be marked with all markings that appear on the original equipment component that it replaces except that the name of the manufacturer may be different. Replacement components must be marked with the name of the manufacturer or importer of the component.

4.5 Mechanical Axis Marking

To assure proper horizontal and vertical alignment of the aiming screen or optical aiming equipment, the optical axis location shall be indicated. The mark or markings may be on the interior or exterior of the lens or indicated by a mark or central structure on the interior or exterior of the headlamp.

5. TESTS

The voltage for all testing shall be design voltage ± 0.1 V DC as measured at the terminals of the headlamp unless otherwise specified. The test procedures and test requirements specified in this document were developed emphasizing extreme conditions in the headlamp environment. Separate headlamps shall be used for each test. Unless otherwise indicated, all drain holes, breathing devices or other openings or vents of headlamp units under test shall be in their normal operating condition.

Bulbs—Unless otherwise specified, bulbs used in the tests shall be representative of bulbs in regular production.

5.1 SAE J575, Tests for Motor Vehicle Lighting Devices and Components

The following tests are applicable with the modifications as indicated.

5.1.1 Vibration Test

The filament(s) shall not be operated during the test.

5.1.2 Dust Test

The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the dust test. If no dust is visible inside the headlamp after the dust test, the headlamp does not need to be photometered after the dust test.

5.1.3 Corrosion Test

5.1.3.1 The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the corrosion test.

5.1.3.2 The test period shall be 240 h consisting of 10 cycles of 23 h exposure followed by 1 h drying.

5.1.4 Photometry

5.1.4.1 Test samples shall be new, unused headlamps manufactured from production tooling and assembled by means of production processes.

5.1.4.2 Bulbs

The lamp shall be fitted with an accurate rated bulb (selected per SAE J387) and tested at the rated luminous flux output. Where special bulbs are used, they shall be seasoned per SAE J387 and operated at their rated luminous flux output. If the rated luminous flux output is not available, or not applicable, operate the bulb at its specified design voltage. If the luminous flux output of the bulb is intentionally modified from specifications for the device through internal or external circuitry, operate the bulb at its modified voltage, or with the voltage modification circuitry attached and with the specified design voltage applied to the input of the modification circuitry.

- 5.1.4.3 The headlamp shall be photometered at the appropriate test points as listed in Table 1 and/or Table 2 as applicable. The headlamp shall be in operation a minimum of 3 min prior to photometry.
- 5.1.4.4 Photometric tests shall be made with the photometer sensor at a minimum distance from the headlamp of 10 m for determining the cut-off gradient for visual/optical aim headlamps and 18.3 m for photometrics.
- 5.1.4.5 Mechanically aimable headlamps shall be aimed with the aiming plane at the design angle(s) to the photometer axis and the headlamp optical axis coincident with the photometer axis.
- 5.1.4.6 VHAD aimable headlamps shall be aimed to the zero indication of the VHAD.
- 5.1.4.7 Visually/Optically aimable headlamps shall be aimed according to the aim requirements in 6.15.5.1.

5.1.5 Humidity

The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the humidity test as required by the humidity requirement of SAE J575.

5.2 Color Test

SAE J578 is a part of this report.

5.3 Plastic Materials

SAE J576 is a part of this report except for Luminous Transmittance Test.

5.4 Impact Test

This test applies to headlamps with external plastic lenses or outer covers.

- 5.4.1 The headlamp or lens shall be rigidly mounted in a test fixture on the seating plane with the lens facing up.
- 5.4.2 The seating plane of the test fixture shall consist of a rigid material, such as 13 mm thick oak wood. The test fixture shall rest on a rigid base (such as an oak wood base).
- 5.4.3 One impact shall be delivered to the headlamp lens along the mechanical axis using a 23 mm diameter steel sphere (approximately 50 g) dropped freely, without side forces, from a distance of 40 cm above the lens.

5.5 Aiming Adjustment Test

- 5.5.1 When making the aiming adjustment test, an accurate measurement technique shall be used. This may consist of:
 - 5.5.1.1 Attaching a device such as a spot projector to the headlamp, or
 - 5.5.1.2 Replacing the replaceable bulb with a mirror along with a separate light source, or
 - 5.5.1.3 Other equally accurate means.
- 5.5.2 When conducting the test, the headlamp shall be mounted initially in the design position with the unit at nominal aim (0,0).
- 5.5.3 The vertical aiming screw shall be turned to the upper and lower extremes of its range as defined in 6.5 and the vertical angle between the mechanical and H-V axes shall be measured in each position. Any change in horizontal angle throughout the vertical aim range shall also be recorded.

5.5.4 The horizontal aiming screw shall be turned to the left and right extremes of its range as defined in 6.5 and the horizontal angle between the mechanical and H-V axes shall be measured in each position. Any change in vertical angle throughout the horizontal aim range shall also be recorded.

5.6 Aim Range Test

For headlamps aimed by moving the reflector relative to the lens and headlamp housing or vice versa.

5.6.1 Test the photometry per 5.1.4 with the lens at any position relative to the reflector within the range limits as specified in 6.5.

5.7 Inward Force Test

For mechanically aimable headlamps.

The headlamp assembly, including the aiming adjusters, shall be subjected to an inward force of 222 N directed normal to the headlamp aiming plane and symmetrically about the center of the headlamp assembly face. (See Figure 5.)

5.8 Torque Deflection Test

For mechanically aimable headlamps.

5.8.1 The headlamp assembly to be tested shall be mounted in design vehicle position and set at nominal aim (0,0).

5.8.2 Replaceable bulb headlamps shall be equipped with an appropriate fixture which mates to one of the deflectors shown in SAE J2595 on the face of the lens with an applied torque of 222 N acting parallel to the aiming reference plane and in a downward direction. The force shall be applied through the aiming pads.

5.8.3 The torque shall be applied to the headlamp assembly through the deflectometer and a reading on the thumbwheel shall be taken. The torque shall then be removed and a second reading on the thumbwheel shall be taken.

5.9 Chemical Resistance Test

This test applies only to headlamps with plastic lenses or outer covers.

5.9.1 The test shall be conducted with the headlamps and the test fluids at an ambient temperature of $23^{\circ}\text{C} \pm 4^{\circ}\text{C}$.

5.9.2 The test headlamps shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the chemical resistance test (see 5.1.4).

5.9.3 A separate headlamp may be used for each of the test fluids.

5.9.4 The test fluids are:

5.9.4.1 Windshield washer fluid (50% concentration by volume of methanol/detergent base, 0.16% ethanalamine).

5.9.4.2 Antifreeze (50% concentration by volume of ethylene glycol in water).

5.9.4.3 Simulated unleaded gasoline (test fluid ASTM D 471-79 Reference fuel "D").

5.9.5 An unfixtured headlamp in its design operating position and condition shall be used for the test.

5.9.6 A 15 cm square cotton cloth shall be folded twice to form a 7.5 cm square and placed at the bottom of a beaker.

5.9.7 Meter 3 mL of the test fluid onto the folded cloth.

- 5.9.8 Remove the cloth from the beaker (5 s after completion of test fluid metering for Reference Fuel D and windshield washer fluid, and 60 s after completion of test fluid metering for antifreeze).
- 5.9.9 Within 5 s after removal of the cloth from the beaker, wipe the lens and the top surface of the lens-lamp housing joint with that cloth surface which was uppermost in the beaker. The entire exterior optical surface of the lens and top surface of the lens-lamp housing joint of the fixtured headlamp shall be wiped in three horizontal cycles (one cycle consists of one back and forth motion). The first cycle shall apply the test fluid to the upper segment of the lens and the joint, the second cycle shall apply it to the center segment of the lens and the third cycle shall apply it to the lower segment of the lens.
- 5.9.10 After applying the test fluid, the test headlamp shall be set aside for a period of 48 h whereupon the headlamp shall be wiped clean with a soft, dry, cotton cloth.

5.10 Abrasion Test of Plastic Headlamp Lens Material

- 5.10.1 A 100 mm x 165 mm flat test specimen shall be measured for luminous transmittance (Y) using an Illuminant A or headlamp bulb per ASTM E 308 before abrasion test and after wiping clean following the abrasion test. An actual headlamp lens could also be used as a test specimen.
- 5.10.2 The test specimen shall be mounted in the abrasion test machine as indicated in Figure 6.
- 5.10.3 The size of the abrading pad shall be 25 mm x 100 mm constructed of 0000 steel wool and firmly attached to a pad support of equal size such that the "grain" of the pad is perpendicular to the direction of motion.
- 5.10.4 The abrading pad shall be loaded such that an average pad pressure of $14 \text{ kPa} \pm 1 \text{ kPa}$ exists normal to the surface of the test specimen.
- 5.10.5 The density of the abrading pad shall be such that when the abrading pad mounted to the pad support is resting unloaded on the test specimen, the pad support shall be no closer than 3.1 mm to the surface of the test specimen.
- 5.10.6 An abrasion cycle is one forward stroke $10 \text{ cm} \pm 2 \text{ cm}$ and one rearward stroke of the same distance. The velocity of the abrading pad shall be $10 \text{ cm/s} \pm 2 \text{ cm/s}$.
- 5.10.7 The test specimen shall be subjected to 20 abrasion cycles.

5.11 Thermal Cycle Test

This test applies only to headlamps that have a plastic lens, a plastic reflector, or both

- 5.11.1 The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the thermal cycle test (see 5.1.4).
- 5.11.2 The headlamp shall be rigidly mounted in a test fixture in designed operating condition and designed mounting position.
- 5.11.3 The headlamp shall be exposed to the thermal cycle profile shown in Figure 7. The minimum temperature is -40°C and the maximum temperature is 50°C .
- 5.11.4 Separate or single test chambers may be used to generate the temperature environment described by the thermal cycle.
- 5.11.5 The headlamp shall be energized at design voltage $\pm 20 \text{ mV}$, in its highest wattage mode commencing at point "A" of Figure 7 and de-energized at point "B" of each cycle.
- 5.11.6 The test period shall be 10 cycles of 8 h per cycle.

5.12 Internal Heat Test

- 5.12.1 The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the internal heat test (see 5.1.4).
- 5.12.2 The headlamp shall be rigidly mounted in a test fixture in designed operating condition and designed mounting position.
- 5.12.3 A dirt mixture, consisting of Portland cement (per ASTM C 150-84), distilled or deionized water, and a small amount of surfactant shall be uniformly applied on the face of the lens and allowed to dry until the light intensity at the maximum intensity location in the beam pattern is reduced to $25\% \pm 2\%$ of the original value for the highest wattage function of the lamp. The mixture may be uniformly applied by spraying or brushing.
- 5.12.4 The headlamp assembly shall be energized in its highest wattage continuous operation mode and placed in a chamber at $35\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ in still air.
- 5.12.5 The test duration shall be 1 h.
- 5.12.6 The test voltage for the headlamp shall be design voltage $\pm 0.1\text{ V}$.
- 5.12.7 After the internal heat test, the lens face shall be wiped clean.

5.13 Chemical Resistance of Reflectors of Replaceable Lens Headlamps

- 5.13.1 The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the chemical resistance test (see 5.1.4).
- 5.13.2 With the headlamp in the headlamp test fixture and the lens removed, the entire surface of the reflector that receives light from a headlamp light source shall be wiped once to the left and once to the right with a 6-inch square soft cloth (with pressure equally applied) which has been saturated once in a container with 2 ounces of one of the test fluids listed in 5.13.3. The lamp shall be wiped within 5 seconds after removal of the cloth from the test fluid. A new lamp shall be used for each test fluid.
- 5.13.3 Test Fluids
 - 5.13.3.1 Commercially available window cleaner, such as Windex®;
 - 5.13.3.2 Tar remover (consisting by volume of 45% xylene and 55% petroleum base mineral spirits);
 - 5.13.3.3 Mineral spirits;
 - 5.13.3.4 Fluids other than water contained in the manufacturer's instructions for cleaning the reflector.
- 5.13.4 After the headlamp has been wiped with the test fluid, it shall be stored in its designed operating attitude for 48 h at a temperature of $73\text{ }^{\circ}\text{F} \pm 7\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 4\text{ }^{\circ}\text{C}$) and a relative humidity of $30\% \pm 10\%$. At the end of the 48-h period, the headlamp shall be wiped clean with a soft dry cotton cloth and visually inspected.

5.14 Corrosion Resistance of Reflectors of Replaceable Lens Headlamps

- 5.14.1 The headlamp shall be seasoned and photometered to the test points in Table 1 and/or Table 2 as applicable before and after the corrosion test (see 5.1.4).
- 5.14.2 The headlamp with the lens removed, unfixtured and in its designed operating attitude with all drain holes, breathing devices or other designed openings in their normal operating positions, shall be subjected to a salt spray (fog) test in accordance with ASTM B 117-73, Method of Salt Spray (Fog) Testing, for 24 hours, while mounted in the middle of the chamber.

5.14.3 Afterwards, the headlamp shall be stored in its designed operating attitude for 48 hours at a temperature of $73^{\circ}\text{F} \pm 7^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 4^{\circ}\text{C}$) and a relative humidity of $30\% \pm 10\%$ and allowed to dry by natural convection only. At the end of the 48-hour period, the reflector shall be cleaned according to the instructions supplied with the headlamp manufacturer's replacement lens, and inspected. The lens and seal shall then be attached according to these instructions and the headlamp tested for photometric performance.

6. PERFORMANCE REQUIREMENTS

A headlamp, when tested in accordance with the test procedures specified in Section 5, shall meet the following requirements:

6.1 SAE J575, Test Requirements for Motor Vehicle Lighting Devices and Components

6.1.1 Vibration Requirement

There shall be no evidence of loose or broken parts, or intermittent electrical circuit.

6.1.2 Dust Requirement

6.1.2.1 There shall be no evidence of dust in the headlamp; or,

6.1.2.2 If internal dust is present, the photometric values measured after the dust test shall not vary more than $\pm 20\%$ from the corresponding values measured before the test.

6.1.3 Corrosion Requirement

6.1.3.1 The test headlamp shall show no evidence of exterior or internal corrosion or edge corrosion beyond 2 mm (0.08 in) from a weld or sheared or cut edge.

6.1.3.2 The headlamp shall conform to the requirements of SAE J575 and all lamp operational features shall remain functional per design intent.

6.1.3.3 The photometric values measured after the corrosion test shall either: a) not vary more than $\pm 20\%$ from the corresponding values measured before the test, or b) meet the photometric requirements for the headlamp.

6.1.4 Photometric Performance Requirement

Headlamps shall be designed to conform to the photometric requirements of Table 1 and/or Table 2 as applicable.

6.1.4.1 On headlamps with visual/optical aim, photometric tests shall be performed with the aim set vertically by the gradient value as described in section 6.15.5.1. Aim is then to be set horizontally by the appropriate means according to the lamp design.

6.1.4.1.1 Adjust the horizontal VHAD to "0," or

6.1.4.1.2 Aim the horizontal gradient value if the lamp has a horizontal adjustment mechanism without a VHAD, or

6.1.4.1.3 Mount the headlamp assembly to the test fixture in its design mounting position in the vehicle if it does not have a horizontal adjustment mechanism.

6.1.5 Humidity Performance Requirement

Headlamps shall meet the requirements of SAE J575.

6.2 Color Requirement

The color of the emanating light produced by a headlamp shall be white per SAE J578.

6.3 Plastic Materials Requirements

Headlamps shall meet the material requirements of SAE J576, except Luminous Transmittance.

6.4 Impact Requirement

The headlamp shall show no evidence of broken, cracked, or chipped pieces of the headlamp, coating adhesion failure, or delamination of material, or visible loosening or breaking apart of headlamp parts.

6.5 Aiming Adjustment Requirement

When tested in accordance with 5.5, the headlamp shall meet the following requirements:

- 6.5.1 When a headlamp system is tested in a laboratory, the range of its vertical aim shall not be less than ± 4.0 degrees in the vertical plane from the nominal correct aim position or the full range of pitch of the vehicle on which the headlamp system is installed [from empty to full rated Gross Vehicle Weight].
- 6.5.2 A minimum aiming adjustment of ± 2.5 degrees from the nominal correct aim position shall be provided in the horizontal plane for headlamp assemblies that have a horizontal adjuster.
- 6.5.3 When tested in the laboratory, adjustment of one aim axis through its full on-vehicle range (specified in 6.5.1 and 6.5.2) shall not cause the aim of the other axis to deviate more than ± 0.76 degrees.
- 6.5.3.1 If the aim mechanism does not meet the requirements of 6.5.2, a cautionary label shall be placed adjacent to the mechanism stating the caution and including either the reason for the caution or the corrective action necessary. Each such label shall also refer the reader to the vehicle operator's manual for complete instructions. Each such vehicle shall be equipped with an operator's manual containing the complete instructions appropriate for the mechanism installed.
- 6.5.4 On headlamps with a vertical VHAD tested in the laboratory, the headlamp shall be able to indicate variations in vertical aim within a range extending from 1.2 degrees above to at least 1.2 degrees below a longitudinal horizontal plane through the center of the headlamp system.
- 6.5.5 On headlamps with a horizontal VHAD tested in the laboratory, the headlamp shall be able to indicate variations in horizontal aim within a range extending from 0.76 degrees left to at least 0.76 degrees right of a longitudinal vertical plane through the center of the headlamp system.
- 6.5.6 The self-locking devices used to hold aiming screws in position shall continue to operate satisfactorily for a minimum of 20 adjustments on each screw, over a length of screw thread of not less than 3 mm.
- 6.5.6.1 When a headlamp system is installed on a motor vehicle, it shall be aimable with at least one of the following: An externally applied aiming device, an on-vehicle headlamp aiming device (VHAD) installed by the vehicle or lamp manufacturer, or by visual/optical means.

NOTE: Paragraphs 6.5.3, 6.5.4 and 6.5.5 are not applicable to headlamps with ball and socket or equivalent adjusting means.

6.6 Aim Range Requirements

Headlamps shall be designed to conform to the photometric requirements of Table 1 and/or Table 2 as applicable when tested within the limits defined in 6.5.

6.7 Inward Force Requirements

When subjected to the tests in 5.7, the headlamp shall meet the following requirements:

- 6.7.1 The headlamp shall not permanently recede by more than 2.5 mm.

6.7.2 The aim of the headlamp shall not permanently deviate in any direction by more than 32 mm at a distance of 7.6 m (equivalent to 0.25 degree).

6.8 Torque Deflection Requirement

When subjected to the tests in 5.8, the difference between the two readings shall not exceed 0.30 degree.

6.9 Chemical Resistance Requirement

6.9.1 The exposed headlamp, when compared to an unexposed headlamp, shall not show surface deterioration, delamination, fractures, deterioration of bonding materials, color bleeding, or color pickup as a result of exposure to the test fluids.

6.9.2 The photometric values measured after the chemical resistance test shall either: a) not vary more than $\pm 20\%$ from the corresponding values measured before the test, or b) meet the photometric requirements for the headlamp.

6.10 Abrasion of Plastic Headlamp Lens Material Requirements

The luminous transmittance of the abraded test specimen using CIE Illuminant A (2856K), shall show a maximum of 3% deterioration from the luminous transmittance of the unabraded control sample.

6.11 Thermal Cycle Requirement

6.11.1 The headlamp shall show no evidence of delamination, fractures, seal fractures, deterioration of bonding material, color bleeding, warp, or deforming.

6.11.2 The photometric values measured after the thermal cycle test shall either: a) not vary more than $\pm 20\%$ from the corresponding values measured before the test, or b) meet the photometric requirements for the headlamp.

6.12 Internal Heat Requirement

6.12.1 The headlamp shall show no evidence of delamination, fractures, seal fractures, deterioration of bonding material, color bleeding, warp, or deforming.

6.12.2 The photometric values measured after the internal heat test shall either: a) not vary more than $\pm 20\%$ from the corresponding values measured before the test, or b) meet the photometric requirements for the headlamp.

6.13 Chemical Resistance of Reflectors of Replaceable Lens Headlamps Requirements

6.13.1 The headlamp shall conform to the requirements of SAE J575 and all lamp operational features shall remain functional per design intent.

6.13.2 The photometric values measured after the chemical resistance test shall either: a) not vary more than $\pm 20\%$ from the values measured before the test, or b) meet the photometric requirements for the headlamp.

6.14 Corrosion Resistance of Reflectors of Replaceable Lens Headlamps Requirements

6.14.1 The headlamp shall conform to the requirements of SAE J575 and all lamp operational features shall remain functional per design intent.

6.14.2 The photometric values measured after the corrosion resistance test shall either: a) not vary more than $\pm 20\%$ from the values measured before the test, or b) meet the photometric requirements for the headlamp.

6.15 Design Requirements

6.15.1 Dimensions for Mechanical Aiming of Headlamps

Headlamps shall meet the following requirements to assure compatibility with mechanical aimers.

6.15.1.1 Aiming pad design may vary but shall meet the limiting dimensions as shown in Figures 1 to 4.

6.15.1.2 Except as provided in 6.15.1.5, a whole number, which represents the distance in tenths of an inch (i.e., 0.3 in = 3) from the aiming reference plane to the respective aiming pads which are not in contact with that plane, shall be inscribed adjacent to each respective aiming pad on the lens.

6.15.1.3 The height of these numbers shall not be less than 4 mm.

6.15.1.4 If the most forward aiming pad is the lower inboard aiming pad, then the numbers may be placed anywhere on the lens.

6.15.1.5 The number for the outboard aiming pad shall be followed by the letter "H" and the number for the center aiming pad shall be followed by the letter "V."

6.15.2 Headlamps when mounted on a vehicle shall meet the aimer compatibility requirements described in 6.15.3, or the Vehicle Headlamp Aiming Device (VHAD) requirements described in 6.15.4, or the Visual/Optical Aim requirements described in 6.15.5.

6.15.3 Aimer Compatibility

Mechanically aimable headlamps shall be designed and installed so that they may be inspected and aimed by mechanical aimers as specified in SAE J602 without the removal of any ornamental trim rings or other parts.

6.15.4 A Vehicle Headlamp Aim Device (VHAD) shall meet the requirements specified as follows:

6.15.4.1 Aim

The VHAD shall provide for headlamp aim inspection and adjustment in the vertical and/or horizontal directions.

6.15.4.2 Vertical Aim

The VHAD shall include the necessary references and scales relative to the horizontal plane to assure correct vertical aim for photometry and on-vehicle usage. An off-vehicle measurement of the angle of the plane of the ground is permitted. In addition, an equal number of graduations from the "0" position representing angular changes in the axis in the upward and downward directions shall be provided. The "0" position shall be marked "0" and shall be accurate to within ± 0.1 degree.

6.15.4.2.1 Each graduation shall represent a change in the vertical angle not larger than 0.19 degree. Graduations shall provide for variations in aim at least 1.2 degrees above and below the horizontal axis. For each graduation, the angle indicated by the mark or number shall be accurate to within ± 0.1 degree of the actual angle between the mark and the horizontal axis.

6.15.4.2.2 Graduations on the VHAD scale shall be spaced a minimum of 1.27 mm (0.05 in) apart. If a direct reading analog indicator is provided, it shall represent the actual aim movement in a clear, understandable format.

6.15.4.2.3 The graduations shall be legible at a distance of 0.3 m under an illumination of 30 fc maximum, measured at the top of the radiator, by an observer having 20/20 vision (Snellen).

6.15.4.3 Horizontal Aim

The VHAD shall include references and scales relative to the longitudinal axis of the vehicle necessary to assure correct horizontal aim for photometry and on-vehicle usage. A mark shall be used to indicate alignment of the headlamps relative to the longitudinal axis of the vehicle. The mark shall consist of the symbol "0" and shall be accurate to within ± 0.2 degree. In addition, an equal number of graduations representing equal angular changes in the leftward and rightward directions relative to the vehicle longitudinal axis shall be provided.

6.15.4.3.1 Each graduation shall represent a change in the horizontal angle not greater than 0.38 degree to the left and right of the longitudinal axis of the vehicle, and shall have an accuracy relative to the zero mark of equal to or better than ± 0.1 degree.

6.15.4.3.2 The graduations shall be legible at a distance of 0.3 m under an illumination of 30 fc maximum, measured at the top of the radiator, by an observer having 20/20 vision (Snellen).

6.15.4.3.3 The horizontal indicator shall perform through a minimum range of 0.76 degrees left and right; however, the indicator itself shall be capable of recalibration over an angular range of ± 2.5 degrees relative to the longitudinal axis of the vehicle to accommodate any adjustment necessary for recalibrating the indicator.

6.15.5 Visual Optical Aim lamps shall meet requirements as follows:

6.15.5.1 Visual/Optical Aiming

Each visually/optically aimable headlamp shall be designed to conform to the following requirements:

6.15.5.1.1 Vertical aim, low beam. Each low beam headlamp, designed to be visually/optically aimed, shall have a horizontal cutoff in the beam pattern. It may be either on the left side or on the right side of a vertical line through the optical axis. The minimum gradient of the cutoff shall be not less than 0.13 when measured as described in 6.15.5.1.3.

6.15.5.1.1.1 For a headlamp designed with the cutoff on the left side of the vertical line, the headlamp shall be aimed vertically so that the cutoff on the left side shall be positioned at 0.4 degree down from the H-H line when the cutoff is measured at 2.5°L of the vertical.

6.15.5.1.1.2 For a headlamp designed with the cutoff on the right side of the vertical line, the headlamp shall be aimed vertically so that the cutoff on the right side shall be positioned at the H-H line when the cutoff is measured at 2.0°R of the vertical.

6.15.5.1.1.3 The horizontal width of the cutoff used for vertical aim shall be not less than two degrees, with not less than two degrees of its actual width centered at either 2.5°L or 2.0°R. The vertical location of the highest gradient at the ends of the minimum width shall be within $\pm 0.2^\circ$ of the vertical location of the maximum gradient measured at the appropriate vertical line (at either 2.5°L for a left side cutoff or 2.0°R for a right side cutoff).

6.15.5.1.2 Horizontal Aim, Low Beam

There shall be no adjustment of the horizontal aim unless the lamp is equipped with a horizontal VHAD meeting the requirements of 6.15.4.3 or unless the lamp meets the requirements of Visual/Optical Horizontal Aim in 6.15.5.1.2.1.

6.15.5.1.2.1 Each low beam headlamp that is equipped with a horizontal adjuster and no VHAD shall have a vertical or angled cutoff in the beam pattern. The manufacturer may specify one of 2 horizontal aim methods. If the "3 line" method (Figure 8) is used, 3 vertical lines shall be scanned at 1R, 2R, and 3R after the lamp is aimed vertically. The maximum gradient found on the 2R line shall be not less than 0.08. If the "0.2D line" method (Figures 9 and 10) is used, a single horizontal line shall be scanned. The maximum gradient found on the 0.2D line shall be not less than 0.08. The scan shall be performed as described in 6.15.5.1.4 and shall be positioned as described in 6.15.5.1.5.

6.15.5.1.3 To measure the low beam vertical aim cutoff parameter, the headlamp shall be mounted on a fixture which simulates its actual design location on a vehicle. The fixture shall be attached to the goniometer table such that the fixture alignment axes are coincident with the goniometer axes. The headlamp shall be energized at the specified photometric test voltage.

The headlamp beam pattern shall then be aimed with the cutoff at the H-H axis if the cutoff is to the right of the vertical and with the cutoff at 0.4° below the H-H axis if the cutoff is to the left of the vertical. If there is a horizontal VHAD it shall be adjusted to zero. If the headlamp is designed with Visual/Optical Horizontal aim, the horizontal position shall be adjusted to position the beam pattern close to the final aim position.

A vertical scan of the beam pattern shall be conducted for a headlamp with a left side gradient by aligning the goniometer on a vertical line at 2.5°L and scanning from 1.5°D to 1.5°U. For a headlamp with a right side gradient, a vertical scan of the beam pattern shall be conducted by aligning the goniometer on a vertical line at 2.0°R and scanning from 1.5°U to 1.5°D. Determine the maximum gradient within the range of the scan by using the formula:

$$G = \log E(a) - \log E(a+0.1) \quad (\text{Eq. 1})$$

where

G is the gradient,
E is illumination, and
a is vertical angular position.

The maximum value of the gradient "G" determines the vertical angular location of the cutoff. Perform vertical scans at 1.0° left and right of the measurement point of the maximum gradient to determine the inclination.

6.15.5.1.4 To measure the low beam horizontal aim cutoff parameter, the headlamp shall be mounted on a fixture which simulates its actual design location on a vehicle. The fixture shall be attached to the goniometer table such that the fixture alignment axes are coincident with the goniometer axes. The headlamp shall be energized at the specified test voltage.

The headlamp beam pattern shall then be aimed vertically per 6.15.5.1.1 with the horizontal aim reference at the V-V axis.

When using the "3 line" method (Figure 8), 3 vertical lines shall be scanned from 2°D to 2°U at 1R, 2R, and 3R after the lamp is aimed vertically. Determine the maximum gradient by using the formula:

$$G = \log E(a) - \log E(a+0.1) \quad (\text{Eq. 2})$$

where

G is the gradient,
E is illumination, and
a is vertical angular position.

The maximum gradient positions found on the 3 lines shall be used to construct the cutoff line using the "least squares" method.

The headlamp shall be aimed horizontally in such a way that the line found will intersect the V line at 0.4 D.

When using the "0.2D line" method (Figures 9 and 10), a single horizontal line at 0.2°D shall be scanned from 5L to 5R after the lamp is aimed vertically. Determine the maximum gradient by using the formula:

$$G = \log E(a) - \log E(a+0.1) \quad (\text{Eq. 2})$$

where

G is the gradient,
E is illumination, and
a is horizontal angular position.

The maximum gradient positions found on the 0.2D line shall be placed on the V line.

- 6.15.5.1.5 If the lamp does not pass photometry in the aim position found by the methods in 6.15.5.1 it may be re-aimed vertically within $\pm 0.25^\circ$ if it is a VOR or VOL lamp. If the lamp does not pass photometry in the aim position found by the above methods it may be re-aimed vertically within $\pm 0.25^\circ$ and horizontally within $\pm 1.0^\circ$ if it is a VORH, VOLH1, or VOLH2 lamp. See Table 3.
- 6.15.5.1.6 If the high beam is combined in a headlamp with a low beam, the low beam vertical aim shall be used in testing the photometry of the high beam. If the high beam is not combined in a headlamp with a low beam, the vertical aim of the high beam shall be adjusted so that the maximum beam intensity is located on the H-H axis.
- 6.15.5.1.7 If the high beam is combined in a headlamp with a low beam, the low beam horizontal aim shall be used in testing the photometry of the high beam. If the high beam is not combined in a headlamp with the low beam and has fixed horizontal aim, there shall be no adjustment of the horizontal axis. If there is a horizontal VHAD it shall be adjusted to zero. If there is a horizontal adjustment that is not a VHAD, the horizontal aim of the high beam shall be adjusted so that the maximum beam intensity is located on the V-V axis.

6.16 Installation Requirements

See SAE J2442 for installation requirements.

7. GUIDELINES

- 7.1 When in use, a headlamp shall not have any styling ornament or other feature, such as a glass cover or grille, in front of the lens unless the headlamp meets the requirements of SAE J1383 with the styling ornament or feature in place.
- 7.2 Headlamps shall be designed to conform to the photometric requirements applicable to their design.
- 7.3 Fixed Horizontal Aim Guideline

If horizontal aim adjusting screws are provided on fixed horizontal aim headlamps, they shall be of a tamper-proof design or the end user shall not be able to access the adjuster when the headlamp is installed in the vehicle.

7.4 High beam hotspot design guideline

Peak intensity should be located in the area of 1U to 1D and 2L to 2R.

7.5 Out-of-Focus Test

This test may be conducted on headlamps with replaceable bulbs. In place of this test, a computer simulation of the test may also be used.

7.5.1 Out-of-Focus Procedure

- 7.5.1.1 The headlamp shall be mounted in the goniometer with the mechanical axis coincident with the photometer axis.
- 7.5.1.2 The headlamp shall be photometered at the appropriate test points listed in Table 1 and/or Table 2 as applicable.
- 7.5.1.3 Intensity measurements shall be made at six out-of-focus positions with the filament located at 2/3 of the bulb design tolerance contained in SAE J2560.

7.5.2 Out-of-Focus Requirement

At each test point in Table 1 and/or Table 2 as applicable, the intensity shall be at least 80% of any required minimum intensity and no more than 120% of any required maximum intensity with a $1/2^\circ$ reaim allowed at each test point for each of the out-of-focus test positions.

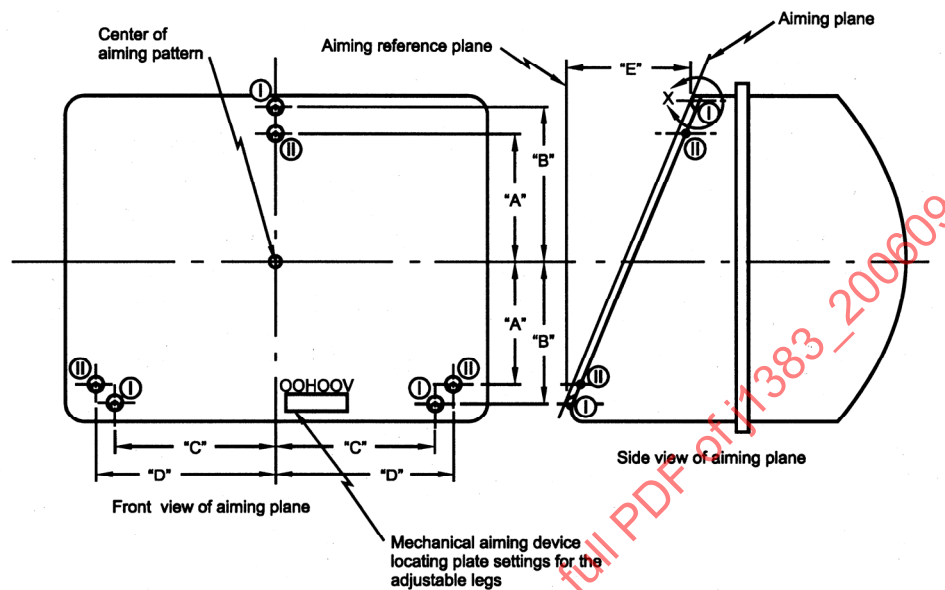


FIGURE 1 - DIMENSIONAL SPECIFICATIONS FOR LOCATION OF AIMING PADS ON REPLACEABLE BULB HEADLAMPS

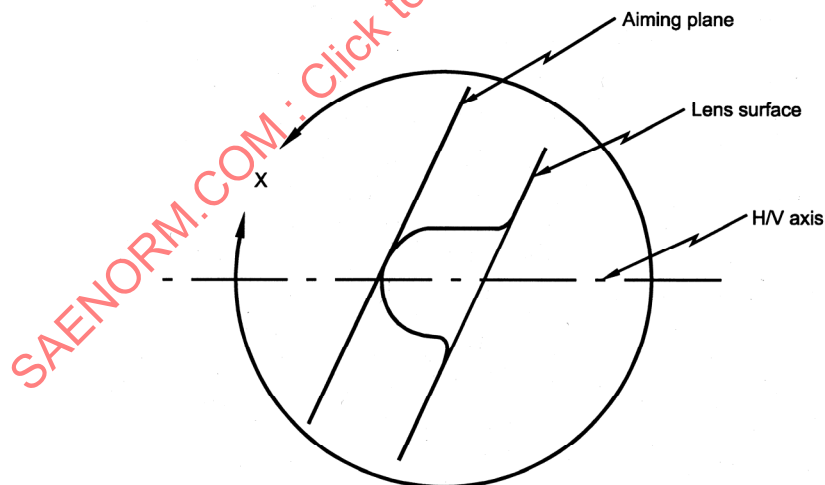
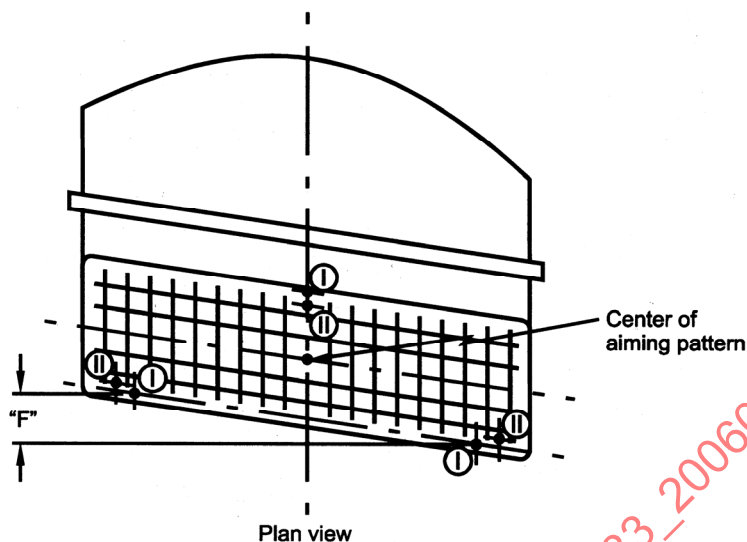


FIGURE 2 - DETAIL EXAMPLE OF AIMING PAD



Notes:

- Group I or Group II aiming pad locations may be used.
- Group I aiming pad location (front view) is that prescribed for 2B1 sealed beam units.
- Group II aiming pad location (front view) is that prescribed for 1A1 and 2A1 sealed beam units.

FIGURE 3 - DIMENSIONAL SPECIFICATIONS FOR LOCATION OF AIMING PADS ON REPLACEABLE BULB UNITS

<u>Dimension</u>	<u>Millimeters</u>	<u>Inches</u>
A	42.16 ± 0.25	1.660 ± 0.010
B	60.05 ± 1.00	2.364 ± 0.039
C	64.0 ± 1.00	2.520 ± 0.039
D	68.58 ± 0.51	2.700 ± 0.020
E	Mechanical aiming device locating plate setting for the vertical adjustable leg. (Millimeters)	
F	Mechanical aiming device locating plate setting for the horizontal adjustable leg. (Millimeters)	

FIGURE 4 - DIMENSIONAL SPECIFICATIONS FOR LOCATION OF AIMING PADS ON REPLACEMENT BULB UNITS