SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2009

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(R) Discharge Forward Lighting System and Subsystems

Foreword

This document is being revised in order to encompass the technical advance and knowledge in discharge lighting technology for automotive use over the past several years. It still addresses the procedures and guidelines to be used for forward discharge lighting systems. Forward discharge lighting systems consist of low beam headlamps and high beam headlamps.

1. Scope

This SAE Recommended Practice applies to motor vehicle forward illumination systems and subsystems generated by discharge sources. It provides test methods, requirements, and guidelines applicable to the special characteristics of gaseous discharge lighting devices which supplement those required for forward illumination systems using incandescent light sources. The document is applicable to both discharge forward lighting systems, subsystems and components. This document is intended to be a guide to standard practice and is subject to change to reflect additional experience and technical advances.

1.1 Rationale

The J2009 document has been revised to reflect industry changes in the last five to seven years. In an attempt to support further worldwide harmonization, several tests and requirements have been aligned with ECE regulations, especially ECE R98 and R99 and IEC regulations, especially IEC 60810.

Many manufacturers have produced DFL systems and the field experience gathered has allowed the further advancement of specifications in the area of photometry, maintenance and color. These advancements are captured in this revised document. Several references have been added where additional information has been derived and as the systems continue to develop, more data will be accumulated and the specifications refined. The document remains a recommended practice for the use of low and high beam forward lighting systems. The addition of other forward lighting devices such as daytime running light (DRL), cornering lamp and fog lamp will be considered in future revisions of the document as these devices become more widely used in the industry. The specifications outlined in SAE J2009, written with the automotive industry input, will continue to serve in conjunction with federal regulations in the hope that they will become the standard referenced in future federal regulation changes.

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These are changes to the following sections and guidelines:

2. References – References to the revised document have been updated to reflect new changes. This includes references both directly and related to the J2009 document.

3. Definitions – Definitions have been revised to be consistent with new changes.

4.4 Notices/Labeling – Manufacturers of devices that may be hazardous in normal use, operation or service have a duty to warn of such hazards if such hazards cannot reasonably be designed out of the product. Such warnings should comply with applicable standards, such as ANSI Z535.4. Additionally, some materials have restricted use and/or labeling requirements for components and/or vehicles, (specific references) and the manufacturers of devices containing such substances may have to provide information to the original equipment manufacturer and/or on the device to meet government mandated labeling requirements.

5. Seasoning and Stabilization – In order to provide a stable light output during the period of the test, light sources shall be seasoned. Because the light output of discharge forward lighting may vary during the period of thermal stabilization of the system, tests shall be done after an appropriate time of stabilization. The Initial start up behavior is addressed in dedicated tests.

5.1 and 5.3 Photometry – The photometry procedure and requirements were separated into component and system sections. It was determined that the light source should meet the “standard” requirements as outlined in Table 1 and when tested with an adjustable wattage ballast per Table 1, the system shall meet the photometric system requirements of J1383. Because a DFL system output will vary with wattage as a tungsten filament will change with voltage, the “rated” system is measured to a rated wattage (Table 1) and then measured in the system optical assembly. The various versions of DFL light sources were added to Table 1 and reflect the industry sources identified in Part 564 of FMVSS 108. Seasoning was added due to fluctuations in the discharge capsule during initial ageing of the light source. Once a stabilized output has been achieved (relatively constant spherical flux for ten to 20 hours), the source has been adequately aged. This is typically about 1 percent of the laboratory design life of the source.

5.4. System Starting – The system starting requirements have been established through various field tests and production experience by the system manufacturers and vehicle manufacturers. The requirements have been refined to reflect this knowledge and experience. Studies have been performed and in particular a study of “Rise-Time Requirements For High-Intensity Discharge Headlamps” – UMTRI-2001-14, University of Michigan Transportation Research Institute, was used to confirm the performance criteria established in this document. Field experience and studies with European manufacturers also confirm the performance of system starting for discharge headlamp systems.

The steady state requirement in ECE R98 for low beam is 12 lx, during run-up is 10 lx is required after 4 seconds, FMVSS requires 15 000cd, therefore 10 000 cd should be appropriate. For high beam ECE R98 requires 70 lx in steady state conditions and 60 lx during run-up after 4 seconds. FMVSS requires 45 000 cd, thus 30 000 cd after 4 seconds should be appropriate, non-continuous accordingly.

5.4.3 Hot restrike – The DFL system shall be switched off for the period of time indicated in Table 4 in order to simulate momentary switching to the alternate beam or erroneously switching of the lighting during driving.

5.5 Red spectral content – It is required that the spectral power distributions of DFL systems produce adequate color rendering to interpret road signs and markings. This implies that some portion of light should be present in the system output across the visual spectrum. This is particularly true in the long wavelength region (610 nm - 780 nm where some discharge sources may be deficient.

5.6 Color in beam pattern – It is also required that light from DFL systems be perceived as white as defined by SAE J578. The white color of DFL systems is presumed to exhibit only minor localized variations from the integrated measurement. Use of the CRI metric does not ensure that sufficient light exists in this region to ensure red objects are rendered red. Therefore the use of a mandatory spectral content method was adopted. No significant color variation should exist within the projected light beam when the device is energized over the life of the DFL system.

5.7 Ultraviolet Energy – The combination of UV light and moisture generated accelerated degradation of plastic headlamp lenses, if they were not properly protected. Initially, the effect was found with halogen bulbs using quartz capsules. These capsules were transparent to UV radiation in contrary to the hardglass capsules used for certain other halogen bulb types.

First gas discharge bulbs used only pure quartz arc tubes without outer bulb. Since the discharge tubes are also transparent to UV radiation, an additional filter UV filter tube had to be applied. The UV requirement was simultaneously introduced for halogen and discharge bulbs.

Additionally, concerns about health supported the introduction of UV free bulbs.

5.8 Life – A common life test failure mode is failure of the quartz to metal seal in the press area of the arc tube. The stress on this seal during life test is temperature dependent. It is recommended in the guidelines that life testing of HID light sources be performed in enclosures sized to provide a temperature of approximately 400 degrees Celsius in the press area of the arc tube after 20 minutes of operation. In this way testing will be more consistent and comparable between laboratories.

5.9 Environmental Tests – Environmental conditions such as temperature, humidity, moisture, dust and chemical substances can negatively affect the performance of forward lighting devices. Appropriate tests to prove the robustness of the devices are defined in the applicable device standards. Additionally, SAE J2357 addresses specifically devices operated with electrical control modules. These tests are referenced in the environmental test section.

5.12 Light Source Deflection – Light source deflection was added to the new set of requirements. It is recognized that the light source may experience some handling stress before installation. And, photometric performance of lighting systems is sensitive to the light source location. The bulb deflection test sets a standard for bulb resistance to handling stress. Although the 18 Newton force is quite severe this test and requirements reflect the requirement in FMVSS 108.

2. *References*

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

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

SAE J575—Tests for Motor Vehicle Lighting Devices and Components
SAE J578—Color Specification
SAE J759—Lighting Identification Code
SAE J1383—Performance Requirements for Vehicle Headlamps
SAE J1647—Plastic Materials and Coatings for Use in or on Optical Parts Such as Lenses and Reflectors of High-Intensity Discharge Forward Lighting Devices Used in Motor Vehicles
SAE J2320—Discharge Signal Lighting System
SAE J2357—Application Guidelines for Electronically Driven and/or Controlled Exterior Automotive Lighting Equipment

2.1.2 ANSI PUBLICATIONS

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, www.ansi.org.

ANSI C78.376-1969—Spectroradiometrically Determined Assignments
ANSI Z535.4—Product Safety Signs and Labels
ANSI/IESNA RP 16-96—American National Standard Nomenclature and Definitions for Illuminating Engineering (http://www.iesna.org/)
ANSI/IESNA RP 27.1—Photobiological Safety for Lamps and Lamp Systems—General Requirements (http://www.iesna.org/)
ANSI/IESNA RP 27.2—Photobiological Safety for Lamps and Lamp Systems—Measurement Techniques (http://www.iesna.org/)

2.1.3 FEDERAL PUBLICATIONS

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

49 CFR 571.108—Lamps, Reflective Devices and Associated Equipment (FMVSS 108)
49 CFR 564—Replaceable Lightsource Information (Part 564)

2.1.4 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) PUBLICATIONS

Available from Head of Sales, Marketing and Information Services, IEC Central Office, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland, email: info@iec.ch.

IEC Publication 60061—Lamps for Road Vehicles—Performance Requirements
IEC Publication 60810—Lamp Caps and Holders Together with Gauges for the Control of Interchangeability and Safety

2.1.5 IES PUBLICATIONS

Available from Illuminating Engineering Society, 120 Wall Street, Floor 17, New York, NY 10005.

IES Procedure LM-45—Approved Method for Electrical and Photometric Measurements of General Service Incandescent Filament Lamps, IES Lighting Handbook, Reference Volume, III

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 CIE PUBLICATIONS

Available from Commission Internationale de l'Eclairage, CIE Central Bureau, Kegelgasse 27, A-1030 Wien, Austria. See also: national organizations of CIE in the case of the USA: United States National Committee of the CIE, c/o Ronald B. Gibbons, Virginia Tech Transportation Institute, 3500 Transportation Research Place, Blacksburg, VA 24061, U.S.A., e-mail: gibbons@vtti.vt.edu, http://www.cie-usnc.org.

CIE Pub. 13.2—Method of Measuring and Specifying Color Rendering Properties of Light Sources (TC3.2) 1974

2.2.2 ACGIH PUBLICATIONS

Available from American Council of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.

Threshold Limit Values and Biological Exposure Indices for 1989–1990, American Conference of Governmental Industrial Hygienists

2.2.3 ECE REGULATIONS

Available from United Nations Economic Commission for Europe, Palais des Nations, CH-1211, Geneva 10, Switzerland, www.unece.org.

2.2.4 UNDERWRITERS LABORATORIES (UL) PUBLICATIONS

Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, www.ul.com.

Underwriters Laboratories (UL) 935—Fluorescent-Lamp Ballasts

2.2.5 OTHER

“Safety with Lasers and Other Optical Sources" by Sliney and Wolbarsht (1980, Plenum Press)

3. Definitions

3.1 Discharge Forward Lighting (DFL) System

An automotive lighting system, providing forward illumination, comprised of the headlamps, discharge source, ballast/starting system, and interconnecting wiring.

3.2 Discharge Source

An electric light source in which light is produced by a stabilized arc.

3.3 Run-Up Time

The period of time between the instant when the user operates a switch to power a lamp ON and the instant when the DFL system reaches a level within a designated output level (% or absolute).

3.4 Hot Restrike

The ability of a "hot" DFL system to relight before its temperature has returned to initial.

3.5 Photometric Maintenance

Change in luminous intensity (DFL system) or luminous flux (light source) during operational life.

3.6 Subsystem

A component or assembly of components, which comprise a portion of the entire system (assembly).

3.7 Light Source Rated Laboratory Life

A claim made by the manufacturer of operating time and starting cycles, under laboratory test conditions, over which at least 50% of the light sources will meet the life test performance specifications in this standard.

3.8 Color Rendering Index (CRI)

Measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source of comparable color temperature.

3.9 Ultraviolet Radiation

Radiation in the spectral region between 100and 400 nm. Definitions and terminology are adopted in accordance with proposed IES RP-27.1-96.

3.10 Steady-State

A condition under which the light output of the device is considered to be stable or changing at such a slow rate as to be insignificant. A "steady-state" condition is generally measured in terms of a "maximum percent change per time period." Steady-state light level is established by allowing the lamp to operate for a designated time after switched "on".

3.11 Automotive Ballast

A device for stabilizing the operating characteristics of a discharge lamp. The ballast contains all the necessary circuitry to ignite a lamp and cause it to operate within a specified power profile range. It controls the required light output characteristics of the automotive discharge lighting system. The ballast may consist of one or more separate components.

3.12 Integral Beam

An "Integral Headlamp" produces a light pattern when normal vehicle voltage is applied. It cannot be disassembled by the user for the purpose of replacing any failed subassemblies within the lamp or housing package. Discharge headlamps in which the ballast component is remote from the starter/lamp component may be considered integral if the user cannot disconnect the two components. Such a lamp may be disassembled and serviced by the manufacturer for the purpose of recycling the assembly by replacing nonfunctioning parts. It may also be disassembled and serviced by a service factory or dealer service facility. In any case, there is the assumption that the servicing facility will certify that the performance of the serviced device will meet all standards applicable to the original equipment.

3.13 Seasoned

A procedure where a new DFL system or light source is operated over a specific period of time to ensure stabilization of the discharge. This may include multiple on/off cycles.

3.14 Spectral Irradiance $E_\lambda(\lambda)$

The spectral concentration of irradiance in accordance with ANSI/IESNA RP-16-96.

3.15 Spectral Luminous Efficiency Function V(λ)

Standard spectral efficiency function for the human eye under photopic conditions as defined by ANSI/IESNA RP-16-96.

3.16 Color Content (Red)

The percentage of total visible light energy in the spectral region of 610 nm to 780 nm.

4. Lighting Identification Codes, Markings, and Notices

4.1 Lamps shall be marked in accordance with SAE J759 for the applicable forward lighting system and discharge system, “HG”.

4.2 The DFL system shall contain a label indicating the presence of high voltage, e.g., the international electric shock hazard symbol ("lightning bolt") per ANSI Z535.4 - Product Safety Signs and Labels.

4.3 Subsystem components shall be marked per 49 CFR 564 – Replaceable Light source Information (Part 564) for light sources and ballast subsystems.

4.4 It is strongly recommended to use mercury free components. If applicable, subsystem components shall be marked for mercury content per ANSI Z535.4 - Product Safety Signs and Labels.

5. Tests

Unless otherwise indicated, all sample DFL systems shall be seasoned at design voltage and steady operation for 20 hours prior to being subjected to the tests that follow. Alternatively, these tests shall be carried out with light sources which have been seasoned for a minimum of 15 cycles having the following switching cycle: 45 minutes on, 15 seconds off, 5 minutes on, 10 minutes off.

The power supply used in a test shall be capable of supplying the proper current the subsystem requires during the specified conditions.

A new DFL system may be used for each test.

5.1 Light Source Photometry

5.1.1 BURNING POSITION

The burning position shall be horizontal within ± 10° with the lead wire down. Seasoning and testing positions shall be identical. If the lamp is accidentally operated in the wrong direction, it shall be re-seasoned before measurements begin. During seasoning and measurements no electrically conducting objects shall be allowed within a cylinder having a diameter of 32 mm and a length of 60 mm concentric with the reference axis and symmetric to the arc. Moreover stray magnetic fields shall be avoided.

If the light source is part of an integral assembly with other electronics, the accompanying components shall be shielded (covered) in such a manner that the transmission and absorption of these components is nulled (measurement system calibration to “zero” components) in determination of the flux measurement.

5.1.2 TEST WATTAGE

For the photometric test, the ballast output wattage under steady state conditions shall meet the system rated wattage specifications in Table 1.

NOTE—The input wattage to the ballast is typically higher.

5.1.3 STABILIZATION

Before any measurement, the light source shall be stabilized for a period of 15 minutes.

5.1.4 LUMINOUS FLUX MEASUREMENT

The test shall be conducted in accordance with IES Approved Method for Electrical and Photometric Measurements of General Service Incandescent Filament Lamps, IES Lighting Handbook, Reference Volume, Illuminating Engineering Society, New York, NY. Procedure LM-45.

5.1.5 SPHERICAL COLOR

The color of the light source shall be measured in an integrating sphere using a measuring system, which shows the CIE chromaticity coordinates of the received light with a resolution of ± 0.002.

TABLE 1—LUMINOUS FLUX REQUIREMENTS

Design Designation (a)	Alternate Designation (ANSI)	Light Source Voltage (b)	Rated Wattage	Rated Luminous Flux at rated wattage	Accurate Rated Luminous Flux	Rated Average Life (d)	Cap (base)	Cap (base) number (e)
		[V]	[W]	[lm]	[lm]	[hours]		
D1R	-	85 ± 17	35 ± 3.0	2800 ± 450 (c)	2800 ± 150 (c)	2000	n/a	Pk32d-3
D1S	-	85 ± 17	35 ± 3.0	3200 ± 450	3200 ± 150	2000	n/a	Pk32d-2
D2R	9706	85 ± 17	35 ± 3.0	2800 ± 450 (c)	2800 ± 150 (c)	2000	axial	P32d-3
D2S	9705	85 ± 17	35 ± 3.0	3200 ± 450	3200 ± 150	2000	axial	P32d-2
D3R	-	42 ± 9	35 ± 3.0	2800 ± 450 (c)	2800 ± 150 (c)	2000	n/a	Pk32d-6
D3S	-	42 ± 9	35 ± 3.0	3200 ± 450	3200 ± 150	2000	n/a	Pk32d-5
D4R	-	42 ± 9	35 ± 3.0	2800 ± 450 (c)	2800 ± 150 (c)	2000	axial	P32d-6
D4S	-	42 ± 9	35 ± 3.0	3200 ± 450	3200 ± 150	2000	axial	P32d-5

(a) 49CFR564 and ECE Regulation 99 designation
(b) at 35 watts design wattage
(c) with opaque coating
(d) minimum laboratory life
(e) cap data from IEC60809

5.2 Light Source Starting Procedures – Initial Run-Up and Hot Restrike

5.2.1 Burning Position

See 5.1.1.

5.2.2 Luminous Flux Run-Up Measurement

The output flux of the light source shall be measured and recorded as a function of time (no less than 0.1 second intervals) until steady state operation of the subsystem is achieved.

5.2.3 Initial Run-Up

The initial (cold) run-up test shall be applied with light sources, which have not been used for a period of at least 1 hour prior to the test. The subsystem shall be measured at "cold" run-up continuously until the light output reaches steady state.

5.2.4 Hot Restrike

The subsystem shall be operated for at least 15 minutes. Then the supply voltage to the ballast shall be switched off for 10 seconds and be switched on again.

5.3 DFL System Photometry

5.3.1 A seasoned light source(s) shall be chosen which meets the requirements for the accurate rated luminous flux according to Table 1 at the system rated wattage. A ballast which can be adjusted to the wattage specified in Table 1 may be used. The source(s) shall be placed in the DFL system(s) to be tested.

5.3.2 The system rated voltage shall be applied to the DFL system and the system shall be aimed. After 10 minutes stabilization photometer the DFL system to SAE J1383 procedures. Photometric measurements shall be made at a minimum distance of 18.3 meters (60 feet) from the unit.

5.3.3 Multiple measurements can be made using the same DFL system with various rated light sources (per 5.1) or a chosen rated light source (per 5.1) may be used to test multiple DFL systems. The DFL system shall be measured and recorded at the nominal voltage specified and the minimum and maximum voltage values designated for stabilized light output for the particular DFL system under test.

5.4 DFL System Starting Procedures – Initial Run-Up and Hot Restrike

5.4.1 Set-Up

The DFL system shall be held in its normal operating position and mechanically aimed with a photocell or cells at the appropriate test point as shown in Table 2. Tests shall be conducted at room temperature (25 °C ± 5 °C), design voltage ± 0.1 V and for a duration required to obtain a reading. After completion of one test point, the second test point shall be measured. The response time of the measurement instrument should be less than 0.1 s.

TABLE 2—TEST POINTS FOR DFL SYSTEM STARTING TESTS

Low Beam	High Beam
1.5 D - 2 R	H – V

5.4.2 INITIAL RUN-UP

The initial Run-up test shall be applied with light sources, which have not been operated for a period of at least 1 hour prior to the test. The DFL system shall be activated and the luminous intensity at the photometric test points of Table 2 sampled and recorded for each headlamp from initial actuation through steady state operation for the specific lamp type specified in Table 3. The DFL system is then turned off.

TABLE 3—LIGHT OUTPUT CHARACTERISTIC DURING START-UP

DFL System Type	Time (seconds)	Low Beam Intensity (cd)	High Beam Intensity (cd)
non-continuous low beam	0.5 1.5	5000 10 000	15 000 30 000
continuous low beam	4.0	10 000	30 000

[Each beam should be measured at the point prescribed in Table 2 with the other beam blocked or not operating.]

5.4.3 HOT RESTRIKE [CONTINUOUS LOW BEAM MODE]

The DFL system shall be energized for 15 minutes minimum. After this time period, a restart test shall be conducted once for each time interval as indicated in Table 4.

TABLE 4—RESTART COOL DOWN TIMES

Interval	Time (seconds)
1	1
2	4
3	10
4	30
5	60

The DFL system shall be switched off for the period of time indicated in Table 4. The DFL system shall be energized and the luminous intensity at the applicable photometric test point shown in Table 2 sampled. For DFL systems designed to have the low beam on continuously, the low beam lamp shall be operated during the test. However, only the photometric characteristics of the high beam switching shall be measured.

5.5 Red Spectral Content

A spectrophotometric method shall be used to check the “red” spectral content, k_{red}, of the light from the light source for compliance with minimum red content specifications. Refer to ASTM E 308-66 for more details on spectrophotometric measurement.

$$k_{red} = \frac{\int_{\lambda=610nm}^{780nm} E_e(\lambda)V(\lambda)d\lambda}{\int_{\lambda=380nm}^{780nm} E_e(\lambda)V(\lambda)d\lambda} \quad \text{(Eq. 1)}$$

where:

$E_e(\lambda)$ [W/nm]	is the spectral distribution of radiant flux
$V(\lambda)$	is the spectral luminous efficiency
λ [nm]	is the wave length

5.6 Color in Beam Pattern

The color coordinates at the test points in Table 2 in the bam pattern shall be tested per SAE J578.

5.7 Ultraviolet(UV) Test

Measure the light source for UV energy per ANSI C78.376—Spectroradiometrically Determined Assignments.

$$k_{UV} = \frac{\int_{\lambda=250nm}^{400nm} E_e(\lambda)S(\lambda)d\lambda}{k_m \int_{\lambda=380nm}^{780nm} E_e(\lambda)V(\lambda)d\lambda} \quad \text{(Eq. 2)}$$

where:

$E_e(\lambda)$ [W/nm]	is the spectral distribution of radiant flux
$V(\lambda)$	is the spectral luminous efficiency
λ [nm]	is the wave length
$S(\lambda)$	is the spectral weighting function
K_m = 683 [lm/W]	is the photometric radiation equivalent

This value shall be calculated using intervals of one nanometer. The UV-radiation shall be weighted according to the values as indicated in Table 5:

TABLE 5—UV WEIGHTING FACTORS

λ	S(λ)	λ	S(λ)	λ	S(λ)
250	0,430	305	0,060	355	0,00016
255	0,520	310	0,015	360	0,00013
260	0,650	315	0,003	365	0,00011
265	0,810	320	0,001	370	0,000090
270	1,000	325	0,00050	375	0,000077
275	0,960	330	0,00041	380	0,000064
280	0,880	335	0,00034	385	0,000053
285	0,770	340	0,00028	390	0,000044
290	0,640	345	0,00024	395	0,000036
295	0,540	350	0,00020	400	0,000030
300	0,300				

Wavelengths chosen are representative; other values should be interpolated.
Values according to "IRPA/INIRC Guidelines on limits of exposure to ultraviolet radiation" [or other reference].

5.8 Light Source Life and Photometrical Maintenance

5.8.1 Burning Position

The burning position shall be horizontal within ± 10° with the lead wire down.

5.8.2 Test Voltage

The voltage for the life test shall be design voltage ± 0.1 V, DC as measured at the terminals of the ballast.

5.8.3 Test Operating Cycle

The light source shall be energized per the operating cycle shown in Table 6.

5.8.4 Photometric Maintenance

Initially and after 75% of rated laboratory life, the light source shall be subjected to the tests of 5.1 (Photometry).

5.8.5 Reported Life Value

The test life shall be reported as the accumulated “on” time hours up to the point at which it fails to start after any “off” period or the point at which it last meet all the requirements of 6.8.

TABLE 6—LIFE TEST CYCLE

On-Time (minutes)	Off-Time (minutes)
20	0.2
8	5
5	3
3	3
2	3
1	3
0.5	3
0.3	0.3
20	4.7
20	15

NOTE: Properties of this Life Test Cycle—
Total Cycle Time = 120 minutes
On Time = 79.8 minutes
Percent On Time = 66.5%
Off Time = 40.2 minutes
Cold Starts Per Hour of On Time = 6.01
Hot Restarts Per Hour of On Time = 1.51

5.9 Environmental Tests

Testing shall be accomplished on a complete DFL system, i.e., ballast, interconnections, and headlamp unless otherwise specified in the specific test.

5.9.1 Leakage Current/Breakdown

The test shall be made on a system positioned in its design orientation by completely covering the exterior of the DFL system to be tested with aluminum foil. The foil is to be connected to a current-sensing device, which terminates at the power source common (chassis ground). The sensing device shall be a non-inductive resistor of 1000 Ω. The leakage current occurring during starting and operating (transient and steady-state) shall be measured using an oscilloscope with a bandwidth capability five times the bandwidth being measured for the observed frequencies and rise times. Current readings shall be recorded during the first 10 s of the initial start. The unit shall then continue to operate for 30 min, be turned off, and immediately restarted. The current readings shall again be recorded during the first 10 s after restart. After completion of this procedure, and without submitting the unit to any other tests, the environmental test shall be carried out on the unit. Within 30 minutes(maximum) of completion of the specified environmental test, the breakdown test shall be repeated. The final readings are then compared with the respective (initial and 30 min) readings made before the environmental test.

5.9.2 Thermal Cycle

The DFL system shall be tested according to SAE J2357 “Thermal Cycle Test”.

5.9.3 Thermal Shock

The DFL system shall be tested according to SAE J2357 “Thermal Shock Test”.

5.9.4 HUMIDITY/MOISTURE

The DFL system shall be subjected to the test described in SAE J2357 “Humidity/Moisture Test” like an non-discharge headlamp or according to its specific function. The DFL system shall be tested before and after the tests in accordance with the Breakdown Test in 5.9.1. In addition, electronic components shall be subjected to the test in SAE J2357 “Humidity/Moisture Test“ for components, if appropriate.

5.9.5 INTERNAL HEAT TEST

The DFL system shall be subjected to the conditions specified in SAE J1383 “Internal Heat Test” for headlamp applications or according to its specific function.

5.9.6 DUST TEST

The DFL system shall be subjected to the conditions specified in SAE J1383 “Dust Test” for headlamp applications or according to its specific function.

5.9.7 CORROSION TEST

The DFL system shall be subjected to the test described in SAE J2357 “ Corrosion Test” like an non-discharge headlamp or according to its specific function. In addition, electronic components shall be subjected to the test in SAE J2357 “Corrosion Test” for components, if appropriate.

5.9.8 CHEMICAL RESISTANCE TEST

The DFL system shall be subjected to the test described in SAE J2357 “ Chemical Resistance Test” like an non-discharge headlamp or according to its specific function. In addition, electronic components shall be subjected to the test in SAE J2357 “ Chemical Resistance Test” for components, if appropriate.

5.9.9 VIBRATION TEST

The DFL system shall be subjected to the conditions specified in SAE J1383 “Vibration Test.” The DFL system shall be tested before and after the vibration test in accordance with the Breakdown Test in 5.9.1.

In addition, electronic components shall be subjected to the test in SAE J2357 “Vibration Test” for components, if appropriate.

5.10 Electromagnetic Interference

5.10.1 CONDUCTED EMISSIONS

DFL system shall be tested to Conducted Emissions testing per SAE J2357.

5.10.2 RADIATED EMISSIONS

DFL system shall be tested to Radiated Emissions testing per SAE J2357, either method may be used.

5.11 Electromagnetic Susceptibility

5.11.1 CONDUCTED IMMUNITY

DFL system shall be tested by either direct or bulk injection methods per Conducted Immunity testing per SAE J2357.

5.11.2 RADIATED IMMUNITY

DFL system shall be tested by any method per Radiated Immunity testing per SAE J2357.

5.11.3 ELECTROSTATIC DISCHARGE

DFL system shall be tested to Electrostatic Discharge testing per SAE J2357.

5.12 Light Source Deflection Test

The light source shall be rigidly mounted in the fixture in a manner indicated in Figure 1. A force of 18 N ± 0.4 N is applied on the outer (glass) envelope for a maximum of 5 seconds at a distance from the reference plane equal to the light center length of the lamp perpendicular to the reference axis using a rod with a hard rubber tip with a minimum spherical radius of 1 mm four times, spaced 90° apart, starting in the vertical direction.

NOTE—The spacing of 90° is approximate, depending on the position of the outer supply wire. The force shall be gradually increased from 0 N to 18 N. The light source deflection shall be measured at the glass surface 180° opposite to the force application. A different lamp may be used for each force application at 0°, 90°, 180° and 270°.

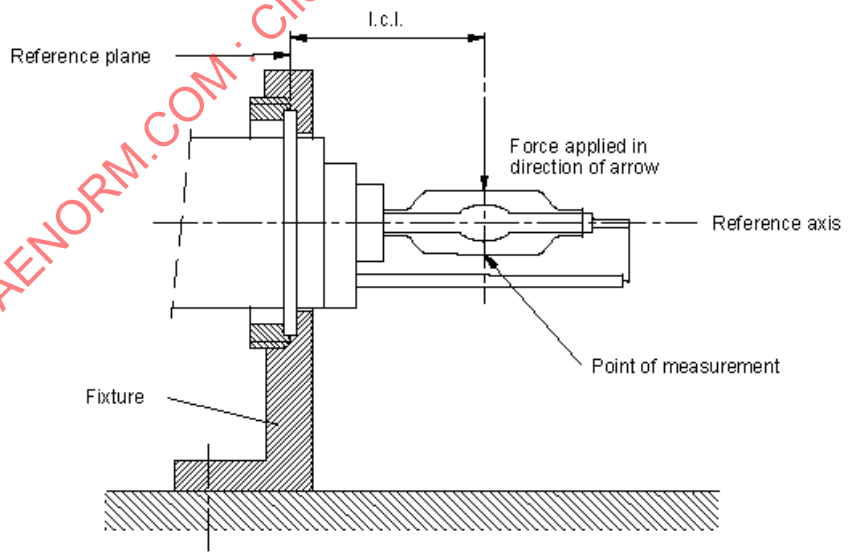

FIGURE 1—DEFLECTION TEST SET-UP