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SPECIFICATION FOR TESTING AUTOMOTIVE HALOGEN LIGHT SOURCES

SUMMARY OF CONTENTS

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1. SCOPE*

The procedures contained in this specification cover the laboratory testing of replaceable halogen incandescent bulbs for use in automotive road illumination. The following tests are intended to be run under the following conditions.

- New bulb design
- Design or process change made to an existing bulb, which could affect the outcome of the test
- The completion of one calendar year, accept as noted in the following Test Schedule Table.

Test Title	Yearly
Physical Dimensions	X
Mean Spherical Candela (MSCD)	X
External Visual Examination	X
Color	X
Leak /Sealability Through Terminals and Seals	X
Deflection	X
Fluid Compatibility	
Terminal Retention	X
Resonant Frequencies	
Aged Resonant Frequency	
Salt Spray	
Outgassing Temperatures Requirement	
Laboratory Life at 14.0 VDC	X
Luminous Intensity Maintenance	
Vibration Durability	
Shock	
Aged Vibration Durability	
Terminal Requirements	
DRL (SAE J2087)	

2. SAFETY PRECAUTIONS

Halogen bulbs have pressurized gas inside and require special handling. They can burst or shatter if scratched or dropped.

- Wear appropriate eye protection, gloves, and shielding when performing any tests on bulbs covered by this specification.
- Use precaution in handling a bulb that has recently been energized. These bulbs operate at a very high temperature.
- Protect operating lamps from contact with liquid and moisture. Liquid contacting a hot bulb can cause it to shatter.
- Hold the bulb only by the base. Do not touch the glass portion of the bulb with bare hands.

This specification may involve hazardous materials, operations, and equipment. This specification does not purport to address all the safety concerns associated with its use. It is the responsibility of whoever uses this specification to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3. REFERENCE STANDARDS

DaimlerChrysler, Ford, and General Motors Advanced Product Quality Planning and Control Plan Reference Manual
Measurement Systems Analysis Reference Manual (AIAG)
Potential Failure Mode and Effects Analysis Reference Manual (SAE J1739)
DaimlerChrysler, Ford, and General Motors Production Part Approval Process Manual
ANSI (C78.390)
ASTM B117 (Standard Practice for Operating Salt Spray [Fog] Testing Apparatus)
DaimlerChrysler, Ford, and General Motors Quality System Requirements—QS-9000 Manual
SAE J1330, Photometry Laboratory Accuracy Guidelines
SAE J578, Color Specification
SAE J1383, Performance Requirements for Motor Vehicle Headlamps
SAE J2087, Daytime Running Lamps for Use on Motor Vehicles

Unless otherwise specified or required by law, suppliers shall use the most recent versions of any applicable reference documents or standards.

4. DIAGRAMS AND DEFINITIONS

4.1 Appendices

Diagrams are provided at the end of this specification to clarify the details of the test procedures. A Glossary of Terms is also included in the Appendix.

5. GENERAL REQUIREMENTS

5.1 Record Retention

Supplier must maintain a file for the storage of laboratory reports and calibration records, and establish a record retention policy concerning these records in accordance with QS-9000 and PPAP requirements. These records need not follow a standard format, but must present the required data in an orderly, professional manner. The file must be made available to any and all customer personnel upon request, including—but not limited to—representatives from the following areas: product engineering, purchasing, quality, and reliability.

5.1.1 Objectives of Record Retention

Following are the main objectives for retention of test documents or records:

1. Retain records that will evidence compliance so that the supplier can appropriately respond when or if product compliance is challenged. Files must exist for the storage of all laboratory records, data, and calibration records. The files must be available at any time for audit or inspection.
2. Retain records as needed to assist in evidencing the exercise of "due care" in matters relating to product compliance, government requirements, or product liability.
3. Comply with statutory requirements for the maintenance and retention of specific records.

5.1.2 Retention Methods

Methods of retention may include retention of original documents, the use of film, or the use of electronic storage equipment. Records shall be stored so that they are accessible in a reasonable amount of time. Storage areas should provide adequate protection from unauthorized access, moisture, and fire.

5.2 Sample Documentation and Retention

Engineering test samples must be identified by ANSI Trade Number and serial number unless otherwise noted. Documentation must identify the type of test performed and describe special tests that are not a part of this specification. (Reference QS-9000 and PPAP requirements.)

5.2.1 Required Data Package

Supplier must submit the data package for the appropriate level of submission to the customer's responsible engineer and purchasing division for approval signatures.

5.2.2 Sample Retention

Samples tested to attain part approval must be retained by the bulb manufacturer for a period of time specified in the PPAP Manual.

5.3 Power Sources

Supplier must use voltage regulated DC power sources for all tests to simulate an automotive battery and charging system.

5.3.1 Output Current

The power source must be capable of supplying a continuous output current as required by the design loads, including inrush current. Where required to simulate automotive inrush current conditions, an automotive battery or batteries with sufficient cold cranking amps may be connected in parallel with the power supply.

5.3.2 Output Voltage

The power source must be capable of supplying an output voltage that must not deviate more than 1.0 volt from the nominal setting over the entire load range (including surges). The power source must recover 63% of its maximum excursion within 5.0 milliseconds. Ripple voltage must not exceed 300 mV peak to peak. Power supplies used for photometric measurements must conform to SAE J1330.

5.4 Equipment Tolerances

Supplier must use test setups and equipment capable of measuring test parameters (expressed in nominals) within the limits found in Equipment Tolerance Table.

Equipment Tolerance Table

Test Chamber Temperature	nominal ± 3°C
Time	nominal ± 0.5%
Forces	nominal ± 0.01 N
Distances	nominal ± 0.01 mm
Voltages	nominal ± 0.01 V for photometrics
	nominal ± 0.1 V for all other tests
MSCD	nominal ± 2.0%

NOTE: This table is not to be used for performance dependent variable (refer to section Measurement Accuracy).

5.5 Measurement Accuracy

Meters and gages used to assess the performance dependent variable, as defined by the basic function of the test sample, must have a smallest unit of measure one order of magnitude less than the least significant digit specified. For example, even though a 0.6 mm and 0.60 mm wire might be the same diameter, calipers capable of 0.01 mm resolution may be used to measure the first wire, but a micrometer with 0.001 mm resolution is needed for the second wire.

5.6 Test Repeatability and Calibration

5.6.1 Equipment Repeatability

All measurement equipment used for product evaluation must be repeatable to within 10% of the part tolerance according to DaimlerChrysler, Ford, and General Motors Measurement Systems Analysis Reference Manual.

5.6.2 Equipment Calibration

Equipment re-calibration/re-certification timing is to be calculated based on the capability of any individual instrument to retain its "Manufacture Stated Accuracy" between recall periods. However, this time shall not exceed one year.

5.6.3 Laboratory Masters (Photometry Only)

Lamps which are traceable to known standards are laboratory masters. Each supplier must use laboratory masters for comparison measurements, calibration of test equipment, and for evaluating long-term drift in test equipment.

5.7 Test Default Conditions*

When specific test conditions are not given, the following basic conditions apply:

1. Test the bulb in its normal operating orientation.
2. Perform tests or measurements at the following ambient conditions:

   Room Temperature.....23°C +/ - 5°C

3. Season the bulbs for 1% of the laboratory life, 10 hours maximum at 14VDC.
4. When testing dual filament bulbs, each filament can be tested in the same capsule or in separate capsules, unless otherwise specified. When testing both filaments in the same capsule, the sequence of testing must be recorded . Both filaments should never be lit at the same time during any test.

5.8 Test Sharing Within Bulb Families

The results of tests performed on one bulb type may, in some cases, be used to indicate the capability of another bulb type within the same bulb family. For example, a crush test performed on a clear, 800 series bulb type may be used as a demonstration of the glass strength of all clear, 800 series bulb types made by the same process from the same glass from the same source. Sound judgment must guide this practice. Bulbs within the same bulb family that share components such as glass envelopes, lead wires, filaments, bases, fill gases, etc., may be able to share test results. The customer will be the final authority on whether this surrogate data may be used.

5.9 Test Failure Procedure

Should a test failure occur, the customer (Quality, Purchasing, and Design/Release Engineer) shall be notified immediately. When contact cannot be immediately made, stop the test until the requesting party can be contacted.

5.10 Control Plans

Supplier must maintain a control plan, consistent with the AIAG, for each bulb type (or bulb family), that contains appropriate controls to ensure that all the significant/critical characteristics covered by the tests in sections Physical Performance, and Durability.

5.11 Reliability Programs and Methods

5.11.1 Reliability Growth and Ongoing Quality Improvements

Suppliers must establish and implement a plan to improve demonstrated product quality and reliability. They must establish procedures for analyzing and correcting end-of-line defects and predominant failure modes identified by the field return program. True reliability growth occurs when design changes to the bulb or manufacturing process are made to eliminate the failure modes.

5.11.1.1 Notification of Process Changes

Suppliers must notify the customer of manufacturing process, material, or design changes to determine if resubmission for PPAP approval is required.

5.11.2 Quality/Reliability Improvement Tools

Suppliers must use appropriate methods to improve the quality and reliability of their products in accordance with QS-9000. Examples of such methods are Field Return Programs, Design Failure Mode Effects Analysis (DFMEA), Process Failure Mode Effects Analysis (PFMEA), and Fault Tree Analysis (FTA) or Fishbone Diagrams. Further information on these methods is available from the Automotive Industry Action Group (AIAG).

6. PHYSICAL PERFORMANCE

These tests are intended to measure the innate characteristics of the bulbs. All data must be recorded according to section: Record Retention.

6.1 Physical Dimensions

The purpose of this examination is to verify that all of the physical dimensions of the bulb are in agreement with the drawing.

6.1.1 Measurement Apparatus

Equipment capable of determining the actual dimensions specified in the bulb drawing within the tolerance limits specified in section: Measurement Accuracy

This equipment typically includes micrometers, calipers, gages, and optical profile projectors.

6.1.2 Procedure

Supplier must measure a minimum of 10 bulbs, selected per the test lot definition in the Appendix, using the appropriate equipment. Record the data according to section Record Retention.

6.1.3 Failure Criteria

Any bulb with a dimension(s) outside the specified drawing limits constitutes a failure.

6.2 Mean Spherical Candela (MSCD)

6.2.1 Test and Measurement Apparatus

An integrating optical sphere with the appropriate power supply, optical detector, photometer, and traceable standard light source are required. The following test equipment or equivalent is recommended:

Photometric Equipment Table

Equipment	Model No.
20-inch Hoffman Integrating Sphere	IS-20-PS
Hoffman Photodetector	85-P
Hoffman System Photometer	TSP-83-A

6.2.2 Procedure

Select a test lot of 10 bulbs per the test lot definition in the Appendix. Season the bulbs according to the section Test Default Conditions. Measure the MSCD at 12.8 volts in the integrating sphere, with or without black top depending on how the bulb is sold, in accordance with accepted photometric procedures.

6.2.3 Failure Criteria

Any bulb with a MSCD or current value outside the specification limits constitutes a failure.

6.3 External Visual Examination

The purpose of this examination is to verify that the materials, design, construction, markings, and workmanship of the bulb are in accordance with the drawings and product design specification. Record the data in compliance with the Record Retention section of this specification.

6.3.1 Test and Measurement Apparatus

Optical equipment having magnification capability of ≥ 1.5X

6.3.2 Procedure

Examine a minimum of 10 bulbs, selected per the test lot definition in the Appendix, using the appropriate magnification device.

6.3.3 Failure Criteria

Any bulb that exhibits any of the following constitutes a failure:

1. Bulb design, identification, or markings (content, placement, and legibility) not in accordance with the applicable specification and/or drawing.
2. Visible evidence of corrosion, contamination, breakage (including grossly bent or broken lead wires), defective, or damaged plating (peeling, flaking, or blistering), or exposed base metal.
3. External wires not intact and/or not aligned in their specified location or that exhibit sharp or unspecified bends.
4. External wires containing deposits of foreign material such as paint or other permanently adherent deposits.
5. Evidence of any nonconformance with the drawing or applicable product design specification or absence of any required feature.
6. Defects or damage resulting from manufacturing, handling, testing, or shipping as applicable.
7. A fractured glass bulb.
8. Glass missing from the press area, even if it does not affect the seal of the bulb.
9. "Flash" on glass or plastic parts exceeding 0.40 mm unless otherwise noted on the drawing.

6.4 Color

The bulb must produce light as defined by SAE J578. This test is intended to be a standard method for measuring the color emitted from a bulb.

6.4.1 Test and Measurement Apparatus

The apparatus shown in the Test for Color Specification of SAE J578

6.4.2 Procedure

Select a test lot of 10 bulbs per the test lot definition in the Appendix and test according to the test for Color Specification of SAE J578, Color Measurement: Tristimulus Method or Color Measurement: Spectrophotometric Method. Some bulbs may emit a different color of light in one direction than another. Measurements should be made in as many directions as required to define the color characteristic of emitted light.

6.4.3 Failure Criteria

The light emitted from the bulb must be white as defined by SAE J578: Color Specification. The bulb may not emit any non-white light in any direction.

6.5 Leak/Sealability Through Terminals and Seal

6.5.1 Refer to SAE J1383, section Sealing Test.

6.5.2 Test and Measurement Apparatus

The apparatus shown in the Test for Air-Tight Seal figure of SAE J1383.

6.5.3 Procedure

Select a test lot of 10 bulbs per the test lot definition in the Appendix and test according to the Sealing Test of SAE J1383.

6.5.4 Failure Criteria

The failure criteria for the Sealing Requirement of SAE J1383 shall be used for this test.

6.6 Deflection

The purpose of this test is to demonstrate that the bulb is robust enough to withstand the side loading forces that accompany shipping, handling, and installation without significantly affecting the location of the filament.

6.6.1 Measurement Apparatus

The apparatus shown in the Bulb Deflection Test of SAE J1383

6.6.2 Procedure

Select a test lot of 12 bulbs per the test lot definition in the Appendix and test according to section Deflection Test of SAE J1383 with the added stipulation that the forces be applied parallel and perpendicular to the smallest dimension of the pressed glass capsule seal.

6.6.3 Failure Criteria

The failure criteria of Deflection Requirement section of SAE J1383 shall be used for this test.

6.7 Fluid Compatibility*

The objective of this test is to evaluate the interaction between common under-hood chemicals and the bulb. This test is to be run on initial bulb submissions and material changes.

6.7.1 Test and Measurement Apparatus

Each of the test fluids as itemized in MVSS108 Chemical Resistance and those listed below.

Chemical Resistance Fluids Table

FLUID TYPE	FLUID DESCRIPTION
Brake Fluid	SAE RM66-04
Oil	ASTM IRM-902
Gasoline	ASTM Ref. Fuel C
Engine Coolant/ Anti-freeze	ASTM Serv. Fluid 104
Automatic Transmission Fluid	Citgo #33123
Windshield Washer Solvent	50% Isopropyl Alcohol + 50% Water
Power Steering Fluid	ASTM IRM-903
Diesel Fuel	90% IRM 903 + 10% P-Xylene
E85 Ethanol Fuel	85% Ethanol + 15% ASTM reference fuel C
Tar Remover	45% Xylene + 55% Petroleum base mineral spirits
Engine Cleaner	Tital Bafal – Parafin wax CH4, Ethylene Glycol, Benzene, detergent
Grease	Petroleum base

6.7.2 Procedure

Submerge the base of the bulb into the test fluid for 2 to 3 seconds. Remove the bulb and let it set for 48 hours at room temperature. At the end of the 48-hour period, the bulb shall be wiped clean with a soft dry cotton cloth and visually inspected. After visual inspection, apply 12.8 volts to the bulb terminals for 5 minutes.

6.7.3 Failure Criteria

No delamination, fractures, deterioration of the plastic base or bonding materials, distortion of the plastic, or color fading shall be exhibited after the test has been completed. The labeling must remain legible.

6.8 Terminal Retention

This test is intended to ensure that the terminals are adequately retained in the bulb base to withstand maximum mating terminal engagement and disengagement forces.

6.8.1 Test and Measurement Apparatus

- Clamps to hold terminals without slipping
- Fixture to hold lamp stationary

6.8.2 Procedure

Place the lamp in the fixture so that the terminals are properly aligned for push/pull. The force shall be applied to the tip of the male terminal in the normal direction of connector insertion. In order to avoid jerking the terminal, attach and secure a clamp to one terminal. Push/Pull parallel to the terminal at a velocity less than 5 mm/sec. The digital force gage records maximum force before the terminal breaks free from the lamp or distorts.

6.8.3 Failure Criteria

Terminals must withstand at least 44.5 N (10 pounds) in either direction without distortion or loosening.

6.9 Resonant Frequencies*

Each bulb design has natural resonant frequencies. If the bulb is excited at one or more of these frequencies over long periods of time, the filament could be damaged because of metal fatigue at stress concentration points. This test is intended only to identify those resonant frequencies of an unaged bulb for use in lamp assembly design. This test is to be run on initial bulb submissions and changes.

6.9.1 Test and Measurement Apparatus

Use the following equipment, or equivalent to determine the resonant frequency of the bulb. Alternative test equipment with appropriate procedures may be used, such as a spectrum analyzer.

Resonant Frequency Equipment Table

Equipment	Requirements
Closed loop dynamic vibration equipment and auxiliary controller capable of vibrating in sinusoidal mode	Variable from 10 - 2000 Hz with tolerance of ± 4.0 dB and min. of 500 lb. Force
Strobe light to "freeze" the vibrating filament	---
Fixture to firmly mount the bulb to the vibration table	Mount bulbs with filament in both the parallel and perpendicular positions with respect to the ground.

6.9.2 Procedure

Select a test lot of 5 bulbs per the test lot definition in the Appendix and test them as follows:

1. After seasoning (refer to section Test Default Conditions), mount the bulb firmly in the fixture with the filament and bulb axis parallel to the ground.
2. Sweep the range from 50 to 1500 Hz and back to 50 Hz (15 minutes nominal each direction) with a 5.0 g vertical input while using a strobe light to "freeze" the vibration and to permit identification of all the resonant frequency ranges or equivalent spectrum analyzer.
3. Record the range, both the starting and stopping frequencies, of each resonant harmonic according to section Record Retention. For purposes of this test, resonance starts when the filament or mount structure is moved approximately 1 filament coiled diameter (perpendicular to the axis of the filament) from its normal "static" position. It continues until the filament resumes its static position.
4. Repeat steps 1 through 3 with the filament mounted vertically to the ground.

6.9.3 Failure Criteria

There is no failure criteria, report results.

6.10 Aged Resonant Frequency*

Each bulb design has a natural resonant frequency that, if present over long periods of time, could damage or destroy the filament due to metal fatigue at stress concentration points. This test is intended only to identify those resonant frequencies of an aged bulb for use in lamp assembly design.

6.10.1 Test and Measurement Apparatus

Use the equipment in Resonant Frequencies Section.

6.10.2 Procedure

Select a test lot of 5 bulbs per the “test lot” definition in the Appendix and test them as specified below.

1. Season the bulbs at 14.0VDC for B_{63} as established by the Weibull life curve according to the Laboratory Life section.
2. Mount the bulb firmly in the fixture with the filament and main bulb axis parallel to the ground.
3. Sweep the range from 50 to 1500 Hz and back to 50 Hz (15 minutes nominal each direction) at 5.0 g while using a strobe light to "freeze" the vibration and to permit identification of all the resonant frequency ranges.
4. Record the range, both the starting and stopping frequencies, of each resonant harmonic according to section Record Retention. For purposes of this test, resonance starts when the filament or mount structure is moved approximately 1 filament coiled diameter (perpendicular to the axis of the filament) from its normal "static" position. It continues until the filament resumes its static position.
5. Repeat steps 1 through 3 with the filament mounted vertically to the ground.

6.10.3 Failure Criteria

There is no failure criteria, report results.

6.11 Salt Spray

The intention of this test is to evaluate the corrosion resistance of all metal parts. All metal base bulbs must pass this test.

6.11.1 Test and Measurement Apparatus

Use the test equipment described in ASTM B117, Standard Practice for Operating Salt Spray (Fog) Testing Apparatus.

6.11.2 Procedure

Perform the salt spray test on 10 bulbs, selected per the test lot definition in the Appendix, according to ASTM B117 for 24 hours.

6.11.3 Failure Criteria

The samples shall exhibit no corrosion or oxidation after the test. The bulb must operate in a normal manner and current draw must be within specification limits.

6.12 Outgassing Temperature Requirement

Record the outgassing temperature (the temperature at which the first non-water volatile is released) of each material inside the reflector.

There is no failure criteria, this information will be used to ensure proper thermal management of light sources in lamp assemblies.

7. DURABILITY

These tests are intended to evaluate the durability of the bulbs and their components under typical and extreme operating conditions on the vehicle. Record all data according to section Record Retention.

7.1 Laboratory Life at 14.0 VDC*

This test verifies life at 14.0 VDC. It does not include any of the "life shortening" conditions (i.e., high temperature, vibration, shock, etc.) encountered on a vehicle.

7.1.1 Test and Measurement Apparatus

A rack capable of mounting bulbs firmly on racks so that the filament is parallel to the ground

7.1.2 Procedure

Operate 30 samples at room temperature and 14.0 VDC. Burn the lamps for 23-1/2 hours each day, with a continuous 1/2 hour off-time each day. Monitor the bulbs at least once each day and record the amount of hours for each bulb to fail according to section Record Retention. Time of failure should be recorded as the last time the bulb was known to be lit. Report the data on a Weibull Chart, showing B_{10}, B_{50}, and B_{70}.

7.1.3 Failure Criteria

The life values must meet product specifications.

Blacktop shall exhibit no cracking or flaking, and shall maintain its opacity. Any other coatings shall exhibit no cracking, flaking or fisheyes.

7.2 Luminous Intensity Maintenance*

The objective of this test is to determine the degradation in MSCD as a function of operating time. This test may be run in conjunction with section Laboratory Life at 14.0 VDC and section Mean Spherical Candela (MSCD).

7.2.1 Test and Measurement Apparatus

The equipment for this test is noted in the following sections of the life and Mean Spherical Candela tests:

1. Section: Mean Spherical Candela (MSCD), Test and Measurement Apparatus
2. Section: Laboratory Life at 14.0 VDC, Test and Measurement Apparatus

7.2.2 Procedure

Select a test lot of 10 bulbs per the test lot definition in the Appendix and season them according to section Test Default Conditions, then proceed as follows:

1. Measure the MSCD of each test bulb (refer to section Mean Spherical Candela (MSCD), Procedure).

Operate the bulbs at 14.0 VDC and measure MSCD at intervals of B_{10}, B_{50}, and B_{70} as defined by the Weibull plot of laboratory life. Record the data according to section Record Retention.

7.2.3 Failure Criteria

At B_{70} the MSCD for single filament bulbs and for each filament of two-filament bulbs must be $\geq$ 70% of the initial MSCD.

7.3 Vibration Durability*

The objective of this test is to verify that the design and construction of the bulb are sufficiently robust to withstand vehicle vibrations. This is an accelerated test for the worst- case orientation of the bulb filament.

7.3.1 Test and Measurement Apparatus

The following equipment, or equivalent:

- A closed loop dynamic vibration equipment and controller capable of vibrating the bulbs from 50-1000 Hz in a random mode according to the accompanying test profile
- A fixture to mount the bulbs firmly to the vibration table in such a manner that voltage can be applied to the bulbs during the test. NOTE: Automotive sockets are not acceptable as fixtures.
- Strip chart recorder, or digital monitoring device.

7.3.2 Procedure

Select a test lot of 10 single filament bulbs or 20 dual filament bulbs according to the test lot description in the Appendix and test them as indicated below. Test each filament of a dual filament bulb separately. Record the data according to section Record Retention.

Use the following breakpoints to define the random vibration input to the test specimen:

Vibration Break Points Table

Break Point	Frequency (Hz)	Amplitude (G^2/Hz)
1	50	0.080
2	400	0.080
3	650	0.0025
4	1000	0.0025

The total resulting acceleration level is 5.8 G_{rms}.

1. Season the bulbs per section Test Default Conditions.
2. Mount the bulbs firmly in the fixture with filaments parallel to the ground.
3. Vibrate the bulbs using the test profile shown in Vibration Break Point Table for a total of 6 hours orientated and lit in the following manner:

   - The glass envelope shall be parallel to the ground.
   - The filament position should be as follows:

     o axial filament – all samples parallel to the ground
     o transverse filament – half of the samples perpendicular to the ground, and half of the samples parallel to the ground

4. Test single filament bulbs as follows:

   (a) Two hours – unlit
   (b) Two hours – lit at 14.0 volts DC
   (c) Two hours – unlit

5. Test dual filament bulbs as follows, with 10 bulbs powering on the minor filament, and 10 bulbs powering on the major filament:

   (a) Two hours – unlit
   (b) Two hours – lit at 14.0 volts DC
   (c) Two hours – unlit

6. During the lit cycle of this test, monitor voltage or current at ≤ 10 millisecond intervals.

7.3.3 Failure Criteria

Any bulb that fails to operate during the test for any length of time, or does not meet dimensional requirements is considered a failure and shall constitute a failure of the entire test group. Any bulb that fails to operate in a normal manner for a minimum of 60 seconds, at rated voltage, at the conclusion of this test shall be considered a failure and shall constitute a failure of the entire test group. Ensure that both filaments of a dual filament bulb operate at the conclusion of this test.

7.4 Shock

This test is used to determine the ability of the bulb to withstand mechanical shock resulting from rough handling, transportation, and field operation including hood "slams" and road shock. Severe shocks may disturb the normal operating characteristics of the bulb, and severe or repetitive shocks may permanently damage or destroy the filament.

7.4.1 Test and Measurement Apparatus

A shock machine that is capable of providing the following repeatable consistent shock pulses:

- 600 g's for 2-4 milliseconds
- 1000 g's for 1 milliseconds

7.4.2 Procedure

Select a test lot of 20 single filament bulbs or 30 dual filament bulbs per the test lot definition in the Appendix and season them according to section Test Default Conditions. Securely mount each test bulb through the appropriate clamping fixture as described below:

- The glass envelope shall be parallel to the ground.
- The filament position should be as follows:
    - o axial filament: all samples parallel to the ground
    - o transverse filament: half of the samples perpendicular to the ground, and half of the samples parallel to the ground.

Apply 100 shock pulses. The shock pulse must have a duration of at least 1 milliseconds and reach at least 800 g's. Test the bulbs under each of the following conditions, recording data as specified in section Record Retention:

SINGLE FILAMENT:

10 bulbs with filament powered ON
10 bulbs with filament powered OFF

DUAL FILAMENT:

10 bulbs with major filament powered ON
10 bulbs with minor filament powered ON
10 bulbs with both filaments powered OFF

7.4.3 Failure Criteria

The criteria for each group of bulb samples is as follows:

No "open" filament or damage to any part of the bulb (i.e., base or glass) after 100 shock pulses

7.5 Aged Vibration Durability

The objective of this test is to determine the effect of bulb filament aging on vibration durability.

7.5.1 Test and Measurement Apparatus

1. A closed loop dynamic vibration equipment and controller capable of vibrating the bulb(s) from 50 to 1000 Hz in random mode according to the accompanying test profile (same as Test and Measurement Apparatus in Vibration Durability section).
2. A fixture to mount the bulbs firmly to the vibration table with the filament and main bulb axis parallel to the ground in such a manner that voltage can be applied to the bulbs during the test.

7.5.2 Procedure

Select a test lot of 10 single filament bulbs or 20 dual filament bulbs per the test lot definition in the Appendix and test them as specified below. Record the data according to section: Record Retention. Season the bulbs at 14.0 VDC for B_{63} as established by the Weibull life curve according to the Laboratory Life section.

Mount the bulbs as follows:

- The glass envelope shall be parallel to the ground.
- The filament position should be as follows:
    - o axial filament – all samples parallel to the ground
    - o transverse filament – half of the samples perpendicular to the ground, and half of the samples parallel to the ground

Vibrate single filament bulbs for a total of 12 hours according to the following schedule:

a) Two hours – unlit
b) Two hours – lit
c) Four hours – unlit
d) Two hours – lit
e) Two hours – unlit