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Distributed Lighting Systems (DLS)

RATIONALE

The technical report covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

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1. Scope—This SAE Recommended Practice applies to motor vehicle Distributed Lighting Systems (DLS) which use light generated by remote sources. It provides test methods, requirements, and guidelines applicable to these systems. This document is intended to be a guide to standard practice and is subject to change dependent upon additional experience and technical advances. This document covers Headlamp, Fog lamp, Auxiliary lamp, plus Signal and Marking lamp functions.

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 the 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 J575—Test Methods and Equipment for Lighting Devices and Components for use on Vehicles Less than 2032 mm in Overall Width
SAE J578—Color Specification
SAE J583—Front Fog Lamps
SAE J759—Lighting Identification Code
SAE J1113-1—Electromagnetic Compatibility Measurement Procedures for Vehicle Components (Except Aircraft) (60Hz to 18GHz)
SAE J1113-2—Electromagnetic Compatibility Measurmen Procedures and Limits for Vehicle Components (Except Aircraft)—Conducted Immunity, 30 Hz to 250 kHz—All Leads
SAE J1113-3—Conducted Immunity, 250 kHz to 5000 MHz, Direct Injection of Radio Frequency (RF) Power
SAE J1113-4—Immunity to Radiated Electromagnetic Fields—Bulk Current Injection (BCI) Method
SAE J1113-11—Immunity to Conducted Transients on Power Leads

SAE J1113-13—Electromagnetic Susceptibility Measurement Procedures for Vehicle Components—Part 13: Electrostatic Discharge
SAE J1113-21—Road Vehicles—Electrical Disturbances By Narrowband Radiated Electromagnetic Energy—Component Test Methods—Part 21: Absorber Lined Chamber
SAE J1113-22—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 22: Immunity to Radiated Magnetic Fields From Power Lines
SAE J1113-23—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 23: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Stripline Method
SAE J1113-24—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 24: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, TEM Cell Method
SAE J1113-25—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 25: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz—Tri-Plate Method
SAE J1113-27—Electromagnetic Compatibility Measurements Procedure for Vehicle Components—Part 27: Immunity to Radiated Electromagnetic Fields
SAE J1113-41—Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers used On Board Vehicles
SAE J1113-42—Electromagnetic Compatibility—Component Test Procedure—Part 42: Conducted Transient Emissions
SAE J1211—Recommended Environmental Practices for Electronic Equipment Design
SAE J1383—Performance Requirements for Motor Vehicle Headlamps
SAE J1889—L.E.D. Lighting Devices
SAE J2009—Discharge Forward Lighting System
SAE J2139—Test for Lighting Devices and Components used on Vehicles 2032 mm or More in Overall Width
SAE J2320—Discharge Signal Lighting System
SAE J2357—Application Guidelines for Electronically Driven and/or Controlled Exterior Automotive Lighting Equipment

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this specification.

2.2.1 ANSI PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI C78.376-1996—Specifications for the Chromaticity of Fluorescent Lamps

2.2.2 CIE PUBLICATION—Available from Commission Internationale de L'eclairage, 52 Bd Malesherbes, F-75008 Paris, France.

CIE Publication 13.2—Method of Measuring and Specifying Color Rendering

3. Definitions

3.1 Photometric Maintenance—Change in luminous intensity of the test points of the beam pattern over time.

3.2 Life—Time in hours and starting cycles of a DLS during which it meets specified operational characteristics.

3.3 Rated Laboratory Life—Specified by the manufacturer as the period of time during which the DLS meets the performance specifications.

3.4 Color 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.

3.5 Distributed Lighting System (DLS)—A system that transmits light from a remote source to one or more lighting function(s).

3.6 Leakage current breakdown—An electronic measurement technique used on electronic devices/modules to determine if a final current (amps) measurement differs from an initial current (amps) measurement by a defined value. The resulting measurement indicates whether a breakdown in the electrical circuit has occurred causing the current (amps) level to change after exposure to a durability or environmental test procedure.

3.7 With controls—Any mechanical or electrical device that effects the DLS state other then the manually activated on/off switch."

4. Lighting Identification Codes, Markings and Notices

4.1 Lamps may be marked in accordance with SAE J759.

4.2 A DLS containing High Voltage Components shall be marked to indicate the presence of high voltage, e.g., the ISO electric shock hazard symbol ("lightning bolt") where applicable.

5. Tests—Sample systems shall be seasoned per the SAE standards applicable for the light source employed by the DLS prior to being subjected to the tests below. A separate DLS may be used for each test. Testing shall be accomplished on a complete system (i.e., light source, interconnections, and lamp) as required unless otherwise specified in the specific test. If "orientation" affects the performance of any component, the component shall be maintained in its design orientation throughout the test. A system component shall be tested to the most severe condition the specific component would be subjected to in application –(e.g., under hood conditions if it passes through the under-hood region). See Table 1.

NOTE—The power supply of a distributed lighting system that employs a ballast shall have its output isolated from the input to prevent any potential danger to laboratory personnel when running tests as required.

TABLE 1—DLS LAMP FUNCTIONS AND TYPES

FUNCTION	TEST GROUP
HEADLAMP (A)	A1 = DISCHARGE SOURCE
	A2 = INCANDESCENT SOURCE
	A3 = INCANDESCENT w/Controls
FOG/AUX. LAMP (B)	B1 = DISCHARGE SOURCE
	B2 = INCANDESCENT SOURCE
	B3 = INCANDESCENT w/Controls
SIGNAL /MARKING (C)	C1 = DISCHARGE SOURCE
	C2 = INCANDESCENT SOURCE
	C3 = INCANDESCENT w/controls
	C4 = DISCHARGE w/controls
	C5 = LED SOURCE

5.1 Lamp/System Starting Procedures—The lamp shall be held in its vehicle operating position and aimed per the appropriate SAE standard. Tests shall be conducted at room temperature (23 °C ± 3 °C), at design voltage ±0.1 V DC, and for a duration required to obtain a reading. The response time of the measurement instrument shall be less then 100 ms.

5.1.1 INITIAL START-UP—Systems shall be tested as follows:

Group A1, A3, B1, B3:	SAE J2009 Initial Start-Up
Group A2, B2, C2, C5:	Not applicable
Group C1, C3, C4:	SAE J2320 Light rise up-time

5.1.2 SWITCHING (OF BEAMS)—Systems shall be tested as follows:

Group A1, A3, B1, B3:	SAE J2009 Switching
Group A2, B2, C2, C5:	Not applicable
Group C1, C3, C4:	SAE J2320 Light rise-up time

5.2 Electrical Characteristics

5.2.1 SYSTEM OPERATING WATTAGE RANGE—The DLS shall be tested as follows:

Group A1, B1:	SAE J2009 Operating Wattage
Group A2, A3:	SAE J1383 Operating Wattage
Group B2, B3, C1,C2, C3, C4, C5:	Not applicable

5.2.2 SYSTEM OPERATING VOLTAGE RANGE—Systems shall be tested as follows:

Group A1, B1:	SAE J2009 Operating Voltage
Group A2, A3, B2, B3:	Not applicable
Group C1, C4:	SAE J2320 Operating Voltage
Group C2, C3:	SAE J2357 Operating Voltage
Group C5:	SAE J1889 Operating Voltage

5.2.3 TEST EQUIPMENT REQUIREMENTS—Test equipment shall conform to the following requirements:

Group A1, B1:	SAE J2009 Equipment Requirements
Group A2, A3, B2, B3, C2:	Not applicable
Group C1, C3, C4, C5:	SAE J2320 Equipment Requirements

5.3 Source Photometric Maintenance—Sources shall be tested in a system as follows:

Group A1:	SAE J2009 Photometric Maintenance
Group A2, A3:	SAE J1383 Photometric Maintenance
Group C1, C4:	SAE J2320 Photometric Maintenance
Group B1, B2, B3, C2, C3, C5:	Not Applicable

5.4 Color and CRI—Systems shall be tested as follows:

5.4.1 COLOR

Group - All:	The color coordinates shall be tested per SAE J578 for the applicable function

5.4.2 COLOR RENDERING INDEX (CRI - SOURCE FOR "WHITE LIGHT" APPLICATIONS ONLY):

Group A1, B1:	Systems shall be tested per SAE J2009 Color Rendering.
Group - All Other:	Not applicable.

5.5 Leakage Current/Breakdown Test—Systems shall be tested as follows:

Group A1,B1,C1,C4:	System electric components shall be tested per SAE J2009 Leakage
Group A2,A3,B2,B3,C2,C3,C5:	Not applicable.

5.6 Thermal Cycle—The DLS shall be mounted on a test fixture in its design orientation.

5.6.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Thermal Cycle
Group A2:	SAE J1383 Thermal Cycle
Group A3,B1,B3:	SAE J2357 Thermal Cycle
Group B2,C1,C2,C3,C4:	Test to applicable SAE Lamp or System Device Standard
Group C5:	SAE J1889 Thermal Cycle

5.6.2 All DLS components (including the source) shall be Thermal Cycle tested as specified in SAE J2357 for the DLS component location on the vehicle.

5.7 Humidity/Moisture—The DLS shall be mounted on a test fixture in its design orientation.

5.7.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Humidity
Group A2:	SAE J1383 Humidity
Group A3,B1,B3,C3:	SAE J2357 Humidity
Group B2:	SAE J583
Group C1,C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	Test to applicable SAE Lamp Standard
Group C5:	SAE J1889 Moisture

5.7.2 All DLS components (including the source) shall be tested by either Humidity, Immersion, or splash testing as specified in SAE J2357 for the DLS component location on the vehicle.

5.8 Internal Heat—(Applicable only for Lighting Devices that contain a Distributive Lighting Source.)

5.8.1 The DLS shall be mounted on a test fixture in its design orientation.

Group A1:	Tested per SAE J2009 Internal Heat and at test conclusion test device to SAE J2009 “Color” test
Group A2,A3:	Device shall be tested per SAE J1383 Internal Heat (as appropriate)
Group B1,B2,B3:	Device shall be tested per SAE J583
Group C1,C2,C3,C4,C5:	Not applicable

5.9 Sand, Dust, and Gravel Test—The DLS shall be mounted on a test fixture in its design orientation.

5.9.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Dust test
Group A2, A3:	SAE J1383 Dust test
Group B1,B2,B3,C3:	SAE J575 Dust test (Option: Use SAE J2139 for Heavy Duty applications)
Group C1,C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	Test to applicable SAE Lamp Standard
Group C5:	SAE J1889 Dust test

5.9.2 All other DLS components shall be subjected to the Sand, Dust or Gravel testing as applicable and as specified in SAE J575 for the DLS component location on the vehicle test. (Option: Use J2139 for Heavy Duty applications.)

5.9.2.1 *Dust Test*—For components containing a discharge light source, ballast or other electronic or electrical components the dust test shall be in accordance with SAE J2009 Dust test. For all other DLS components the dust test shall be in accordance with SAE J575 Dust test. (Option: Use J2139 for Heavy Duty applications.)

5.9.2.2 *Sand Test*—For DLS segments which contain mechanical components the sand exposure test shall be conducted in accordance with SAE J575 Dust test. (Option: Use J2139 for Heavy Duty applications.)

5.9.2.3 *Gravel Test*—For DLS segments other than light emitting surfaces the gravel bombardment test shall be conducted in accordance with SAE J575 Dust test. (Option: Use J2139 for Heavy Duty applications.)

5.10 Corrosion Test—The DLS shall be mounted in its design orientation.

5.10.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Corrosion test
Group A2:	SAE J1383 Corrosion test
Group A3,B1,B3,C3:	SAE J2357 Corrosion test
Group B2:	SAE J583 Corrosion test
Group C1,C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	Test to applicable SAE lamp Standard
Group C5:	SAE J1889 Corrosion test

5.10.2 All other components of the DLS shall be tested as specified in SAE J2357. The DLS component shall be operating or non-operating as defined by the user.

5.11 Chemical Resistance Test—The DLS shall be mounted on a test fixture in its design orientation.

5.11.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Chemical Resistance
Group A2:	SAE J1383 Chemical Resistance
Group A3,B1,B3,C3:	SAE J2357 Chemical Resistance test
Group B2:	SAE J583 Chemical Resistance
Group C1,C4:	SAE J2320 Intended Lighting Function Testing
Group C2, C5:	Test to applicable SAE lamp standard

5.11.2 All other components of the DLS shall be tested by selecting applicable chemicals from Figure 1 based on the DLS components location on the vehicle. Brush the specified chemical solutions onto the DLS and then hold the DLS at the specified temperature shown in Figure 1 for 96 hours.

5.12 Vibration Test—The DLS shall be mounted on a test fixture in its design orientation.

5.12.1 The lamp portion of the DLS shall be tested as follows:

Group A1:	SAE J2009 Vibration
Group A2,C2:	SAE J575 Vibration (Option: Use J2139 For Heavy Duty applications)
Group A3,B1,B3,C3:	SAE J2357 Vibration test
Group B2:	SAE J583 Vibration test
Group C5:	SAE J1889 Vibration test
Group C1,C4:	SAE J2320 Intended Lighting Function Testing

5.12.2 All other DLS components shall be vibration tested as specified in SAE J2357 for the DLS component location on the vehicle. Components may be grouped per the manufacturer's discretion.

5.13 Altitude Test

5.13.1 The DLS shall be tested as follows:

Group A1, A3:	Test per SAE J2009 Altitude test.
Group A2,B1,B2,B3,C1,C2,C3,C4,C5:	Applicable tests

5.13.2 All other DLS electronic components shall be tested to SAE J1211 Altitude Test with "DLS" replacing "system" and the Breakdown test in 5.5. For "operating" test in SAE J1211, subject DLS to the same total number hours testing as specified in the Thermal Cycle Test using T-min as operating temperature. (Option: Run test in conjunction with thermal cycle test). For "nonoperating" test in SAE J1211, subject DLS to 2X total hours as specified in the Thermal Cycle Test at –40 °C operating temperature.

5.14 Photometry—(Use Accurate Rated Source – or as referenced in applicable standard):

Group A1:	Systems shall be tested per SAE J2009 Photometry.
Group A2,A3:	Systems shall be tested per SAE J1383 Photometry.
Group B1,B2,B3;	System tested to SAE J583 Photometry
Group C1,C2,C3,C4,C5:	Tested to appropriate SAE standard for lamp function.

5.15 Electromagnetic Compatibility (EMS and EMR)—The DLS will incorporate the appropriate fixture and components necessary to perform the electromagnetic compatibility tests as outlined. When specified, the DLS will be fixtured to attain design orientation of all components comprising the system.

5.15.1 The DLS shall be tested to the appropriate sections of SAE J1113 (as applicable to the particular type of system being tested) and according to the following:

Group A1,A3,B1,B3,C1,C3,C4,C5:	Tested to SAE J2357
Group A2,B2,C2:	Not applicable

5.15.2 Other DLS electronic components shall be tested to the appropriate sections:

Group A3,B3,C3,C4,C5:	Tested to SAE J2357

6. Performance Requirements

6.1 Lamp/system Starting Procedures

6.1.1 INITIAL START-UP—Systems shall conform to the following:

Group A1, A3, B1, B3:	SAE J2009 Initial Start-Up
Group A2,B2,C2,C5:	Not applicable
Group C1,C3, C4:	SAE J2320 Light rise-up time

6.1.2 SWITCHING (OF BEAM)—Systems shall conform to the following:

Group A1, A3, B1, B3:	SAE J2009 Switching
Group A2, B2, C2,C5:	Not applicable
Group C1,C3, C4:	SAE J2320 Light rise-up time

6.2 Electrical Characteristics

6.2.1 SYSTEM OPERATING WATTAGE RANGE—The DLS shall meet the following requirements:

Group A1, B1:	SAE J2009 Operating Wattage
Group A2, A3:	SAE J1383 Operating Wattage
Group B2,B3,C1,C2,C3,C4,C5:	Not applicable

6.2.2 SYSTEM OPERATING VOLTAGE RANGE—Systems shall meet the following requirements:

Group A1,B1:	SAE J2009 Operating Voltage
Group A2,A3,B2,B3:	Not applicable
Group C1,C4:	SAE J2320 Operating Voltage
Group C2,C3:	SAE J2357 Operating Voltage
Group C5:	SAE J1889 Operating Voltage

6.3 Source Photometric Maintenance—Systems shall meet the following requirements:

Group A1:	SAE J2009 Photometric Maintenance plus meet 6.4 “Color” after testing
Group A2,A3:	SAE J1383 Photometric Maintenance plus meet 6.4 “Color” after testing
Group C1,C4:	SAE J2320 Photometric Maintenance
Group B1,B2,B3,C2,C3,C5:	Not Applicable

6.4 Color (and CRI)

NOTE— SAE J1383 and SAE J578 are a part of this document.

6.4.1 COLOR

Group – All:	The color coordinates shall meet the requirements of SAE J578 for the applicable function

6.4.2 COLOR RENDERING INDEX FOR CRI.

Group A1,B1:	See Guidelines 7.7
Group -All Other:	Not applicable

6.5 Leakage Current/Breakdown Test:—Systems shall meet the following requirements:

Group A1, B1, C1, C4:	System electrical components shall meet the requirements of SAE J2009 Leakage
Group A2,A3,B2,B3,C2,C3,C5:	Not applicable

6.6 Thermal Cycle

6.6.1 The lamp portion of the DLS shall meet the following requirements:

Group A1:	SAE J2009 Thermal Cycle plus meet 6.4 “Color” after testing
Group A2:	SAE J1383 Thermal Cycle plus meet 6.4 “Color” after testing
Group A3,B1,B3:	SAE J2357 Thermal Cycle
Group B2,C1,C2,C3,C4:	The applicable SAE lamp or System Device standard
Group C5:	SAE J1889 Thermal Cycle

6.6.2 The manufacturer must insure that all other DLS components shall operate after the test. The system shall have no visible signs of deterioration, or damage. All DLS components (including the source) shall meet the Thermal Cycle requirements as specified in SAE J2357 for the DLS component location on the vehicle.

6.7 Humidity/Moisture Test

6.7.1 The lamp portion of the DLS shall meet:

Group A1:	SAE J2009 Humidity plus meet 6.4 “Color” after testing.
Group A2:	SAE J1383 Humidity plus meet 6.4 “Color” after testing.
Group A3,B1,B3,C3:	SAE J2357 Humidity.
Group B2:	SAE J583
Group C1, C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	The applicable SAE Lamp Standard
Group C5:	SAE J1889 Moisture

6.7.2 The manufacturer must insure that all other DLS components shall operate after the test. The system shall have no visible signs of deterioration, or damage. All other DLS components (including the source) shall meet the requirements of either Humidity, Immersion, or splash as specified in SAE J2357 for the DLS component location on the vehicle.

6.8 Internal Heat—(Applicable only for Lighting Devices that contain a Distributive Lighting Source.)

Systems shall meet the following requirements:

Group A1:	SAE J2009 Internal Heat and at test conclusion test device to SAE J2009 “Color” test
Group A2:	A3 SAE J1383 Internal Heat (as appropriate)
Group B1, B2, B3:	SAE J583
Group C1, C2, C3, C4, C5:	Not applicable

6.9 Sand, Dust, and Gravel Test

6.9.1 The lamp portion of the DLS shall meet the following requirements:

Group A1:	SAE J2009 Dust
Group A2, A3:	SAE J1383 Dust
Group B1,B2,B3,C3:	SAE J575 Dust test (Option: Use SAE J2139 for Heavy Duty applications)
Group C1,C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	Requirements of applicable SAE Lamp Standard
Group C5:	SAE J1889 Dust test

6.9.2 Lamp manufacturer must insure that all other DLS components shall operate after the test.

The system shall have no visible signs of deterioration, or damage. Components subjected to the Sand, Dust or Gravel testing shall meet the applicable requirements as specified in SAE J575 Dust test for the DLS component location on the vehicle. (Option: Use SAE J2139 for Heavy Duty applications.)

6.9.2.1 *Dust test*—Components containing a discharge light source, ballast or other electronic or electrical components shall meet the requirements of SAE J2009 Dust test. All other DLS components shall meet the requirements of SAE J575 Dust test. (Option: Use SAE J2139 for Heavy Duty applications.)

6.9.2.2 *Sand Test*—DLS segments which contain mechanical components shall meet the requirements of sand exposure in SAE J575 Dust test. (Option: Use SAE J2139 for Heavy Duty applications.)

6.9.2.3 *Gravel test*—DLS segments other than light emitting surfaces shall meet the requirements of the gravel bombardment specified in SAE J575 Dust test. (Option: Use SAE J2139 for Heavy Duty applications.)

6.10 Corrosion Test

6.10.1 The lamp portion of the DLS shall meet:

Group A1:	SAE J2009 Corrosion plus meet 6.4 “Color” after testing
Group A2:	SAE J1383 Corrosion plus meet 6.4 “Color” after testing
Group A3,B1, B3, C3:	SAE J2357 Corrosion test
Group B2:	SAE J583 Corrosion test
Group C1, C4:	SAE J2320 Intended Lighting Function Testing
Group C2:	Test to applicable SAE lamp Standard
Group C5:	SAE J1889 Corrosion test

6.10.2 All other DLS components shall meet the requirements as specified for corrosion in SAE J2357 for the DLS location on the vehicle. Also the DLS component shall operate properly throughout the test. After completing the test there shall be no significant change in performance or visible signs of deterioration or damage.

6.11 Chemical Resistance Test

6.11.1 The lamp portion of the DLS shall meet:

Group A1:	SAE J2009 Chemical Resistance plus meet 6.4 “Color” after testing
Group A2:	SAE J1383 Chemical Resistance plus meet 6.4 “Color” after testing
Group A3,B1,B3,C3:	SAE J2357 Chemical resistance test
Group B2:	SAE J583 Chemical resistance
Group C1, C4:	SAE J2320 Intended Lighting Function Testing
Group C2, C5:	Applicable SAE Lamp Standard Chemical resistance

6.11.2 ALL OTHER DLS COMPONENTS—After completing the test there shall be no significant degradation in performance or visible signs of deterioration or damage.

6.12 Vibration Test

6.12.1 The DLS lamp portion shall meet the requirements of applicable sections in the SAE standards noted:

Group A1:	SAEJ2009 Vibration
Group A2, C2:	SAE J575 Vibration test (Option: Use SAE J2139 for Heavy Duty applications)
Group A3,B1,B3, C3:	SAE J2357 Vibration test
Group B2:	SAE J583 Vibration test
Group C5:	SAE J1889 Vibration test
Group C1,C4:	SAE J2320 Intended Lighting Function Testing

6.12.2 All other DLS components shall meet the vibration requirements as specified in SAE J2357 for the DLS component location on the vehicle. Components may be grouped per the manufacturers discretion.