



# SURFACE VEHICLE RECOMMENDED PRACTICE

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## Recommended Testing Methods for Physical Protection of Wiring Harnesses

### RATIONALE

This Recommended Practice is being revised to better define the noise suppression test, to correct the heat aging test procedure and to make editorial corrections throughout the document.

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## 1. SCOPE

This SAE Recommended Practice describes the recommended methods for testing flexible harness coverings for use on ground vehicle electrical distribution systems. This Recommended Practice shall apply to all tapes, extruded tube and textile tube.

### 1.1 Application

This document shall be applied for coverings used on wiring assemblies. The Customer's Engineering Group must approve material based on the functional application performance requirements to assure proper validation of covering materials.

## 2. REFERENCES

### 2.1 Applicable Documents

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](http://www.sae.org).

SAE ARP1536A	Abrasion Test Procedure for Chafe Guard
SAE J311	Fluid for Passenger Car Type Automatic Transmissions
SAE J369	Flammability of Polymeric Interior Materials—Horizontal Test Method
SAE J1128	Low Voltage Primary Cable
SAE J1756	Determination of the Fogging Characteristics of Interior Automotive Materials
SAE J2302	Thermal Effectiveness of Sleeve Insulation
SAE J2495	Thermal Containment Efficiency of Sleeve Materials

#### 2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

ASTM D 471	Standard Test Method for Rubber Property—Effect of Liquids
ASTM D 3032	Standard Test Methods for Hookup Wire Insulation, Section 22—Dynamic Cut Through
ASTM D 4157	Test Method for Abrasion Resistance of Textile Fabrics
ASTM D 5423	Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation
ASTM F 1306	Test Method for Slow Rate Penetration Resistance of Flexible Barrier Films

#### 2.1.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, [www.ansi.org](http://www.ansi.org).

ISO 3795	Road vehicles, and tractors and machinery for agriculture and forestry—Determination of burning behavior of interior materials
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Applicable Quality Standards (e.g., QS 9000, ISO/TS16949, etc.)

### 3. GLOSSARY

#### 3.1 FUNCTIONALITY

Performs to design intent.

#### 3.2 DEGRADATION

Loss of functionality due to physical changes such as cracks, tears, melting or other forms of reduction in material strength, composition or integrity.

#### 3.3 EXTERIOR APPLICATION

Applications outside the passenger compartment

#### 3.4 INTERIOR APPLICATION

Applications inside the passenger compartment.

#### 3.5 RECOMMENDED PRACTICES

Suggested test method that does not include specification limits.

#### 3.6 TAPE

A continuous strip of cloth, fabric, metal, paper or plastic material with or without adhesive.

#### 3.7 EXTRUDED TUBE

Tubes, plain or profiled, including convoluted tubings, that are extruded from elastomers, metals, plastics, or combination of materials.

#### 3.8 TEXTILE TUBE

Tubes that are made with textile materials

#### 3.9 SPECIMEN

The combination of one or more coverings applied to a wire bundle, where the coverings and wires are specified by the customer.

### 4. QUALITY REQUIREMENTS

#### 4.1 Product Quality Assurance

Product Quality Assurance must follow the requirements and be in compliance with the applicable Quality Standard.

### 5. CLASSIFICATION (TEMPERATURE IDENTIFICATION)

Temperature requirement is by class as noted in Table 1. It is the responsibility of the customer to determine the "Class" to be used for any application. Temperature ratings are to be considered the minimum service temperature required.

It is the responsibility of the supplier to properly designate the service temperature of their product and provide the necessary data to the performance criteria in this specification when submitting to the customer for approval. Verification of any and all of the data submitted by the supplier is at the discretion of the customer.

TABLE 1 - TEMPERATURE CLASSIFICATIONS

Class	Temperature (°C)
Class A	-40 to 85
Class B	-40 to 100
Class C	-40 to 125
Class D	-40 to 150
Class E	-40 to 175
Class F	-40 to 200
Class G	-40 to 225
Class H	-40 to 250

## 6. TESTING METHODS

The recommended test methods are found in Table 2.

TABLE 2 - TESTING METHODS AND THEIR APPLICABILITY TO COVERING CATEGORIES AND CLASSES

Test	Category			Applicable Class and/or Application	Test Method
	Tape	Extruded Tube	Textile Tube		
Heat Aging	X	X	X	All	7.3
Temperature/Humidity	X	X	X	All	7.4
Flammability	X	X	X	All	7.5
Low Temperature Flexibility	X	X	X	All	7.6
Automotive Fluids Resistance	X	X	X	For Exterior Applications Only	7.7
Fogging	X	X	X	For Interior Applications Only	7.8
Component Compatibility	X	X	X	Customer Designated	7.9
Noise Suppression	X	X	X	Customer Designated	7.10
Abrasion Resistance	X	X	X	Customer Designated	7.11
Puncture/Pinch	X	X		Customer Designated	7.12
Cut Through	X	X	X	Customer Designated	7.13
Impact		X		Customer Designated	7.14
Thermal Insulation	X	X	X	Customer Designated	7.15

## 7. TESTS PROCEDURES

### 7.1 Sampling

If it is not specified, the sample size must be five. The suggested dimension of the sample is 10 mm minimum, however, if the manufacturer is supplying sizes other than 10 mm, the customer may request other sample sizes. Selection must be representative of the current production for each test and test results should be reported. Precondition/equilibrate dry samples to 23 °C ± 5 °C and 50% ± 5% relative humidity for a minimum of 24 h prior to testing unless otherwise noted.

## 7.2 Sample Preparation

### 7.2.1 Tape

Assemble a bundle of wire 450 mm or greater in length of an appropriate number and size to approximate a diameter of 10 mm as designated by customer. Wire sizes and insulation types will be specified by the customer. If specified, cover the bundle with a 450 mm length of 10 mm diameter convoluted tubing. Note that the appropriate wire type and tubing with the same operation temperature as the tape in question must be used. Wrap the tape to be tested around the bundle with a 50% overlap.

### 7.2.2 Extruded Tube

Assemble a bundle of wire 450 mm or greater in length of wire of an appropriate number and size to approximate a diameter of 10 mm or as specified by customer. Wire sizes and insulation types will be specified by the customer. Cover the bundle with a 450 mm length of extruded tube. Note that the appropriate wire type with the same continuous operating temperature must be used with the extruded tube being tested as specified by the customer or test method.

### 7.2.3 Textile Tube

Assemble a bundle of wire 450 mm or greater in length of an appropriate number and size to approximate a diameter of 10 mm or as specified by customer. Wire sizes and insulation types will be specified by the customer. Cover the bundle with a 450 mm length of textile tube. Note that the appropriate wire type with the same continuous operating temperature must be used with the textile tube being tested as specified by the customer or test method.

## 7.3 Heat Aging

- 7.3.1 The material shall withstand temperature according to class noted in Table 3, and tested according to the procedure described in 7.3.2.
- 7.3.2 Place 30 pieces of 450 mm long test specimens of each sample in a forced air convection oven (Type II as specified in ASTM D 5423, with air exchange rate of 100 to 200 per hour) at the sample maximum class temperature (refer to Table 3) for the duration of time interval.

TABLE 3 - TEST TEMPERATURE FOR HEAT AGING  
AND TEMPERATURE/HUMIDITY CYCLING

Class	Temperature (°C)
Class A	85 ± 2
Class B	100 ± 2
Class C	125 ± 3
Class D	150 ± 3
Class E	175 ± 3
Class F	200 ± 3
Class G	225 ± 4
Class H	250 ± 4

7.3.3 At 500, 1000, 1500, 2000, 2500, and 3000 h intervals, remove five pieces of test specimens of each sample from the oven and condition them at  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  and  $50\% \pm 5\%$  relative humidity for at least 4 h.

7.3.4 Wrap each of the conditioned test specimens around a mandrel with a diameter equal to four times the nominal ID of the test specimen at a uniform rate of one turn per 10 s. After 1500 h of heat aging and at 500-h intervals to 3000 h, bend the specimens around a mandrel with a diameter equal to ten times the nominal ID of the test specimen at a uniform rate of one turn per 10 s. Visually inspect each specimen for any sign of degradation. Record and report any change in appearance and signs of degradation (e.g., cracks, melting, etc.). Perform any quantitative measurements (e.g., length of any cracks or flagging sections, etc.) as requested by the customer.

#### 7.4 Temperature/Humidity Cycling

7.4.1 Place test specimens in an environmental chamber and set the cycling sequence as following for three cycles. Refer to SAE J1128 for complete description.

TABLE 4 - CYCLING SEQUENCE FOR TEMPERATURE/HUMIDITY CYCLING TEST

Step	Condition	Duration	Total Time
1	Increase Temperature from $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ & $50\% \pm 5\%$ RH to $-40\text{ }^{\circ}\text{C}$	30 min	0:30
2	Hold Temperature at $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$	1 h	1:30
3	Increase Temperature from $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ to $80\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ & $95\% \pm 5\%$ RH	30 min	2:00
4	Hold Temperature at $80\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ & $95\% \pm 5\%$ RH	4 h	6:00
5	Change Temperature from $80\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ & $95\% \pm 5\%$ RH to the Class Temperature <sup>(1)</sup>	30 min	6:30
6	Hold at Class Temperature <sup>(1)</sup>	1 h	7:30
7	Change Temperature from the Class Temperature <sup>1</sup> to $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ & $50\% \pm 5\%$ RH	30 min	8:00

1. Refers to Table 3.

7.4.2 Wrap each of the conditioned test specimens around a mandrel with a diameter equal to four times the nominal ID of the test specimen at a uniform rate of one turn per 10 s. Visually inspect each specimen for any sign of degradation. Record and report any change in appearance and signs of degradation (e.g., cracks, melting, etc.). Perform any quantitative measurements (e.g., length of any cracks or flagging sections, etc.) as requested by the customer.

#### 7.5 Flammability

##### 7.5.1 Horizontal

Conduct horizontal burn test, calculate and record burn rate of each test specimen following the guidelines as established in SAE J369 (ISO 3795). Record and report as required by the customer.

##### 7.5.2 Vertical

Conduct vertical burn test, calculate and record burn rate of each test specimen following the procedure specified in standard UL94 section 8, "20 mm Vertical Burning Test." Record and report as required by the customer.

#### 7.6 Low Temperature Flexibility

7.6.1 Assemble test specimens by inserting a taped wire bundle into a 450 mm length of harness covering sample. The wire bundle shall have a diameter equal to 80% of the ID of sample. Condition test specimens in a  $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  cold chamber for 4 h.

7.6.2 Remove test specimens from cold chamber and condition them at  $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  and  $50\% \pm 5\%$  relative humidity for 4 h.

- 7.6.3 Wrap the test specimens around a mandrel with a diameter equal to four times the nominal ID of the test specimen at a uniform rate of one turn per 10 s.
- 7.6.4 Visually inspect each specimen for any sign of degradation. Record and report any change in appearance and signs of degradation. Perform any quantitative measurements (e.g., length of any cracks or flagging sections, etc.) as requested by the customer.
- 7.7 Fluids Resistance
- 7.7.1 Prepare three specimens for each test fluid.
- 7.7.2 Immerse each set of test specimens in each test fluid specified in Table 5 for 5 min. Take precautions to ensure that at least 10 mm from each end of the sample is not exposed to the fluid. For exposures to engine coolant, engine oil, power steering and transmission fluids, ensure that fluid and samples are aged at the specified temperature for 5 minutes. For exposures to diesel fuel, gasohol and gasoline, ensure that fluid is saturated by a non-immersion technique until dripping occurs.
- 7.7.2.1 Solutions are determined as % by volume.
- 7.7.2.2 See SAE J1128 (Table C) for reference standard sources as denoted in Table 5.

TABLE 5 - FLUIDS TO BE USED FOR FLUIDS COMPATIBILITY TEST

Fluid Name	Reference Standard [Table Note 1]	Test Temperature (°C)
Engine Oil	ASTM D 471, IRM-902	50 ± 3
Gasoline	ASTM D 471, Ref. Fuel C	23 ± 5
Gasohol	10% Ethanol + 90% ASTM D 471, Ref. Fuel C	23 ± 5
Diesel Fuel	90 % ASTM D 471, IRM-903 + 10% p-xylene	23 ± 5
Power Steering	ASTM D 471, IRM-903	50 ± 3
Auto Trans	Dexron III, SAE J311; Dexron VI	50 ± 3
Engine Coolant	50% distilled Water + 50% Ethylene Glycol	50 ± 3
Battery Acid	H <sub>2</sub> SO <sub>4</sub> , Specific Gravity = 1.260 ± 0.005	23 ± 5
Brake Fluid	SAE RM-66-04	23 ± 5

Table Note 1: Fluid availability may change over time.

- 7.7.3 Remove each specimen from test fluid and allow it to drain for 20 min. Let samples condition 23 °C ± 5 °C for 72 h.
- 7.7.4 Visually inspect each specimen for any sign of degradation after 1, 24, 48, and 72 h. Wrap each bundle a complete 360 degrees around a mandrel with a diameter equal to four times the nominal ID of the test specimen at a uniform rate of one turn per 10 s. Record and report any change in appearance, signs of degradation or loss of flexibility. Perform any quantitative measurements (e.g., length of any cracks or flagging sections, etc.) as requested by the customer.
- 7.8 Fogging
- 7.8.1 Conduct the Fogging Test according to SAE J1756 using either the Photometric Method or the Gravimetric Method per agreement between customer and the supplier.
- 7.8.2 The test duration is to be specified by the customer.

7.8.3 Report Fog Number when using the Photometric Method; and Fog Mass when using the Gravimetric Method or as required by the customer.

## 7.9 Component Compatibility

7.9.1 Assemble components and test as specified by customer.

7.9.2 Test to be performed at rated temperature as required by Class specified (refer to Table 3) with no loss of functionality observed.

## 7.10 Noise Suppression

7.10.1 Noise Suppression is a comparative test and its requirements are to be established by the customer. It is recommended that testing be conducted with a reference standard of known or acceptable noise suppression performance level.

7.10.2 Prepare samples according to 7.2 except use a solid steel mandrel rather than a wire bundle. The mandrel is not to be covered with convolute or any other covering prior to applying the covering being tested.

### 7.10.3 Test Apparatus

#### 7.10.3.1 Insulating Cabinet

Provides a 30 dB attenuation of the laboratory ambient noise.

#### 7.10.3.2 Excitation Equipment

The excitation of test equipment is created by a signal generator and amplified. The power amplifier runs a vibrator. The axle of the vibrator goes through a hole inside the cabinet and is fixed to the equipment.

#### 7.10.3.3 Noise Measurement

The microphone is inside the cabinet and connected to an integrating sonometer outside the cabinet. The microphone is fixed at 150 mm from the noisy contact of the steel mandrel and steel plate.

### 7.10.4 Test Set-Up

#### 7.10.4.1 Rattling Test Set-Up

See Figure 1.

#### 7.10.4.2 Rubbing Test Set-Up

See Figure 2.

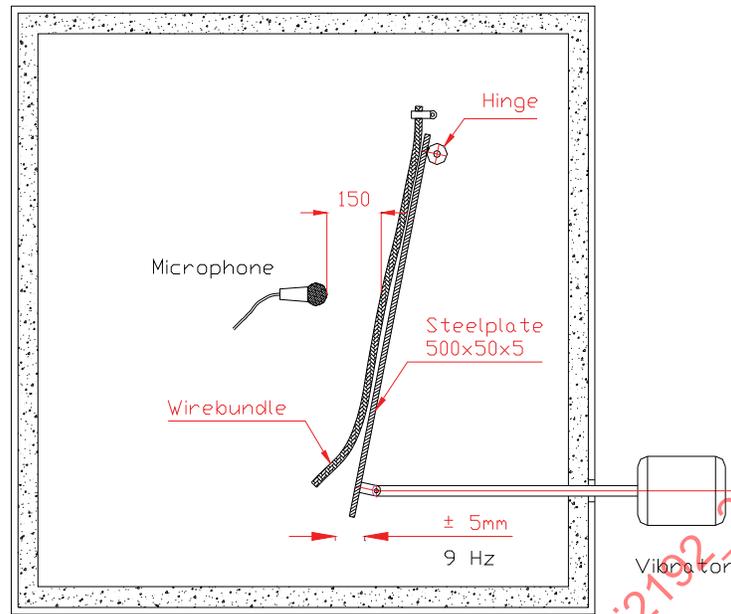


FIGURE 1 - RATTLING TEST SET-UP

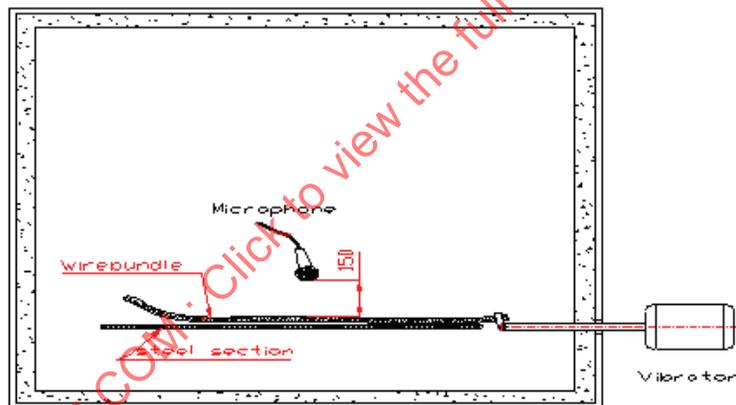


FIGURE 2 - RUBBING TEST SET-UP

#### 7.10.5 Test Procedure

- 7.10.5.1 Run the test on the steel panel without the steel mandrel following the Rattling or Rubbing Test set-up illustration. This provides the background noise (A) inside the cabinet.
- 7.10.5.2 Affix steel mandrel without harness covering along the steel plate and run the test again. The noise level (B) is measured.
- 7.10.5.3 Affix steel mandrel with harness covering material on the steel plate and run the test. The noise level (C) is measured.
- 7.10.5.4 Noise Attenuation in dB is the difference between the noise level B and the noise level C. Record Noise Attenuation Level.