SURFACE VEHICLE RECOMMENDED PRACTICE

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Test Method for Evaluating the Electrical Resistance of Coolant System Hose Covers

RATIONALE

Minor revisions.

1. SCOPE

This test method provides a standardized procedure for evaluating the electrical resistance of automotive coolant hose covers. It is known that an electrical potential exists between the engine and the radiator. Coolant hose cover conductivity has been determined to be a factor to reduce hose clamp life when vehicle build variations allow possible contact of the hose or the clamp to metal components on the radiator and engine thus completing an electrical circuit. The ensuing electrical current can undercut the clamp protective coating, leaving it vulnerable to the corrosive effects of road salts, moisture, and other environmental contaminants. SAE Recommended Practice J1684 addresses the electrochemical resistance of the tube portion of the coolant hose.

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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1684 Test Method for Evaluating the Electrochemical Resistance of Coolant System Hoses and Materials

2.1.2 ISO Publications

Copies these documents are available online at http://webstore.ansi.org/.

ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories

2.1.3 Unified Numbering System (UNS)

Information on UNS S4300 can be found on website http://www.ssina.com/publications/primer.html.

2.1.4 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.

ASTM E177 Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods.

3. TERMINOLOGY AND ACRONYMS

DC	Direct current
ISO	International Standards Organization
UNS	Unified Numbering System
Voltage Sense	Measurement of a voltage drop between two electrodes
Current Source	A power supply that provides constant current to the test set-up
Source/Measurement Device	A combination power source and measurement device (in this document, it relates to sourcing current and measuring a voltage drop across a designated distance)

4. SAFETY

The foregoing test procedure involves use of potentially dangerous DC electrical voltage. The user of this procedure shall consult the manual for the test equipment being used, its manufacturer, and/or other pertinent documents as to the safe handling of electrical equipment used to conduct this test procedure. The user of this test procedure shall be solely responsible for understanding and following all safety guidelines of this test procedure and those of the manufacturers of the electrical equipment.

It is recommended the users of this test procedure electrically insulate the test hose set-up, such as by constructing a clear plastic box to house the test hose set-up. This box should have grounded interlocks in the event that access doors/panels are opened for any reason.

SAE, and members of the Non-Hydraulic Hose Committee, shall not be held liable for any accidents causing injuries or death due to inappropriate or improper manipulation of electrical generating/discharge equipment, or failure to follow the procedures set forth in this test method and the safety guidelines of the equipment manufactures whose equipment was used.

5. METHOD

5.1 Materials and Equipment

5.1.1 Source/measurement device[1] with the following capabilities: Voltage range 200 mV to 200 VDC, current range 1 μA to 1 A, and resistance measurement of 0.2 Ω to 200 MΩ. Tolerance ranges shall be as specified by the literature of the equipment referenced in footnote 1.

5.1.2 Two 9 mm wide non-perforated stainless steel screw clamps[2] and two 0.57 mm copper or brass blades for contact sensing with a weight (pressure).

5.1.3 Two sets (two wires per set) of leads with shrouded banana jacks on each end, and four alligator clips.

5.1.4 Hand torque wrench suitable for the torque being applied to the clamps in 5.3.

5.1.5 Plugs per SAE J1684, sized to fit snug in ends of test hose.

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[1] Keithley Model 2400 source meter, Yojogawa GS610 source measure unit, or equivalent.
[2] Stainless steel per UNS S43000.

5.1.6 130 mm straight hose sample(s).

5.1.7 Non-conductive test surface large enough to support the test sample, plastic containment box, and the source/measuring device.

5.2 Hose Pre-Conditioning

5.2.1 Sample Cleaning

Samples shall be cleaned by rubbing with aluminum magnesium silicate ("Fuller's earth") and water. The surface shall be flushed thoroughly with distilled/deionized water. The surfaces should not be abraded or buffed.

5.2.2 Drying and Equilibration

Sample shall be placed in a hot air oven at 70 °C for 2 hours, then allowed to equilibrate at 23 °C ± 2 °C and 50% ± 10% relative humidity for at least 16 hours.

5.3 Procedure - Source Current

5.3.1 Insert plug in each end of the test hose.

5.3.2 Attach the two outboard clamps 12 mm ± 6 mm (approximately) from each end of the hose. Torque outboard clamps to 3 N·m.

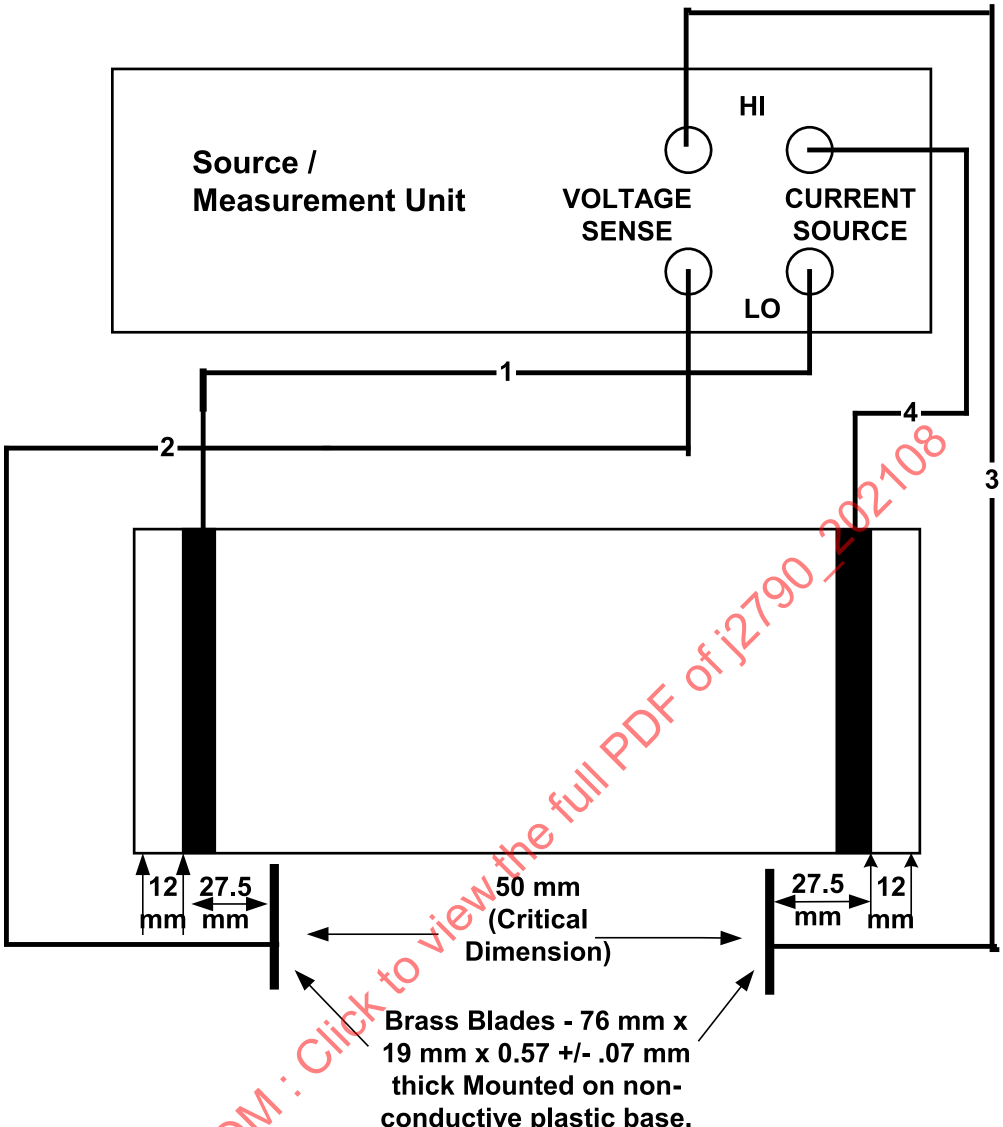
5.3.3 Locate source blades 27.5 mm ± 6 mm from the outboard edge of each clamp and 50 mm from each other. (The 50 mm between the blades is a critical dimension and it is recommended to mount blades on non-conductive plastic base to maintain this spacing.) Place a 600 g weight on hose to provide a consistent firm contact with the hose. Weight shall not come in contact with clamps or brass electrodes.

5.3.4 Place hose/clamp assembly into plastic interlock box.

5.3.5 Set the source/measurement device to read ohms.

5.3.6 Set the source/measurement device to four-wire.

5.3.7 Note: See Figure 1 to verify proper attachments. For clarity, Figure 1 has generic labels. Current source HI and Current source LO in the figure represent input/output HI and input/output LO labels for the instrument referenced in footnote 1. For clarity, Figure 1 is also labeled voltage sense HI and voltage sense LO, which represent sense HI and sense LO labels for the instruments referenced in footnote 1.



Source current to electrodes 1 and 4; measure voltage between electrodes 2 and 3.

Figure 1 - Four-wire coolant hose cover resistance set-up

All wires used in the following subsections have shrouded banana jacks as referenced in 5.1.3.

5.3.7.1 Attach a wire (Lead 4) from the current source HI port to the tail portion of one outboard screw clamp using an alligator clip, and another wire (Lead 1) from the current source “input/output LO” power supply port to the tail portion of the other outboard screw clamp using an alligator clip.

5.3.7.2 Attach a wire (Lead 3) from the voltage sense HI port of the ammeter to the blade inboard of Lead 4 with an alligator clip, and a wire (Lead 2) from the “sense LO” port of the ammeter to the blade inboard of Lead 1 using an alligator clip.

5.3.8 Securely close access panels to interlock box.

5.3.9 Set the source/measurement device to convert the data from voltage to resistance.

5.3.10 Adjust to 10 µA, turn on supply. It may be necessary to deviate from this set point for certain materials. The manufacturer and end user must agree on an alternate set point.

5.3.11 Turn on and program the source/measurement device to collect data every 30 seconds for 5 minutes.

5.3.12 Report the resistance (Ω) for each data point collected, or dump data into a spreadsheet.

5.4 Report

5.4.1 Report the average, maximum, and minimum of the readings for the ten readings.

5.4.2 Plot the data as resistance on the Y-axis and time in seconds on the X-axis.

6. POTENTIAL FAILURE MODES

To verify proper set-up, it is advisable to run initial calibration 1 certified hose. A certified hose is obtained by testing the same hose, using the same parameters at two or more labs to verify resistance values. Preferably, one of the labs should include the equipment supplier.

6.1 Improper Source/Measurement Apparatus Settings

Some instruments may be set to default to two-wire settings, and may have to be adjusted each time the unit is used. Some units may allow the user to set to the four-wire setting and be saved. Laboratory round robin testing proved this to be a common problem.

Upon acquisition of a source/measurement apparatus, it is recommended that the laboratories run a correlation with one or two hose formulations with the equipment manufacturer. These hose samples should be kept available for use as calibration standards.

6.2 Hose Surface Variation

Extruded hose variations are manifested in surface texture, cure state, migration of ingredients such as oils, waxes, cure by-products, and exterior contamination including ink markings on hose.

7. LABORATORY ROUND ROBIN PROGRAM

Six laboratories (designated: A, B, C, D, E, and F) participated in evaluating the method.

All laboratories were either hose or vehicle manufacturers, except Laboratory “E,” which was an equipment supplier. The data from Laboratory “E” was used to determine if proper equipment set-up was utilized.

Three suppliers provided eight ethylene propylene diene rubber formulations (designated: 1, 2, 3, 4, 5, 6, 7, and 8). Formulations included three peroxide cure systems, and five sulfur/sulfur donor cure systems.

Hose samples and plugs were provided to Laboratory “A,” along with clamps from the same lot. Laboratory “A” cleaned and assembled the hose in accordance with procedures outlined in this document. Each hose variation was marked with the formulation code and orientation measurement points (0 degrees, 90 degrees, 180 degrees, and 270 degrees). Each orientation point indicates the electrode contact position. Starting with the initial reading, the 0-degree position is oriented down, or in line with the electrodes.

The assembled hoses were shipped and tested at each participating laboratory. The original sequence was to have Laboratory “A” run the initial test and final test in order to verify consistency. In actuality, each laboratory tested in this order:

A, B, C, D, E, D, A, F

The above procedure was followed, using 10 μA. Data points were taken every 30 seconds over a 5 minute test period.