



# SURFACE VEHICLE STANDARD

J343™

DEC2017

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Superseding J343 MAY2016

## Test and Test Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies

### RATIONALE

The pressure impulse wave forms for the high pressure and low-pressure tests in Figures 2 and 3 were inconsistent and the support notes were presented differently. This was the same situation in ISO 6605 and was corrected in the latest version - ISO 6605:2017.

The pressure impulse wave forms for the high pressure and low-pressure tests in Figures 2 and 3 were redrawn and a key was added along with supporting notes.

### FOREWORD

SAE J343 has been revised to be technically equivalent to ISO 6605, except that additional tests in 4.9 to 4.14 were included.

#### 1. SCOPE

This SAE Standard gives methods for testing and evaluating performance of the SAE 100R series of hydraulic hose and hose assemblies (hose and attached end fittings) used in hydraulic fluid power systems.

Specific tests and performance criteria for evaluating hose assemblies used in hydraulic service are in accordance with the requirements for hose in the respective specifications of SAE J517.

This document further establishes a uniform means of testing and evaluating performance of hydraulic hose assemblies.

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## 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 Publication

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

SAE J517 Hydraulic Hose

#### 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 D380 Standard Methods of Testing Rubber Hose

ASTM D5964 07 Standard Practice for Rubber IRM 901, IRM 902, and IRM 903 Replacement Oils for ASTM No. 1, ASTM No. 2, and ASTM No. 3 Oils

#### 2.1.3 ISO Publications

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

ISO 3448 Industrial liquid lubricants - ISO viscosity classification

ISO 6605 Hydraulic fluid power - Hose assemblies - Method of test

## 3. TEST PROCEDURES

The test procedures described in the current issue of ASTM D380 shall be followed. However, in cases of conflict between the ASTM specifications and those described as follows, the latter shall take precedence. Unless otherwise specified in this document, or other SAE standards, tests shall be conducted at the prevailing ambient temperature of the testing facility.

## 4. STANDARD TESTS

**WARNING:** Water or another liquid suitable for the hose under test shall be used as the test medium. The use of air and other gaseous materials as testing media should be avoided because of the risk to operators. In special cases where such media are required for the tests, strict safety measures are imperative. Furthermore, it is stressed that when a liquid is used as the test medium, it is essential that all air is expelled from the test piece because of the risk of injury to the operator due to the sudden expansion of trapped air released when the hose bursts.

### 4.1 Dimensional Check Test

The hose shall be inspected for conformity to all dimensions tabulated in the applicable specification.

Determine finished outside diameters and reinforcement diameters, where required, by calculation from measurement of the respective circumference.

As an alternative, use a flexible tape graduated to read the diameter directly.

Measure the inside diameter by means of a suitable expanding ball or telescoping gage.

Measure concentricity over both the reinforcement and the finished outside diameters using either a dial indicator gage or a micrometer.

Round the foot of the measuring instrument to conform to the inside diameter of the hose.

Take readings at 90° intervals around the hose.

NOTE: Acceptability is based on the total variation between the high and the low readings.

Take inside and outside diameter measurements at a minimum of 25 mm from the hose ends and concentricity measurements at a minimum of 13 mm from the hose ends.

#### 4.2 Proof Test

Test the hose assemblies hydrostatically to the specified proof pressure for a period of not less than 30 seconds nor more than 60 seconds.

There shall be no indication of failure or leakage.

#### 4.3 Change in Length Test

Conduct measurements for the determination of elongation or contraction on a previously untested, unaged hose assembly having at least 600 mm length of free hose between hose fittings.

Attach the hose assembly to the pressure source in an unrestricted straight position. If the hose is not straight due to its natural curvature, it may be fastened laterally to achieve a straight position. Pressurize to the specified operating pressure for a period of 30 seconds, then release the pressure.

Place accurate reference marks 500 mm apart on the outer cover of the hose, midway between fittings, after allowing the hose assembly to restabilize for a period of 30 seconds following pressure release.

Repressurize the hose assembly to the specified operating pressure for a period of 30 seconds.

Measure the final length while the hose is pressurized. The final length is the distance between reference marks while the hose is pressurized.

Complete the determination of the change in length using Equation 1:

$$\Delta l = \frac{l_1 - l_0}{l_0} \times 100 \quad (\text{Eq. 1})$$

where:

$l_0$  = distance between the reference marks when the hose was not pressurized following the initial pressurization

$l_1$  = distance between the reference marks under pressure

$\Delta l$  = percentage change in length, which will be positive (+) in the case of an increase in length and negative (-) in the case of a decrease in length

#### 4.4 Burst Test

Subject unaged hose or hose assemblies, on which the end fittings have been attached for not more than 30 days, to a hydrostatic pressure. Increase the pressure at a rate in accordance with the following paragraph until the hose or hose assembly fails.

The rate of pressure increase shall be constant and chosen to reach hose or hose assembly failure after a period of between 30 and 60 seconds for hoses with nominal inside diameters up to 51 mm. For hoses with nominal inside diameters greater than 51 mm and less than or equal to 250 mm, the time needed to reach hose or hose assembly failure shall be between 60 and 240 seconds.

Reject hose or hose assemblies showing leakage, hose burst or indication of failure below the specified minimum burst pressure. The location, pressure and mode of failure shall be recorded in the test report.

NOTE: This is a destructive test. Assemblies which have been subjected to this test shall be destroyed.

#### 4.5 Cold Bend Test

Subject hose assemblies to the specified temperature in a straight position for 24 hours.

Then, while still at the specified temperature, the samples shall be evenly and uniformly bent once over a mandrel having a diameter equal to twice the specified minimum bend radius. Bending shall be accomplished within a period of not less than 8 seconds nor more than 12 seconds.

In the case of hose sizes up to and including 22 mm nominal inside diameter, bend them through 180° over the mandrel; in the case of hose sizes larger than 22 mm nominal inside diameter, bend them through 90° over the mandrel.

After bending, allow the sample to warm to room temperature, visually examine it for cover cracks and subject it to the proof test. There shall be no cover cracks or leakage. (In lieu of the bending test, hoses larger than 22 mm nominal inside diameter may be considered acceptable if samples of tube and cover pass the Low Temperature Test on Tube and Cover of ASTM D380.)

Reject any samples with visible cracks or leakage.

NOTE: This is a destructive test. Assemblies which have been subjected to this test shall be destroyed.

#### 4.6 Impulse Test

The impulse test has two categories:

1. High pressure, which covers pressures higher than 3 MPa
2. Low pressure, which covers 1.5 to 3 MPa

Test four unaged hose assemblies with end fittings, which have been attached for not more than 30 days. Where the individual standard requires, also test aged hose assemblies.

Calculate the free (exposed) length of hose under test, shown on Figure 1, as follows:

- a. Hose sizes up to and including 22 mm nominal inside diameter (see Equation 2):

$$180^\circ \text{ bend free length} = \pi(r + d/2) + 2d \quad (\text{Eq. 2})$$

- b. Hose sizes larger than 22 mm nominal inside diameter (see Equation 3):

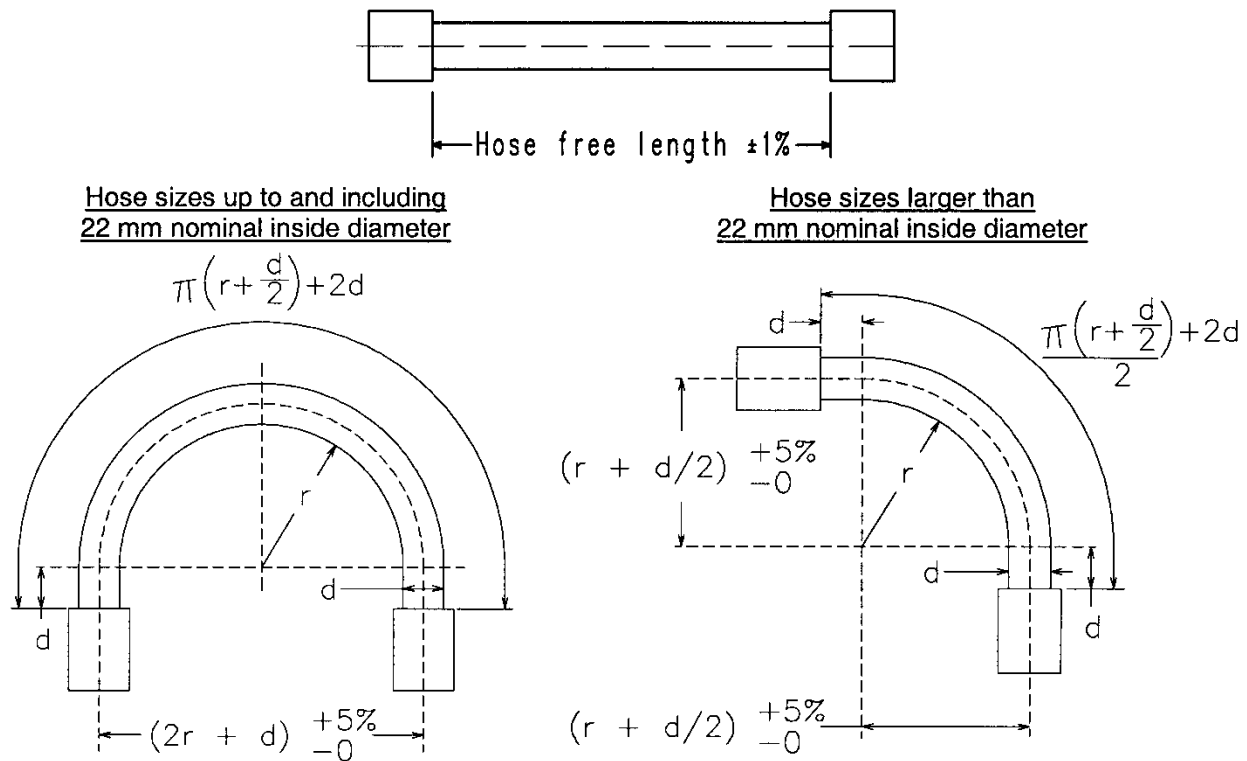
$$90^\circ \text{ bend free length} = \pi/2(r + d/2) + 2d \quad (\text{Eq. 3})$$

where:

r = minimum bend radius

d = hose outside diameter

NOTE: Use  $d = 25.4$  mm for the  $2d$  term until  $d$  is equal to or greater than 25.4 mm.



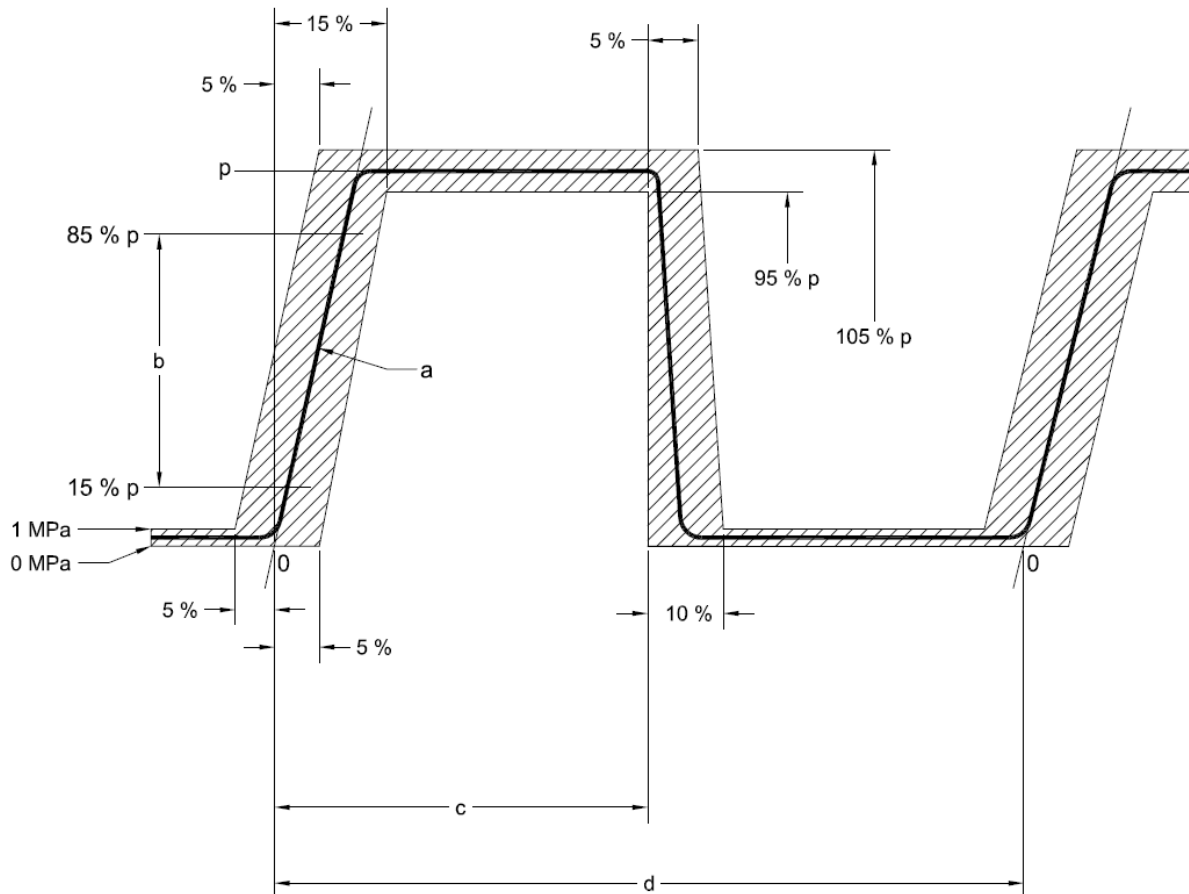
**Figure 1 - Test specimen for pressure impulse test**

Connect the test pieces to the apparatus. The test pieces shall be installed according to Figure 1. Test pieces of hose of nominal inside diameter up to and including 22 mm shall be bent through  $180^\circ$  and hoses of nominal inside diameter larger than 22 mm shall be bent through  $90^\circ$ .

Select a test fluid from ISO VG 32 to VG 100 at  $40^\circ\text{C}$  per ISO 3448, and circulate it at a rate sufficient to maintain a uniform fluid temperature within the hose assemblies. Other fluids may be used as agreed upon between the customer and the manufacturer.

Test the hose at the impulse test pressure indicated in the individual specification. The test fluid shall be circulated through the assemblies at the specified temperature with a tolerance of  $\pm 3$  °C. Cooling or heating of the test chamber shall not be permitted, except when individual standards require testing with synthetic base test fluids at a temperature higher than 150 °C. When such higher temperatures are required, the impulse test fluid need not be circulated if both the fluid and the assemblies are externally heated in the test chamber, at the specified temperature with a tolerance of  $\pm 5$  °C.

Apply a pulsating pressure internally to the hose assemblies at a rate described in the category chosen and record the frequency used. The pressure cycle shall fall within the shaded area of either Figures 2 or 3, depending upon the test category and conform as closely as possible to the curve shown. The actual rate of pressure rise shall be determined as shown on Figure 2, and shall be within a tolerance of  $\pm 10\%$  of the calculated nominal value.



**Key**

- a Secant pressure rise rate.
- b Rate of pressure rise to be determined between these two points.
- c 45% to 55% of a complete impulse cycle.
- d One complete impulse cycle.

**Figure 2 - Pressure impulse wave form envelope for high pressure impulse test category 1**

NOTE 1: Secant pressure rise is the straight line drawn through two points on the pressure rise curve; one point at 15% of the test pressure and the other at 85% of the test pressure

NOTE 2: Point '0' is the intersection of the secant pressure rise with a pressure of 0 MPa (0 bar).

NOTE 3: Pressure rise rate is the slope of the secant pressure rise expressed in megapascals per second (MPa/s).

NOTE 4: Cycle rate shall be uniform at 0.5 to 1.3 Hz.

NOTE 5: The nominal rate of pressure rise shall be equal to that shown in Equation 4:

$$R = f(10p - k)$$

(Eq. 4)

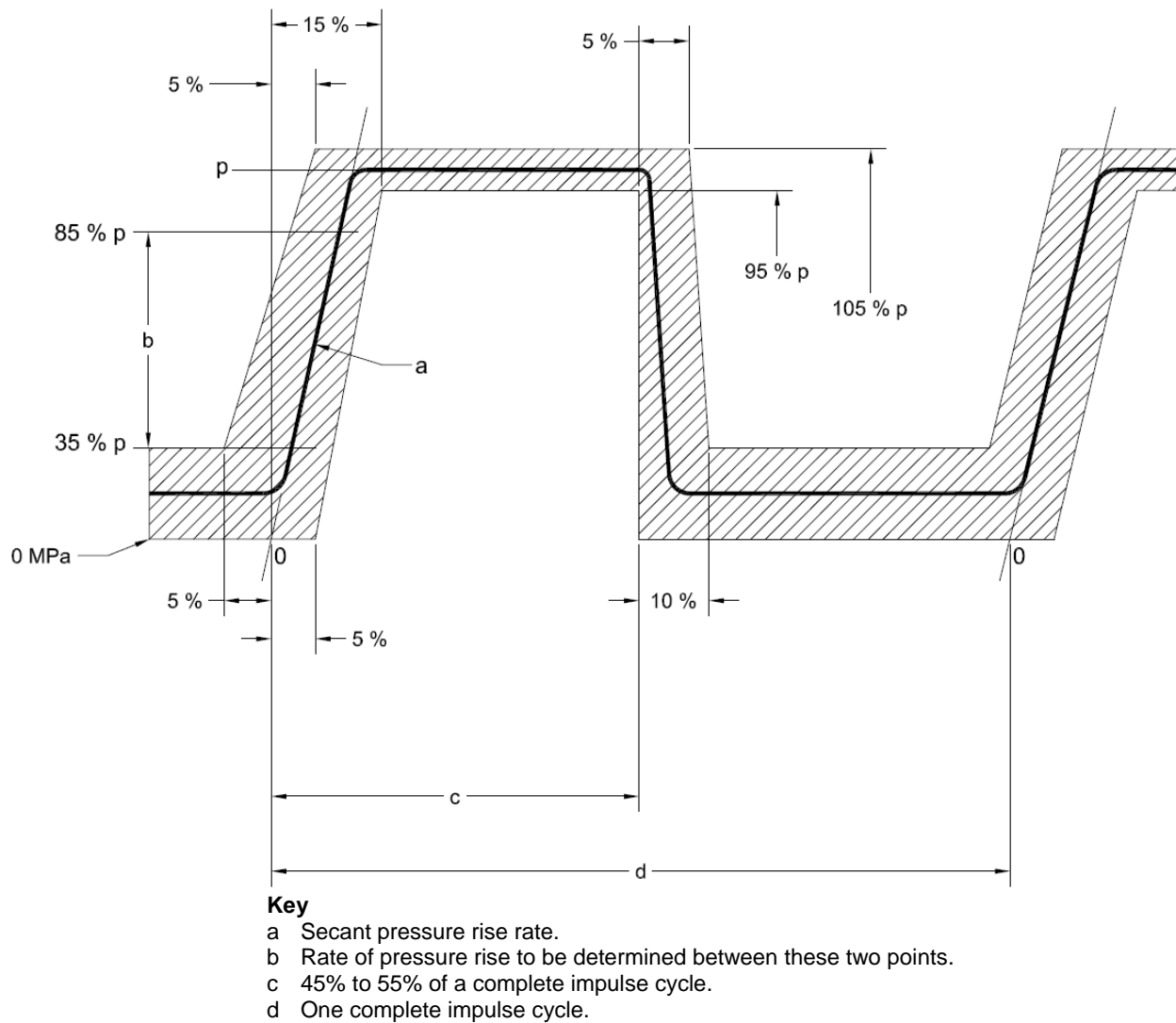
where:

R = rate of pressure rise in megapascals per second (MPa/s).

F = frequency in hertz (Hz).

P = nominal impulse test pressure in megapascals (MPa).

K = is equivalent to 5 megapascals (MPa).



**Figure 3 - Pressure impulse wave form envelope for low pressure impulse test category 2**

NOTE 1: Secant pressure rise is the straight line drawn through two points on the pressure rise curve; one point at 35% of the test pressure and the other at 85% of the test pressure

NOTE 2: Point '0' is the intersection of the secant pressure rise with a pressure of 0 MPa (0 bar).

NOTE 3: Pressure rise rate is the slope of the secant pressure rise expressed in megapascals per second (MPa/s).

NOTE 4: Cycle rate shall be uniform at 0.2 to 1.0 Hz.

NOTE 5: The nominal rate of pressure rise shall be equal to that shown in Equation 4.

Determine the duration of the impulse test in total number of cycles by the individual standard for the hose assemblies. Where aged samples are required, refer to the individual standards.

It is recommended the test fluid be changed frequently to prevent breakdown.

NOTE: This is a destructive test. Assemblies, which have been subjected to this test, shall be destroyed.

#### 4.7 Leakage Test

Subject unaged hose assemblies, on which the end fittings have been attached for not more than 30 days, to a hydrostatic pressure of 70% of the specified minimum burst pressure for a period of between 5.0 to 5.5 minutes.

Reduce the fluid pressure to 0 MPa.

Re-apply the 70% of minimum burst hydrostatic pressure for another 5.0 to 5.5 minute period.

Reject assemblies showing leakage or failure.

NOTE: This is a destructive test. Assemblies which have been subjected to this test shall be destroyed.

#### 4.8 Visual Examination of Product

All bulk hose shall be visually inspected to see that the hose identification has been properly applied and all assemblies shall be inspected to determine that the correct fittings are properly installed.

#### 4.9 Oil Resistance Test

After 70-hour immersion in ASTM Emergency Standard Practice IRM903 oil at the designated temperature, the volume change of specimens taken from the hose inner tube and cover shall be within the specified limits.

#### 4.10 Ozone Resistance Test

Hydraulic hose shall be tested for resistance of the cover compound to ozone in accordance with the latest issue of ASTM D380, except that the mandrel shall be a diameter twice the minimum bend radius specified in the individual hose standard, and the cover shall be examined at the completion of the test under 2X magnification.

#### 4.11 Electrical Conductivity Test (for thermoplastic hose only)

Hose assemblies having a free length of 152 mm  $\pm$  13 mm without fluid and capped to prevent entry of moisture shall be exposed to a minimum of 85% relative humidity at 24 °C  $\pm$  3 °C for a period of 168 hours. Surface moisture shall be removed prior to testing.

Conditioned assemblies shall have one end fitting attached to the lead from a source of 60 Hz sinusoidal, 37.5 kV (RMS) electricity. This lead shall be suspended by dry fabric strings so that the hose hangs free, at least 600 mm from any extraneous objects. The lower end of the hose shall be connected to ground through a 1000 to 1000000  $\Omega$  resistor, keeping the resistor near the end of the hose. A suitable AC voltmeter shall be connected across the resistor, using a fully shielded cable with the shielding well grounded. Thirty-seven and one-half kV shall be applied to the specimen for 5 minutes and a current reading taken. This current shall not exceed the value specified.

#### 4.12 Electrical Conductivity Test (PTFE hose only)

Test specimen shall be a 330 mm  $\pm$  10 mm cut length of hose with fitting attached to one end and the reinforcing braid flared away from the PTFE tube on the opposite end to prevent contact with the free end of the tube. The inner surface of the tube shall be cleaned, first with naphtha dry cleaning fluid or Stoddard solvent, and then with isopropyl alcohol to remove surface contamination, followed by thorough drying at room temperature.

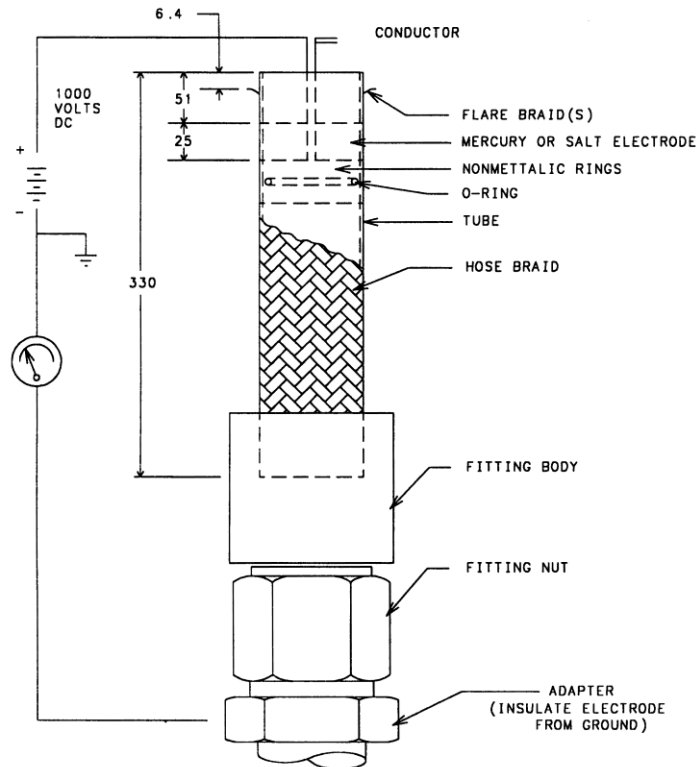
Relative humidity shall be kept below 70% and room temperature between 16 and 32 °C.



The specimen shall be mounted in a vertical position as shown in Figure 4. The adapter at the base is simply a convenient means of assuring proper electrical contact if a swivel female fitting is chosen, and may be omitted if a male fitting is used. In either case, the electrode must be insulated from ground.

A mercury or salt water solution electrode shall be provided at the upper end as shown, by inserting a nonmetallic plug with an O-ring seal to a distance of 75 mm from the end of the tubing, thus providing an average test length of 255 mm. Mercury or salt water solution shall then be added to a level 25 mm above the plug. Any suitable conductor to this electrode may be used, including a threaded end attached to the plug if so desired. Concentration of salt water, if used, shall be 450 g NaCl per liter of H<sub>2</sub>O.

1000 VDC shall be applied between the upper electrode and the lower electrode (adapter or male fitting hex). The current shall be measured with an instrument with a sensitivity of at least 1  $\mu$ A ( $1 \times 10^{-6}$  A).



**Figure 4 - Conductivity test diagram**

#### 4.13 Resistance to Vacuum Test

The hose shall not blister nor show any other indication of failure when subjected to the specified vacuum for a period of 5 minutes. Where practicable, one end of the hose shall be equipped with a transparent cap and electric light to permit visual examination for failure. Where the length or size of the hose precludes visual examination, failure shall be determined by inability to pass through the hose a ball or cylinder 6.5 mm less in diameter than the bore of hoses of 12.5 mm nominal inside diameter and larger. For hoses under 12.5 mm nominal inside diameter, a ball or cylinder 3.0 mm smaller in diameter than the bore shall be used.

#### 4.14 Volumetric Expansion Test

Volumetric expansion tests shall be run in accordance with the current issue of ASTM D380.

## 5. NOTES

### 5.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE HYDRAULIC HOSE AND HOSE FITTINGS COMMITTEE