



AEROSPACE STANDARD

AS2078**REV. A**

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Superseding AS2078

(R) Test Methods, Hose Assemblies, Polytetrafluoroethylene (PTFE)

This standard is equivalent to ISO 8829

RATIONALE

AS2078A has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

This standard has been prepared to standardize on the test methods for qualification of polytetrafluoroethylene (PTFE) hose and hose assemblies used in aircraft fluid systems. Compliance with these test methods is necessary for hose and hose assemblies which are used in systems where a malfunction could affect the safety of flight.

1. SCOPE AND FIELD OF APPLICATION

This SAE Aerospace Standard (AS) describes the test methods for flexible PTFE hose and hose assemblies used in aircraft fluid systems in the pressure and temperature ranges defined in specific procurement specifications. It applies to the hose and the hose coupling. The tests and assembly requirements for the connecting end fitting are covered in the procurement specification.

This document applies each time that it is referred to in a procurement specification or other definition document.

1.1 Hose Assembly Test Methods

The test methods to be used for testing of hose and hose assemblies shall be defined as follows:

- a. Section 3 - PTFE Inner Tube Test Methods
- b. Section 4 - Metallic Braided Hose and Hose Assembly Test Methods
- c. Section 5 - Non-Metallic Braided Hose and Hose Assembly Test Methods

Refer to Appendix A for an index listing of test methods.

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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 724-776-4970 (outside USA), www.sae.org.

AS603	Impulse Testing of Hydraulic Hose, Tubing and Fitting Assemblies
AS1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components
ARP1153	Method for Determining Relative Specific Gravity Polytetrafluoroethylene Tubing

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.

ASTM D 471	Standard Test Methods for Rubber Property – Effects of Liquids
ASTM D 792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 4895	Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion

2.1.3 Military Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>

MIL-PRF-680	Dry Cleaning Solvent
MIL-DTL-5624	Turbine Fuel, Aviation, Grade JP4, JP5, JP5/JP8 ST
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-F-8815	Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems, General Specification for
MIL-C-81302	Cleaning Compound, Solvent, Trichlorotrifluoroethane
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic, Hydrocarbon Base, Aircraft
MIL-PRF-87257	Hydraulic Fluid, Fire Resistant, Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

2.2 Definitions

ROOM TEMPERATURE: Temperature in the test laboratory between 60 and 90 °F (15.6 and 32.2 °C).

FIRE SLEEVE: Flame and fire retardant element to protect the hose assembly in a fire zone. Normally tubular which is slipped over the hose assembly and fastened at the hose fitting, or extruded/molded, normally (silicone) rubber, onto the hose and hose to fitting sealing joint.

FIRE CUFF: Flame and fire retardant element, normally (silicone) rubber, either molded, or added and bonded in place, over the hose to fitting sealing joint.

ABRASIVE SLEEVE: Material used to resist mechanical wear between the hose and some other surface. Can be tubular, integrally braided, extruded, or wrapped over the hose.

PRESSURE TOLERANCES: The tolerance allowed for all noted pressures. This tolerance shall be as defined in the applicable hose assembly procurement specification.

3. PTFE INNER TUBE TEST METHODS

3.1 Density and Relative Density

This test is intended to verify the crystallinity of PTFE inner tubes. The relative density of PTFE tubing shall be measured in accordance with ARP1153. The density of the PTFE tubing shall be measured in accordance with ASTM D 792 or ASTM D 1505.

3.2 Tensile Test and Elongation

This test is intended to verify the mechanical properties of the PTFE tubing.

3.2.1 Test Conditions

Test specimens shall be conditioned for at least 2 h at room temperature before testing.

3.2.2 Testing Machine

Tension tests shall be conducted using a power-driven machine which maintains a uniform rate of grip separation at 2 in/min (50 mm/min) and which has a suitable dynamometer and a device for measuring the applied force within $\pm 2\%$. If the capacity range cannot be changed during a test, as in the case of pendulum dynamometers, the applied force at break shall be measured within $\pm 2\%$, and the smallest tensile force measured shall be accurate to within $\pm 10\%$. If the dynamometer is of the compensating type for measuring tensile stress directly, means shall be provided to adjust for the cross-sectional area of the specimen. The response of the recorder shall be sufficiently rapid that the applied force is measured accurately during the extension of the specimen to rupture. If the test machine is not equipped with a recorder, a device shall be provided that indicates after rupture the maximum force applied during extension. Test machines shall be capable of measuring elongation in increments of 10%.

3.2.3 Micrometers

The micrometer used for measuring flat specimen thickness shall be capable of exerting a pressure of 3.6 psi $\pm$ 0.7 psi (25 kPa $\pm$ 5 kPa), on the specimens and of measuring the thickness to within ± 0.001 in (± 0.025 mm).

NOTE: Dial micrometers exerting a force of 0.18 lbf $\pm$ 0.034 lbf (0.8 N $\pm$ 0.15 N) force on a circular foot 0.25 in (6.35 mm) in diameter, or 0.045 lbf $\pm$ 0.009 lbf (0.2 N $\pm$ 0.04 N) force on a circular foot 0.125 in (3.2 mm) in diameter conform to this pressure requirement. A micrometer should not be used to measure the thickness of specimens narrower in width than the diameter of the foot unless the contact pressure is properly adjusted.

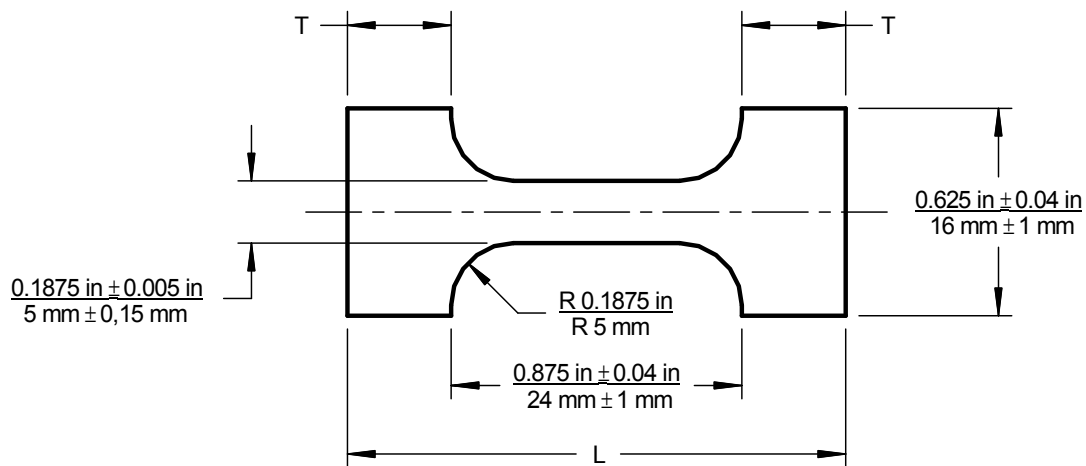
3.2.4 Calibration of Testing Machine

The testing machine shall be calibrated. If the dynamometer is of the strain-gage type, calibrate the test machine at one or more forces at regular intervals.

3.2.5 Tensile Test Specimens

Tensile test specimens shall be as shown in Figure 1.

NOTE: Careful maintenance of die cutting edges is of extreme importance and can be obtained by light daily honing and touching up the cutting edges with jewelers' hard honing stones. The condition of the die may be judged by investigating the rupture point on any series of broken specimens. When broken specimens are removed from the clamps of the testing machine, it is advantageous to pile these specimens and note if there is any tendency to break at or near the same portion of each specimen. Rupture points consistently occurring at the same place may be an indication that the die is dull, nicked, or bent at that particular position.



Dimensions in inch / mm

Thickness = Measured Thickness of Specimen

Minimum Tab Length $T = 0.3125 \text{ in} / 8 \text{ mm}$

Minimum Length $L = 1.50 \text{ in} / 40 \text{ mm}$

FIGURE 1 - TENSILE TEST SPECIMEN

3.2.6 Determination of Tensile Strength and Elongation

Place the specimens in the jaws of the testing machine, using care to adjust the specimen symmetrically in order that the tension will be distributed uniformly over the cross section. Start the machine and note continuously the distance between the jaws, taking care to avoid parallax. At rupture, measure and record the elongation to the nearest 10% on the scale.

3.2.7 Calculation

a. Calculate the tensile strength as follows:

$$\text{Tensile strength (psi or N/mm}^2\text{)} = F/A \quad (\text{Eq. 1})$$

where:

F = observed force, in pounds or newtons, required to rupture the specimens

A = cross-sectional area in in² or mm², of the unstretched specimen

NOTE: 1 N/mm² = 1 MPa

Calculate the elongation as follows:

$$\text{Elongation, \%} = (L - L_o)/L_o \times 100 \quad (\text{Eq. 2})$$

where:

L = observed distance between the jaws at rupture of the specimen

L_o = original distance between the jaws

3.3 Tube Roll and Proof Test

This test is intended to verify that there are no flaws in the sintered tube.

3.3.1 Tube Rolling

Each tube shall be passed, in a single pass, through six sets of metal rollers so that it is subjected to the following sequence of diametral flexings; rollers shall be arranged to prevent inadvertent rotation of the tube. It is assumed that the tube is in a horizontal position and that pressure of the first set of rolls is exerted vertically; angles given for the final three sets of rolls may be taken as either clockwise or counterclockwise from the vertical diameter of the tube. Roller angles are specified in Table 1. A tolerance of ±2 degrees is allowed on each roller angle. The roller gap dimensions are specified in Table 2.

Roller gaps shall not be larger than specified in Table 2 for each size.

TABLE 1 - ROLLER FUNCTIONS AND ANGLES

Phase	Type of Action	Roller Angle Degree
A	Flattening	0
B	Flattening	90
C	Rounding	0
D	Flattening	45
E	Flattening	135
F	Rounding	45

TABLE 2 - GAP DIMENSIONS FOR ROLLING¹

Hose size Inch (DN)	Flattening Gap Max 1500 psi (10 500 kPa) Hose Inch (mm)	Flattening Gap Max 3000 psi (21 000 kPa) and Higher Hose Inch (mm)	Rounding Gap Max 1500 psi (10 500 kPa) Hose Inch (mm)	Rounding Gap Max 3000 psi (21 000 kPa) and Higher Hose Inch (mm)
03 (05)	0.203 (5,2)	0.203 (5,2)	0.218 (5,5)	0.250 (6,4)
04 (06)	0.218 (5,5)	0.281 (7,1)	0.218 (5,5)	0.250 (6,4)
05 (08)	0.218 (5,5)	--	0.250 (6,4)	--
06 (10)	0.218 (5,5)	0.281 (7,1)	0.312 (7,9)	0.328 (8,3)
08 (12)	0.234 (5,9)	0.328 (8,3)	0.375 (9,5)	0.469 (11,9)
10 (16)	0.250 (6,4)	0.328 (8,3)	0.500 (12,7)	0.578 (14,7)
12 (20)	0.250 (6,4)	0.328 (8,3)	0.500 (12,7)	0.688 (17,5)
14 (22)	--	0.328 (8,3)	--	0.765 (19,4)
16 (25)	0.250 (6,4)	0.328 (8,3)	0.750 (19,1)	0.828 (21,0)
20 (32)	0.312 (7,9)	0.438 (11,1)	0.875 (22,2)	1.000 (25,4)
24 (40)	0.375 (9,5)	--	1.250 (31,8)	--

¹ 8000 psi (56 000 kPa) odd size high pressure hose assembly callout will utilize lower even hose size except for -03 (DN05) size. (Example: -07 (DN11) assy = -06 (DN10) size.)

3.3.2 Proof Test

Following the roll test, the tube shall be held for not less than 2 min at pressures as specified in Table 3 using water, air, or nitrogen as the test medium.

TABLE 3 - PROOF PRESSURES OF HOSE INNER TUBE¹

Size Inch (DN)	Proof Pressure - Minimum 1500 psi (10 500 kPa) Hose psi (kPa)	Proof Pressure - Minimum 3000 psi (21 000 kPa) and Higher Hose psi (kPa)
03 (05)	390 (2690)	480 (3310)
04 (06)	360 (2480)	380 (2620)
05 (08)	290 (2000)	--
06 (10)	230 (1590)	280 (1930)
08 (12)	180 (1240)	220 (1520)
10 (16)	170 (1170)	170 (1170)
12 (20)	140 (965)	130 (890)
14 (23)	--	110 (758)
16 (25)	90 (621)	95 (660)
20 (32)	65 (448)	95 (660)
24 (40)	45 (310)	--

¹ 8000 psi (56 000 kPa) odd size high pressure hose assembly callout will utilize lower even hose size except for -03 (DN05) size. (Example: -07 (DN11) assy = -06 (DN10) hose.)

3.4 Electrical Conductivity Test

This test is intended to verify that the hose inner tube is sufficiently conductive to prevent buildup of excessive electrostatic charge which could cause arcing and create pin holes in the tube.

- 3.4.1 The test specimen shall be a 14 in (350 mm) length of PTFE hose tube without braid. The inner surface of the tube shall be washed first with solvent per MIL-PRF-680, if required, then/or with isopropyl alcohol to remove surface contamination. The tube inside shall then be thoroughly dried at room temperature.
- 3.4.2 The test specimen shall then be arranged either vertically, as shown in Figure 2A, or bent 180 degrees as shown in Figure 2B. The relative humidity shall be kept below 70%. Apply 1000 V DC maximum between the upper electrode and the lower electrode. The saltwater solution shall be 450 g maximum of Na Cl in 1 ℓ chemically pure distilled or de-ionized water.
- 3.4.3 The current shall be measured with an instrument with a sensitivity of at least 1 μA (1×10^{-6}).

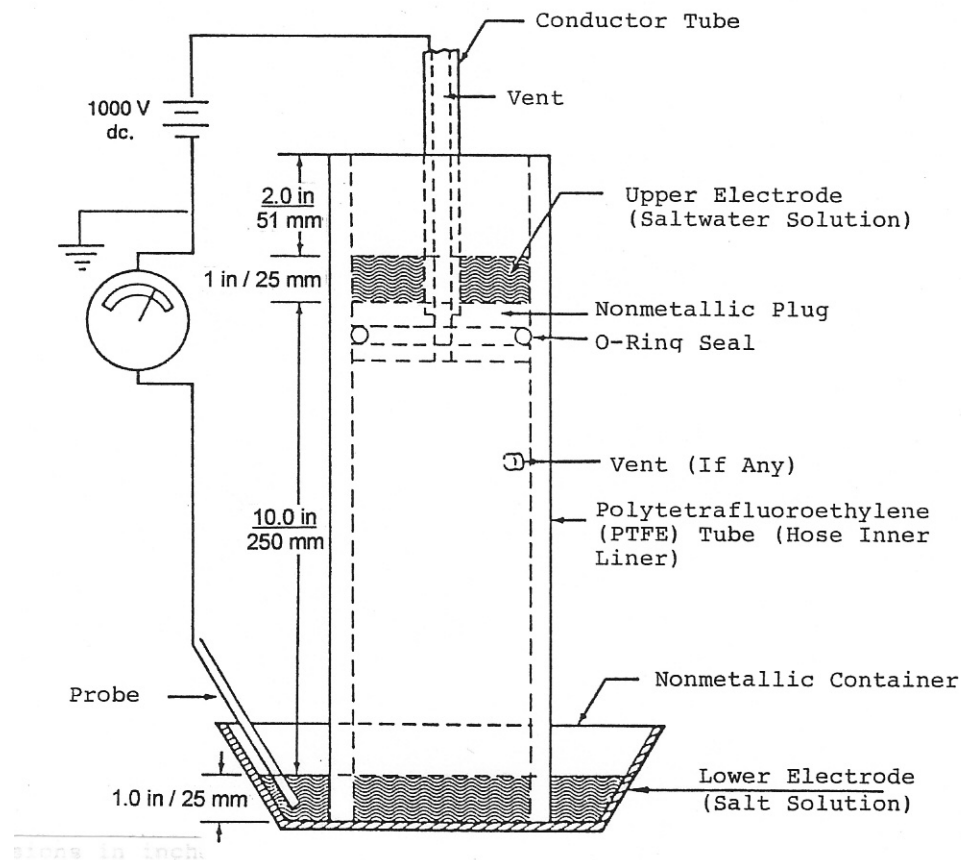


FIGURE 2A - DIAGRAM FOR THE ELECTRICAL CONDUCTIVITY TEST OF LINING IN VERTICAL POSITION

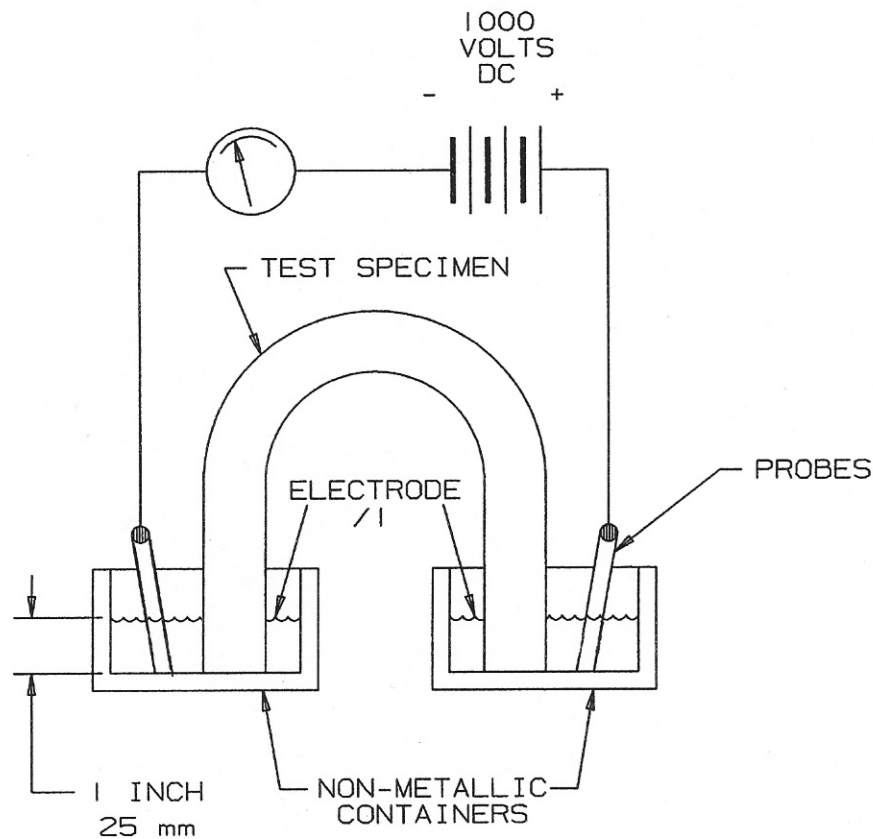


FIGURE 2B - DIAGRAM FOR THE ELECTRICAL CONDUCTIVITY TEST OF LINING IN 180° BENT POSITION

4. METALLIC BRAIDED HOSE AND HOSE ASSEMBLY TEST METHODS

4.1 Stress Degradation Test

This test is intended to verify that the hose inner tube has been sintered and quenched to the proper crystallinity to eliminate stress cracking or creep with subsequent leakage.

4.1.1 Hose (3000 psi / 21 000 kPa and Higher Pressure)

The hose assemblies shall be subjected to the following test sequence:

- a. The hose assemblies shall be filled with a high temperature test fluid per MIL-PRF-7808 or MIL-PRF-83282 and placed in an oven that shall be maintained at $400\text{ }^{\circ}\text{F} \pm 10\text{ }^{\circ}\text{F}$ ($204\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$). The nominal operating pressure specified by the procurement specification shall be applied to the hose assemblies.

NOTE: Precautions shall be taken to assure that the hose assemblies do not come in contact with parts of the oven that are at a higher temperature.

- b. After a minimum of 20 h at $400\text{ }^{\circ}\text{F}$ ($204\text{ }^{\circ}\text{C}$), the pressure shall be gradually released and the assemblies removed from the oven, drained, and cooled to room temperature. The assemblies shall then be flushed with a quantity of new test fluid equivalent in volume to at least twice the test sample volume and drained.

- c. The hose assemblies shall then be filled with hydraulic test fluid per MIL-PRF-83282 or MIL-PRF-87257. The nominal operating pressure specified by the procurement specification shall be applied and held for a minimum of 2 h at room temperature.
- d. The procedure specified in steps a, b, and c shall be repeated for a total of three cycles.
- e. Within 4 h after the final 2 h pressurization period, the hose assemblies shall be drained and flushed with MIL-C-81302 or MIL-PRF-680 and placed in an oven for 1 h minimum. The temperature of the oven shall be maintained at $160^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($70^{\circ}\text{C} \pm 5^{\circ}\text{C}$).
- f. Within 8 h after completion of the drying process the hose assemblies shall be removed from the oven, cooled to room temperature, and then subjected to an air underwater test. To conduct this test, the hose assemblies shall be installed in an apparatus constructed similar to that shown in Figure 3.

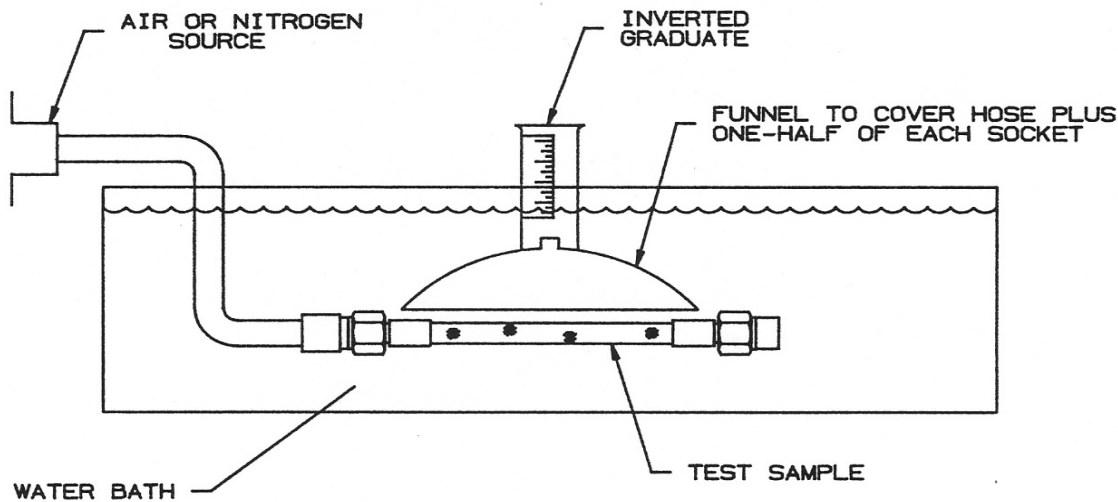


FIGURE 3 - TEST SETUP FOR PNEUMATIC EFFUSION TESTS

- g. The test setup with the installed hose assembly shall be immersed in water. The nominal operating pressure specified by the procurement specification shall be applied for 15 min to allow any entrapped air in the hose to escape.
- h. The pressure shall be held for an additional 5 min period, during which time the effused gas shall be collected from the test sample, including the juncture of the hose and the fitting, but not including the fitting nut. After the 5 min period of pressurization, the average rate of effusion through the hose and two fittings shall be computed into cubic centimeter per minute per inch of hose length.

NOTE: The fluid in the test device shall be water that has been treated for wetting of the hose by adding 1.5% by volume of water softener or wetting agent.

4.1.2 Hose (1500 psi / 10 500 kPa)

The hose assemblies shall be tested in the same manner as specified in 4.1.1 except that the test temperature shall be $450^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($232^{\circ}\text{C} \pm 5^{\circ}\text{C}$) instead of 400°F (204°C).