



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AMS 3380B

Superseding AMS 3380A

Issued 1-15-60
Revised 12-15-74

HOSE, POLYTETRAFLUOROETHYLENE TFE Fluorocarbon Resin Wire Braid Reinforced

1. SCOPE:

- 1.1 Form: This specification covers polytetrafluoroethylene resin in the form of extruded and sintered flexible hose reinforced with wire braid.
- 1.2 Application: Primarily for fluid lines operating at temperatures up to 450° F or 230° C and pressures up to 1500 psi (10,300 kPa).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 3160 - Solvent, Petroleum

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM D412 - Tension Testing of Vulcanized Rubber
ASTM D471 - Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids
ASTM D571 - Testing Automotive Hydraulic Brake Hose
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D1457 - TFE-Fluorocarbon Resin Molding and Extrusion Materials

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Specifications:

TT-S-735 - Standard Test Fluids, Hydrocarbon

2.3.2 Military Specifications:

MIL-H-5606 - Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-H-8446 - Hydraulic Fluid, Nonpetroleum Base, Aircraft

3. TECHNICAL REQUIREMENTS:

- 3.1 Material and Fabrication: Hose shall consist of a polytetrafluoroethylene tube and an overlying corrosion-resistant steel wire braid reinforcement.

SAE Technical Board rules provide that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

3.1.1 Tube: Shall be a seamless, continuous extrusion of virgin polytetrafluorethylene resin. Base resin shall conform to ASTM D1457, Type III. Pigments may be included in the compound from which the tube is extruded.

3.1.2 Reinforcement: Shall be of 18-8 type corrosion resistant steel wire, uniform in quality and size, of sufficient strength to ensure that the hose will meet the requirements of this specification; it shall be well, evenly, and firmly braided, and shall be free from dirt, lumps, and irregularities of braid. Hose under 0.875 in. (22.22 mm) nominal ID shall have a single layer of braid; hose 0.875 in. (22.22 mm) and over nominal ID shall have two layers of braid.

3.2 Properties:

3.2.1 Tube: The tube, before braiding or with reinforcement removed, shall conform to the following requirements; tests shall be conducted in accordance with the methods specified, insofar as practicable:

3.2.1.1	Tensile Strength at 77° F \pm 2 or 25° C \pm 1, min Longitudinal, All sizes	3000 psi (20.7 MPa)	ASTM D412 except separation speed 2 in. (50.8 mm) per min. for sizes 0.500 in. (12.70 mm) ID and under.
	Transverse, Sizes over 0.500 in. (12.70 mm) ID	2500 psi (17.2 MPa)	ASTM D1457 for larger sizes.
3.2.1.2	Elongation at 77° F \pm 2 or 25° C \pm 1, min	200%	As for tensile strength
3.2.1.3	Specific Gravity at 77° F \pm 2 or 25° C \pm 1	2.125 - 2.155	ASTM D792, Method A Add 2 drops of wetting agent to water.

3.2.1.4 Roll and Proof Pressure: Tube pigmented throughout the wall, and other types of tube when specified by purchaser, shall be subjected to the test of 3.2.1.4.1; all tubing shall be subjected to the test of 3.2.1.4.2.

3.2.1.4.1 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.

3.2.1.4.1.1 Roller angles specified in the following table assume 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. A tolerance of ± 2 deg (± 0.035 rad) is allowed on each roller angle.

Phase	Type of Action	Roller Angle	
		deg	(rad)
A	Flattening	0	(0)
B	Flattening	90	(1.57)
C	Rounding	0	(0)
D	Flattening	45	(0.785)
E	Flattening	135	(2.36)
F	Rounding	45	(0.785)

3.2.1.4.1.2 Roller gaps shall be not larger than specified below for each size.

Size	Flattening Gap		Rounding Gap	
	Inch	(Millimetres)	Inches	(Millimetres)
3	0.203	(5.16)	0.218	(5.54)
4	0.218	(5.54)	0.218	(5.54)
5	0.218	(5.54)	0.250	(6.35)
6	0.218	(5.54)	0.312	(7.92)
8	0.234	(5.94)	0.375	(9.52)
10	0.250	(6.35)	0.500	(12.70)
12	0.250	(6.35)	0.500	(12.70)
16Z	0.250	(6.35)	0.750	(19.05)
20Z	0.312	(7.92)	0.875	(22.22)
24Z	0.375	(9.52)	1.250	(31.75)

3.2.1.4.2 Tube shall not leak, burst, or show other evidence of malfunction when held for not less than 2 min. at a pressure not lower than the proof pressure shown in Table I, using water or air as the test medium; the pressure used shall be not higher than the minimum burst pressure value of that table. When the test of 3.2.1.4.1 is required, tubing shall be subjected to that test before being proof pressure tested.

TABLE I

Proof and Burst Pressures of Tube

Size	Nominal ID		Proof Pressure		Burst Pressure	
	Inches	(Millimetres)	psi	(kPa)	psi	(kPa)
3	0.125	(3.18)	390	(2690)	600	(4140)
4	0.188	(4.78)	360	(2480)	550	(3790)
5	0.250	(6.35)	290	(2000)	500	(3450)
6	0.313	(7.95)	230	(1590)	390	(2690)
8	0.406	(10.31)	180	(1240)	320	(2210)
10	0.500	(12.70)	170	(1170)	290	(2000)
12	0.625	(15.88)	140	(965)	220	(1520)
16Z	0.875	(22.22)	90	(621)	140	(965)
20Z	1.125	(28.58)	65	(448)	100	(690)
24Z	1.375	(34.92)	45	(310)	60	(414)

3.2.1.5 **Burst Pressure:** Tube shall not burst at any pressure lower than the burst pressure shown in Table I when pressure is applied at a uniform rate so as to reach the specified minimum burst pressure in 5 - 10 sec and the rate of rise is maintained at the same rate until the tube bursts. Any suitable fluid may be used as the test medium. The tube shall be suitably clamped so as to prevent leakage but to permit axial movement of the tube during test.

3.2.1.6 **Conductivity:** Tube sizes 8 and smaller shall be capable of conducting a direct current of not less than 10 microamp and sizes 10 and larger a current of not less than 20 microamp with a test potential of 1000 V, determined in accordance with 4.5.1.

3.2.2 **Hose:** Specimens of suitable length but not shorter than 9 in. or 230 mm, cut from the complete hose, with suitable end fittings attached (except for the braid flare test) shall conform to the following requirements; tests shall be performed in accordance with the methods specified, insofar as practicable:

3.2.2.1 **Braid Flare:** A specimen shall fall, from the position specified in 4.5.2, through the specified ring and the sleeve normally used in making hose assemblies shall pass over the tube without interference from the braid.

3.2.2.2 Proof Pressure:

3.2.2.2.1 Hose shall not leak, burst, or show other evidence of malfunction when held at a pressure not lower than shown in Table II, column 3 for not less than 30 sec and not more than 5 minutes. The pressure used shall be not higher than 50% of the minimum burst pressure shown in Table II, column 4.

3.2.2.2.2 Hose shall not leak when given a final check by completely immersing in water, to which may be added a wetting agent or corrosion inhibitor or both, applying air or nitrogen pressure not lower than the operating pressure shown in Table II, column 6 but not higher than the proof pressure shown in Table II, column 3, and holding at the selected pressure for not less than 30 sec after stabilizing the pressure. If the test of 3.2.2.2.1 is conducted using air or nitrogen as the test fluid, this test is not required. This test shall be run only by the manufacturer of the hose.

3.2.2.3 Burst Pressure at Room Temperature: Hose shall not leak, burst, or show evidence of malfunction at any pressure lower than the values specified in Table II, column 4 when pressure is applied at a rate of increase of 15,000 - 25,000 psi per min. or 1750 - 2750 kPa/sec, with hose extended straight and the free end unrestrained.

3.2.2.4 Burst Pressure at 450° F or 230° C: Hose shall not leak, burst, or show other evidence of malfunction at any pressure lower than the values specified in Table II, column 5, determined in accordance with 4.5.3 at 450° F \pm 10 or 230° C \pm 5.

3.2.2.5 Change In Length Under Pressure: Hose shall not change in length by more than +0.20 in. (+5.1 mm) or -0.30 in. (-7.6 mm) at the operating pressure specified in Table II, column 6, determined in accordance with 4.5.4.

3.2.2.6 Impulse Test: Hose shall not burst, leak, or show other evidence of malfunction during 100,000 impulse cycles at 400° F \pm 10 or 200° C \pm 5, determined in accordance with 4.5.5.

3.2.2.7 Stress Degradation: Hose shall not burst, leak, or show other evidence of malfunction during the sequence of tests specified in 4.5.6. The effusion rate during that portion of the cycle specified in 4.5.6.5 shall be not greater than the following:

Size	Nominal ID		Effusion Rate cm ³ per in. (25.4 mm)
	Inches	(Millimetres)	
3	0.125	(3.18)	10
4	0.188	(4.78)	8
5	0.250	(6.35)	8
6	0.313	(7.95)	8
8	0.406	(10.31)	4
10	0.500	(12.70)	2
12	0.625	(15.88)	2
16Z	0.875	(22.22)	2
20Z	1.125	(28.58)	2
24Z	1.375	(34.92)	2

3.2.2.8 Leakage: Hose shall not leak when subjected to the test of 4.5.7.

3.2.2.9 Fuel Resistance: Hose shall not leak or show other evidence of malfunction during the test of 4.5.8.

3.2.2.10 Flexibility: Hose shall withstand bending at -67° F \pm 2 (-55° C \pm 1.1) without cracking, breaking, or splitting, determined in accordance with 4.5.9.

3.2.2.11 Vacuum: Hose shall not collapse to the extent that a ball of the specified diameter will fail to pass through the hose and without showing other permanent damage, determined in accordance with 4.5.10.

TABLE II

Proof, Burst, and Operating Pressures Of Hose

Size (Col. 1)	Nominal ID Inches (Col. 2)	Proof Pressure psi (Col. 3)	Burst Pressure		Operating Pressure psi (Col. 6)
			At Room Temperature psi (Col. 4)	At 450° F psi (Col. 5)	
3	0.125	3000	12,000	7500	1500
4	0.188	3000	12,000	7000	1500
5	0.250	3000	10,000	6500	1500
6	0.313	3000	9,000	6500	1500
8	0.406	3000	8,000	6000	1500
10	0.500	3000	7,000	5500	1500
12	0.625	2000	5,000	3500	1000
16Z	0.875	2500	5,000	3500	1250
20Z	1.125	2000	4,000	3000	1000
24Z	1.375	2000	4,000	3000	1000

TABLE II (SI)

Size (Col. 1)	Nominal ID Millimetres (Col. 2)	Proof Pressure MPa (Col. 3)	Burst Pressure		Operating Pressure MPa (Col. 6)
			At Room Temperature MPa (Col. 4)	At 230° C MPa (Col. 5)	
3	3.18	20.7	82.7	51.7	10.3
4	4.78	20.7	82.7	48.3	10.3
5	6.35	20.7	69.0	44.8	10.3
6	7.95	20.7	62.1	44.8	10.3
8	10.31	20.7	55.2	41.4	10.3
10	12.70	20.7	48.3	37.9	10.3
12	15.88	13.8	34.5	24.1	6.90
16Z	22.22	17.2	34.5	24.1	8.62
20Z	28.58	13.8	27.6	20.7	6.90
24Z	34.92	13.8	27.6	20.7	6.90

3.2.2.12 Volumetric Expansion: Hoses of sizes 3, 4, and 5 shall show a volumetric expansion not greater than specified below, determined in accordance with ASTM D571 at a pressure of 1000 psi (6.90 MPa).

Size	Nominal ID		Volumetric Expansion	
	Inch	(Millimetres)	cm ³ per in. free length	mm ³ per mm free length
3	0.125	(3.18)	0.028	1.10
4	0.188	(4.78)	0.028	1.10
5	0.250	(6.35)	0.040	1.57

3.2.2.13 Pneumatic Effusion: The average effusion rate through the hose and two fittings, measured over the last 8 hr of testing at each temperature, shall be not greater than shown in Table III, determined in accordance with 4.5.11.

TABLE III

Size	Nominal ID Inches	Effusion Rate, cm ³ per hr per ft of Length At Temperature Indicated			
		Room	-65° F	+275° F	+400° F
3	0.125	8.0	3.0	100	250
4	0.188	8.0	3.0	100	250
5	0.250	10.0	3.0	110	275
6	0.313	10.0	3.0	125	300
8	0.406	10.0	3.0	125	350
10	0.500	10.0	3.0	140	400
12	0.625	12.0	3.0	140	450
16Z	0.875	16.0	4.0	180	600
20Z	1.125	16.0	4.0	350	700
24Z	1.375	16.0	4.0	400	900

TABLE III (SI)

Size	Nominal ID Millimetres	Effusion Rate, cm ³ per hr per 100 mm of Length At Temperature Indicated			
		Room	-54° C	+135° C	+200° C
3	3.18	2.6	1.0	32.5	81.2
4	4.78	2.6	1.0	32.5	81.2
5	6.35	3.2	1.0	65.8	89.4
6	7.95	3.2	1.0	40.6	97.5
8	10.31	3.2	1.0	40.6	113.8
10	12.70	3.2	1.0	45.5	130.0
12	15.88	3.9	1.0	45.5	146.2
16Z	22.22	5.1	1.3	58.5	195.0
20Z	28.58	5.1	1.3	113.8	227.5
24Z	34.92	5.1	1.3	130.0	292.5

3.2.2.14 Pneumatic Surge Test: There shall be no evidence of leakage at the end fittings of hose subjected to the rated proof pressure shown in Table II, column 3 after 16 cycles of pressurization and rapid depressurization, determined as in 4.5.12.

3.3 Quality: The product shall be uniform in quality and condition, clean, smooth, and free from foreign materials and from internal and external imperfections detrimental to fabrication, appearance, or performance of parts.

3.3.1 Broken or missing reinforcement wires and loops of wire extending above the surface a distance greater than one wire diameter will be causes for rejection; crossed over reinforcing wires will not be cause for rejection.

3.3.2 The product shall have a smooth bore and shall be free from pitting or projections on the inner surface of the tube.

3.4 Sizes and Tolerances:

3.4.1 Diameter and Wall Thickness: Unless otherwise specified, hose shall be furnished in the sizes and to the dimensions shown in Table IV.

TABLE IV

Size	Nominal ID Inches	ID Tolerance Inch		Tube Wall Thickness Inch	OD Over Braid Inches
		plus	minus		
3	0.125	0.025	0.000	0.035 - 0.047	0.237 - 0.268
4	0.188	0.015	0.015	0.035 - 0.047	0.304 - 0.343
5	0.250	0.015	0.015	0.035 - 0.047	0.356 - 0.406
6	0.313	0.015	0.015	0.035 - 0.047	0.430 - 0.469
8	0.406	0.015	0.015	0.038 - 0.050	0.546 - 0.585
10	0.500	0.015	0.015	0.042 - 0.054	0.641 - 0.687
12	0.625	0.020	0.010	0.042 - 0.054	0.766 - 0.812
16Z	0.875	0.031	0.024	0.042 - 0.054	1.078 - 1.140
20Z	1.125	0.031	0.024	0.045 - 0.057	1.328 - 1.390
24Z	1.375	0.031	0.031	0.065 - 0.077	1.637 - 1.707

TABLE IV (SI)

Size	Nominal ID Millimetres	ID Tolerance Millimetres		Tube Wall Thickness Millimetres	OD Over Braid Millimetres
		plus	minus		
3	3.18	0.64	0.00	0.89 - 1.19	6.02 - 6.81
4	4.78	0.38	0.38	0.89 - 1.19	7.72 - 8.71
5	6.35	0.38	0.38	0.89 - 1.19	9.04 - 10.31
6	7.95	0.38	0.38	0.89 - 1.19	10.92 - 11.91
8	10.31	0.38	0.38	0.97 - 1.27	13.87 - 14.86
10	12.70	0.38	0.38	1.07 - 1.37	16.28 - 17.45
12	15.88	0.51	0.25	1.07 - 1.37	19.46 - 20.62
16Z	22.22	0.79	0.61	1.07 - 1.37	27.38 - 28.56
20Z	28.58	0.79	0.61	1.14 - 1.45	33.73 - 35.31
24Z	34.92	0.79	0.79	1.65 - 1.96	41.58 - 43.36

3.4.2 Length: Unless otherwise specified, hose shall be furnished in the lengths shown in Table V but not \emptyset more than 5% of a shipment shall be in 3 ft (914 mm) lengths.

TABLE V

Size	<u>Percent of Shipment in Length Ranges Shown</u>	
	3 to 14 ft, incl	Over 14 ft
4 to 8 , incl	35	65
10 to 16Z, incl	45	55
20Z to 24Z, incl	60	40

TABLE V (SI)

Size	Percent of Shipment in Length Ranges Shown	
	914 mm to 12.8 m, incl	Over 12.8 m
4 to 8 , incl	35	65
10 to 16Z, incl	45	55
20Z to 24Z, incl	60	40

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests of the tube to determine conformance to tensile strength (3.2.1.1), elongation (3.2.1.2), specific gravity (3.2.1.3), and roll and proof pressure (3.2.1.4) requirements and of hose to determine conformance to braid flare (3.2.2.1), burst pressure at room temperature (3.2.2.3), change in length under pressure (3.2.2.5), and tolerance (3.4) requirements are classified as acceptance or routine control tests.
- 4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification or periodic control tests and may be the basis for approval of the hose (See 4.4.1).
- 4.3 Sampling:
- 4.3.1 Acceptance Tests:
- 4.3.1.1 Tube: Three specimens shall be selected from each lot of tube for tests for tensile strength, elongation, specific gravity, and proof pressure. A lot shall be all tube of the same size, produced from the same batch of polymer, extruded and sintered under essentially the same conditions, and presented for inspection at one time. When the roll test of 3.2.1.4.1 is required, the test shall be applied to 100% of the tube.
- 4.3.1.2 Hose: Three specimens shall be selected from each lot of hose for braid flare, burst pressure at room temperature, and change in length under pressure. A lot shall be not more than 3,500 ft (1067 m) of hose of the same size produced from the same lot of tube in one continuous production run and presented for inspection at one time.
- 4.3.2 Qualification Tests: Except where a specific number of samples is specified in 4.5, sampling shall be as agreed upon by purchaser and vendor.
- 4.4 Approval:
- 4.4.1 Sample hose shall be approved by purchaser before hose for production use is supplied, unless such approval be waived. Results of tests on production hose shall be essentially equivalent to those on the approved sample.
- 4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production hose which are essentially the same as those used on the approved sample hose. If any change is necessary in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the revised materials and processing and, when requested, sample revised hose. No production hose made by the revised procedure shall be shipped prior to receipt of reapproval.

4.5 Test Methods:

- 4.5.1 Conductivity: A 14-in. or 350-mm length of tube, without braid, shall be washed on the ID with AMS 3160 or equivalent petroleum solvent and then with isopropyl alcohol and thoroughly dried at room temperature. The specimen shall be mounted for test as shown in Fig. 1 and 1000 V dc shall be applied between the upper and lower mercury electrodes. The current shall be measured with an instrument having sensitivity of less than 1 microampere. The temperature in the testing area shall be 60° - 90° F or 16° - 32° C and the relative humidity shall be less than 70%.
- 4.5.2 Braid Flare: Specimens not over 12 in. or 300 mm in length shall be expanded at each end by forcing a plug of the diameter shown in the "Expansion Diameter A" column of Table VI into the ID of the hose for a distance of not less than 3/16 in. or 5 mm. After expansion, the hose shall be inserted through a ring having an ID as shown in the "Maximum Flare Diameter B" column with the bottom of the flare extending 1/2 - 9/16 in. or 13 - 14 mm above the top of the ring. From this position, the hose shall be allowed to fall freely. The test shall be made not more than 15 min. after cutting the specimen.

TABLE VI

Size	Nominal ID Inches	Expansion Diameter A Inches	Maximum Flare Diameter B Ring ID, Inches
3	0.125	0.155	0.375
4	0.188	0.230	0.500
5	0.250	0.300	0.560
6	0.313	0.370	0.625
8	0.406	0.475	0.750
10	0.500	0.585	0.875
12	0.625	0.720	1.000
16Z	0.875	0.995	1.400
20Z	1.125	1.270	1.700
24Z	1.375	1.545	1.950

TABLE VI (SI)

Size	Nominal ID Millimetres	Expansion Diameter A Millimetres	Maximum Flare Diameter B Ring ID, Millimetres
3	3.18	3.94	9.52
4	4.78	5.84	12.70
5	6.35	7.62	14.22
6	7.95	9.40	15.88
8	10.31	12.06	19.05
10	12.70	14.86	22.22
12	15.88	18.29	25.40
16Z	22.22	25.27	35.56
20Z	28.58	33.26	43.18
24Z	34.92	39.24	49.53

- 4.5.3 Burst Pressure at 450° F or 230° C: Hose shall be filled with a suitable test fluid, such as ASTM Service Fluid No. 101 (Ref. ASTM D471), at 450° F \pm 10 or 230° C \pm 5 and maintained in ambient atmosphere at that temperature for 60 min. \pm 5. At the end of this period and while maintained at 450° F \pm 10 or 230° C \pm 5, pressure shall be applied up to the operating pressure specified in Table II, column 6 and held for not less than 5 min.; pressure shall then be raised at a rate of increase of 15,000 - 25,000 psi per min. or 1750 - 2750 kPa/sec until failure.
- 4.5.4 Change in Length Under Pressure: Hose shall be held in a straight, unpressurized condition, a 10.000 in. \pm 0.010 (254.00 mm \pm 0.25) gage length marked on the hose, and the hose pressurized to the operating pressure specified in 3.2.2.5. After 5 min. \pm 0.5 and while still pressurized, the gage length shall be remeasured and the change in length calculated.

4.5.5 Impulse Test:

- 4.5.5.1 Three hoses filled with MIL-H-8446 hydraulic fluid, or another fluid approved by purchaser, but under no pressure, and three hoses empty and open shall be aged in an air oven for $168 \text{ hr} \pm 0.5$ at $400^\circ \text{ F} \pm 10$ or $200^\circ \text{ C} \pm 5$ and then used for test. The oil aged and air aged hoses shall be subjected to the proof pressure shown in Table II, column 3 for not less than 5 min. before being installed in the impulse tester.
- 4.5.5.2 Hoses of size 12 and smaller shall be bent to the bend radius of 4.5.6.4 and assembled in the impulse tester in this position with both ends connected to rigid supports. Larger sizes shall be installed straight; one end may be left free.
- 4.5.5.3 Using MIL-H-8446 hydraulic fluid, or another fluid approved by purchaser, as the test fluid and with temperature of test fluid at $400^\circ \text{ F} \pm 5$ or $200^\circ \text{ C} \pm 3$ and the ambient air at $400^\circ \text{ F} \pm 10$ or $200^\circ \text{ C} \pm 5$, hose shall be subjected to 100,000 cycles of impulse applied at frequency of 60 - 70 cpm. Electronic devices shall be used to determine and control the impulse pressures within the limits shown in Fig. 2. Peak pressure for sizes 16Z and smaller nominal ID shall be 125% of the operating pressure shown in Table II, column 6; peak pressure for the 20Z and 24Z sizes need not exceed 1000 psi (6.90 MPa).

4.5.6 Stress Degradation:

- 4.5.6.1 Two hoses shall be filled with ASTM Service Fluid No. 101 and heated in an oven at $450^\circ \text{ F} \pm 10$ or $230^\circ \text{ C} \pm 5$, with internal pressure in the hose equal to the rated operating pressure shown in Table II, column 6, for not less than 8 hours. Pressure shall be released and the hose removed from the oven.
- 4.5.6.2 Hose shall be drained, cooled to room temperature, and flushed with a quantity of ASTM Reference Fuel B (Ref. ASTM D471) (TT-S-735, Type III) equal to at least twice the volume of the test specimen, drained, and refilled with ASTM Reference Fuel B (TT-S-735, Type III), and pressure equal to the rated operating pressure shown in Table II, column 6 again applied and maintained for not less than 2 hours.
- 4.5.6.3 The procedures of 4.5.6.1 and 4.5.6.2 shall be repeated four times for a total of 5 complete cycles.
- 4.5.6.4 The hoses shall then be filled with ASTM Reference Fuel B (TT-S-735, Type III) and individually capped. While at room temperature, the hoses shall be bent around a mandrel having a radius equal to the minimum bend radius below and straightened 20 times. Hoses shall be held by the fittings during bending. The procedures of 4.5.6.1 and 4.5.6.2 shall then be repeated for a sixth time.

Size	Nominal ID		Bend Radius	
	Inches	(Millimetres)	Inches	(Millimetres)
3	0.125	(3.18)	2	(51)
4	0.188	(4.78)	2	(51)
5	0.250	(6.35)	2	(51)
6	0.313	(7.95)	4	(102)
8	0.406	(10.31)	4-5/8	(117.5)
10	0.500	(12.70)	5-1/2	(139.7)
12	0.625	(15.88)	6-1/2	(165.1)
16Z	0.875	(22.22)	7-3/8	(187.3)
20Z	1.125	(28.58)	11	(279.4)
24Z	1.375	(34.92)	14	(355.6)

- 4.5.6.5 Within 4 hr after the final 2-hr pressurization with fuel, the hoses shall be drained, flushed with trichlorethylene, and dried in an oven at $160^{\circ}\text{F} \pm 10$ or $70^{\circ}\text{C} \pm 5$ for 60 min. ± 5 . Hoses shall then, within 8 hr after completion of the drying process, be completely immersed in water containing no wetting agent, using the apparatus shown in Fig. 3. Pressure equal to the rated operating pressure shown in Table II, column 6 shall be applied for 15 min. ± 1 , using dry air or nitrogen as the pressurizing medium; during this period, the shield of the test apparatus shall be closed. The shield of the test apparatus shall then be opened and the pressure maintained for an additional 5 min. ± 0.2 during which time the effused gas shall be collected in 1-in. (25.4-mm) increments over the entire length of the hose from cone seat to cone seat. The effusion rate for each individual inch (25.4 mm) of length of hose shall be calculated.
- 4.5.6.6 After completion of the effusion rate test of 4.5.6.5, hoses shall be filled with ASTM Service Fluid No. 101 and placed in a cold chamber for 8 hr ± 0.25 at $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$); at the end of this period and while still maintained at $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$), pressure equal to the rated operating pressure shown in Table II, column 6 shall be applied and held for not less than 5 min. and then released. The pressurization, holding, and releasing of pressure shall be repeated for a total of 10 cycles, allowing not less than 5 min. between each release of pressure and repressurization. After completion of these cycles, ASTM Service Fluid No. 101 at a temperature of $450^{\circ}\text{F} \pm 10$ or $230^{\circ}\text{C} \pm 5$ shall be circulated through the hoses. Within 15 sec after introduction of the hot fluid, the pressure shall be increased to the proof pressure shown in Table II, column 3 and maintained for not less than 2 minutes.
- 4.5.7 Leakage: Two hoses, each having a white paper towel wrapped tightly around the hose so that the towel is in contact with the braid, shall be filled with MIL-H-5606 hydraulic fluid at room temperature and pressurized to 25 psi (172 kPa) for not less than 5 minutes. The pressure shall be raised to $70\% \pm 2$ of the minimum burst pressure shown in Table II, column 4, held for not less than 5 min., and completely released. After at least 5 min. without pressurization, the pressure shall again be raised to $70\% \pm 2$ of the minimum burst pressure shown in Table II, column 4, held for not less than 5 min., and released. Leakage, evidenced by any spot of test fluid on the paper towel, shall be cause for rejection.
- 4.5.8 Fuel Resistance: Two hoses shall be filled with AMS 3160 petroleum solvent or with jet fuel and placed in an oven at $260^{\circ}\text{F} \pm 10$ or $125^{\circ}\text{C} \pm 5$ for 48 hr ± 0.25 with pressure equal to the rated operating pressure shown in Table II, column 6. After the 48-hr heating, the pressure shall be released and the hoses drained and allowed to cool at room temperature for not less than 20 minutes. Hoses shall then be filled with ASTM Reference Fuel B (TT-S-735, Type III) and pressure equal to the rated operating pressure shown in Table II, column 6 applied for 2 hr ± 0.1 at room temperature.
- 4.5.9 Flexibility: Three hoses, one from the stress degradation test of 4.5.6, one from the fuel resistance test of 4.5.8, and one new, shall be used for this test. The hoses shall be filled with ASTM Reference Fuel A (TT-S-735, Type I), cooled to $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$), and held at $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$) for not less than 24 hours. The hoses, while still at $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$), shall be bent around the radius given in 4.5.6.4, straightened, bent equally in the opposite direction, and restraightened 5 times, allowing approximately 4 sec per cycle.
- 4.5.10 Vacuum: The same hoses used for the test of 4.5.9 shall then be drained and placed in an oven at $450^{\circ}\text{F} \pm 10$ or $230^{\circ}\text{C} \pm 5$ with the hoses bent to the minimum bend radius of 4.5.6.4. A negative pressure as shown below shall be applied and maintained for 4 hr ± 0.2 . At the end of the 4-hr period, the hoses shall be removed from the oven with the negative pressure maintained. When the hoses have cooled to room temperature, the pressure shall be restored to atmospheric and the hoses inspected for collapse and other defects. One end of each hose shall then be cut off within 1 in. (25 mm) of the end fitting and a ball of the diameter specified in Table VII shall be rolled through the hose. Reduction of the ID below that at which the ball will roll the length of the hose or other damage to the hose shall constitute failure.

TABLE VII

Size	Nominal ID Inches	Ball Diameter Inches	Negative Pressure In. of Hg
3	0.125	0.076 - 0.080	28
4	0.188	0.125 - 0.132	28
5	0.250	0.187 - 0.193	28
6	0.313	0.250 - 0.255	28
8	0.406	0.332 - 0.337	28
10	0.500	0.421 - 0.426	28
12	0.625	0.531 - 0.538	20
16Z	0.875	0.770 - 0.778	14
20Z	1.125	0.996 - 1.004	10
24Z	1.375	1.246 - 1.252	8

TABLE VII (SI)

Size	Nominal ID Millimetres	Ball Diameter Millimetres	Negative Pressure mm of Hg
3	3.18	1.93 - 2.03	711
4	4.78	3.18 - 3.35	711
5	6.35	4.75 - 4.90	711
6	7.95	6.35 - 6.48	711
8	10.31	8.43 - 8.56	711
10	12.70	10.69 - 10.82	711
12	15.88	13.49 - 13.67	508
16Z	22.22	19.56 - 19.76	356
20Z	28.58	25.30 - 25.50	254
24Z	34.92	31.65 - 31.80	203

4.5.11 Pneumatic Effusion: Two hoses, sealed in an air collecting device similar to that shown in Fig. 4 with the water displacement taking place outside the temperature chamber, shall be subjected to the rated operating pressure shown in Table II, column 6 for 24 hr \pm 0.25 at each of the following temperatures and in the order indicated: room temperature, $-67^{\circ}\text{F} \pm 2$ ($-55^{\circ}\text{C} \pm 1.1$), $+275^{\circ}\text{F} \pm 5$ ($+135^{\circ}\text{C} \pm 2.8$), and $400^{\circ}\text{F} \pm 10$ or $200^{\circ}\text{C} \pm 5$. The average rate of effusion through the hose and two fittings shall be measured over the last 8 hr of testing at each temperature.

4.5.12 Pneumatic Surge Test: The two hoses from the test of 4.5.11 shall then be assembled in the apparatus depicted in Fig. 5 and subjected to the rated operating pressure shown in Table II, column 6 for 25 min. \pm 1 at room temperature. After the 25-min. pressurization, the exhaust valve shall be opened to permit rapid discharge of the compressed gas. After 5 min., the valve shall be closed and the pressure recycled. This sequence of 25 min. at operating pressure and 5 min. at atmospheric pressure shall be repeated for a total of 16 times. The hoses shall then be subjected to the rated proof pressure of Table II, column 3 for not less than 2 minutes.

4.6 Reports:

4.6.1 The vendor of hose shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements specified and stating that the hose is representative of material which has been qualified to all requirements of this specification. This report shall include the purchase order number, material specification number and its revision letter, vendor's material designation, size, and quantity.

- 4.6.2 In addition to the reports of 4.6.1, the vendor of hose shall furnish three copies of a cumulative report showing the results of tests made on samples selected at random from each 20,000 ft (6100 m) of hose of each size, not necessarily manufactured during one continuous run, to determine conformance to the requirements of 3.2.1.6, 3.2.2.6 (unaged only), and 3.2.2.7. This report shall be furnished for each size concurrently with the report of 4.6.1 covering the first shipment of that size following submission of the previous cumulative report.
- 4.6.3 The vendor of assemblies incorporating hose to this specification shall furnish with each shipment three copies of a report showing the purchase order number, material specification numbers and their revision letters, if any, for all items of the assembly, contractor or other direct supplier of hose, part number, and quantity. When hose for making assemblies is produced or purchased by the assembly vendor, that vendor shall inspect each lot of hose to determine conformance to the requirements of this specification, and shall include in the report a statement that the hose conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.
- 4.7 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the hose may be based on the results of testing three additional specimens for each \emptyset original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the hose represented and no additional testing shall be permitted. Results of all tests shall be reported.
5. PREPARATION FOR DELIVERY:
- 5.1 Identification: Hose shall be identified as agreed upon by purchaser and vendor.
- 5.2 Packaging: The product shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.
6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.
7. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.
8. NOTES:
- 8.1 Marginal Indicia: The phi (\emptyset) symbol is used to indicate technical changes from the previous issue of this specification.
- 8.2 Similar Specifications: MIL-H-27267 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.