E-14-16

AS614 -84
20 June 1986

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Title of Document: Hose Assembly, Tetrafluoroethylene, Heavy Duty, High Temperature, High Pressure, 4,000 PSI (27,580 KPa) Hydraulic and Pneumatic

Date of Specific Issue Adopted: 1 May 1984

Releasing Industry Group: Society of Automotives Engineers, Inc.

Notes to Contracting Officers:

(1) This standard has provisions for qualifications inspection. Hose assemblies furnished under this standard shall be products qualified for listing on the applicable Qualified Products List at the time set for opening of bids. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The activity responsible for the Qualified Products List is the Aeronautical Systems Division, ATTN: ENES, Wright-Patterson Air Force Base, Ohio 45433-6503, and information pertaining to qualification of product may be obtained from that activity.

The attention of the contractors shall be called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this standard.

(2) The acquisition documents for hose assemblies conforming to this standard should include a requirement for submission of acceptance test reports in accordance with paragraphs 4.4.1, 4.4.2 and 4.4.3 of AS614 and Data Item Description (DID) DI-T-3721A.

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AEROSPACE STANDARD

AS 614

Issued 7-15-63
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HOSE ASSEMBLY
TETRAFLUOROETHYLENE, HEAVY DUTY, HIGH TEMPERATURE, HIGH PRESSURE, 4,000 PSI (27,580 kPa) HYDRAULIC AND PNEUMATIC

1. SCOPE: This specification defines the requirements for heavy duty hose assemblies suitable for use in high temperature, high-pressure, 4000 psi (27,584 kPa), aircraft and missile hydraulic fluid systems.

2. APPLICABLE DOCUMENTS: The following documents of the issue in effect on date of invitation for bids or request for proposals, form a part of this specification to the extent specified herein.

2.1 Specifications:

2.1.1 Federal:

PPP-T-60 - Tape, Packaging, Waterproof
QQ-W-423 - Wire, Steel, Corrosion-Resisting
P-D-680 - Dry Cleaning Solvent
QQ-S-763 - Steel Bars, Wire Shapes, and Forgings, Corrosion-Resisting
TT-I-735 - Isopropyl Alcohol

2.1.2 Military:

MIL-H-5606 - Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-L-7808 - Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-H-8446 - Hydraulic Fluid, Nonpetroleum Base, Aircraft
MIL-T-8504 - Tubing, Steel, Corrosion-Resisting (304) Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-T-8606 - Tubing, Steel, Corrosion-Resistant (18-8 Stabilized and Extra Low Carbon)
MIL-T-8808 - Tubing, Steel, Corrosion-Resistant (18-8 Stabilized), Aircraft Hydraulic Quality
MIL-F-8815 - Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems
MIL-S-8879 - Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification of
MIL-L-10547 - Liner, Case and Sheet, Overwrap; Water-Vaporproof or Waterproof, Flexible

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2.1.2 Military (Continued):

MIL-T-27602 - Trichloroethylene, Oxygen Propellant Compatibility
MIL-H-83282 - Hydraulic Fluid, Fire-Resistant, Synthetic, Hydrocarbon Base, Aircraft

2.2 Standards:

DOD-STD-100 - Engineering Drawing Practices for Inspection
MIL-STD-105 - Sampling Procedures and Tables by Attributes
MIL-STD-831 - Test Reports, Preparation of
MS19059 - Balls, Bearing, Ferrous, Chrome Alloy Steel
MS21900 - Adapter, Flareless Tube to AN Flared Tube
MS33514 - Fitting End, Standard Dimensions for Flareless Tube Connection and Gasket Seal
MS33656 - Fitting End, Standard Dimensions for Flared Tube Connection and Gasket Seal

(Copies to documents required by suppliers in connection with specific procurement functions shall be obtained from the procuring activity or as directed by the Contracting Officer)

2.3 Industry Publications:

American Society for Testing and Materials:

A262 - Detecting Susceptibility to Intergranular Attack on Stainless Steel
D412 - Rubber, Determination of Tension Characteristics
D571 - Rubber Hose for Automotive Hydraulic Brake Systems
D792 - Specific Gravity and Density of Plastics by Displacement
D1457 - TFE - Fluorocarbon Resin Molding and Extrusion Materials

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103)

Society of Automotive Engineers:

AMS 3380 - Hose, Polytetrafluoroethylene, TFE Fluorocarbon Resin, Wire Braid Reinforced
AMS 5556 - Steel Tubing, Seamless or Welded, Corrosion and Heat-Resistant 18 Cr-11 Ni - (Cb + Ta) (SAE 30347) Hydraulic
AMS 5557 - Steel Tubing, Seamless and Welded, Corrosion and Heat-Resistant 18 Cr - 11 Ni-Ti (SAE 30321) Hydraulic
AMS 5567 - Steel Tubing, Seamless and Welded, Corrosion Resistant 19 Cr - 10 Ni (SAE 30304) Hydraulic, Solution Treated
AMS 5570 - Steel Tubing, Seamless, Corrosion and Heat-Resistant 18 Cr - 11 Ni - 0.40 Ti (SAE 30321)
AMS 5571 - Steel Tubing, Seamless, Corrosion and Heat-Resistant 18 Cr - Ni - 0.70 (Cb + Ta) (SAE 30347)
AMS 5575 - Steel Tubing, Welded, Corrosion and Heat Resistant, 18 Cr - 10.5 Ni - 0.70 (Cb + Ta) (SAE 30347)

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Society of Automotive Engineers (Continued):

AMS 5576 - Tubing, Welded, 18 Cr - 11 Ni - 0.40 Ti
AMS 5536 - Steel Bars, Corrosion-Resistant, 18 Cr - 8.5 Ni (SAE 30302) Cold Drawn, 100,000 psi (690 MPa)
AMS 5637 - Steel Bars, Corrosion-Resistant, 18 Cr - 10 Ni (SAE 30304)
AMS 5639 - Steel Bars, Forgings, Tubing, and Rings, Corrosion-Resistant 19 Cr - 10 Ni (SAE 30304)
AMS 5643 - Steel Bars, Forgings, Tubing and Rings, Corrosion Resistant 16.5 Cr - 4.0 Ni - 4.0 Cu
AMS 5644 - Steel, Bars and Forgings, Corrosion and Heat Resistant 17 Cr - 7 Ni - 1Al
AMS 5645 - Steel Bars, Forgings, Tubing and Rings, Corrosion and Heat Resistant, 18 Cr - 10 Ni - 0.40 Ti (SAE 30321)
AMS 5646 - Steel Bars, Forgings, Tubing and Rings, Corrosion and Heat-Resistant, 18 Cr - 11 Ni - 0.60 (Cb + Ta) (SAE 30347)
AMS 5647 - Steel Bars, Forgings, Tubing and Rings, 18 Cr - 8 Ni
AMS 5659 - Steel Bars, Forgings, and Rings, Corrosion Resistant 15 Cr - 4.5 Ni - 0.30 (Cb + Ta) - 3.5 Cu, Consumable Electrode Melted
AMS 5685 - Wire, Safety, 18 Cr - 11.5 Ni - 0.40 Ti, Solution Heat Treated
AMS 5688 - Steel Wire, Corrosion-Resistant, 18 Cr - 9.0 Ni (SAE 30302) Spring Temper
AMS 5689 - Steel Wire, Corrosion and Heat Resistant, 18 Cr - 9.5 Ni - Ti (SAE 30321) Solution Heat-Treated
AMS 5690 - Steel Wire, Corrosion and Heat-Resistant, 18.5 Cr - 13 Ni - 2.5 Mo (SAE 30316)
AMS 5697 - Steel Wire, Corrosion-Resistant, 19 Cr - 9.5 Ni (SAE 30304)
AMS 5743 - Steel Bars and Forgings, Corrosion and Moderate Heat-Resistant 15.5 Cr - 4.5 Ni - 2.9 Mo - 0.10 N, Solution Heat-Treated, Sub-zero Cooled, Equalized and Over-Tempered
ARP 603 - Impulse Testing of Hydraulic Hose Assemblies, Tubing and Fittings
AS 611 - Tetrafluoroethylene Hose Assembly Cleaning Methods
ARP 908 - Hose Fitting - Installation and Qualification Test Torque Requirements
ARP 1153 - Method for Determining Relative Specific Gravity, Polytetrafluoroethylene Tubing
AIR 1228 - Standard Impulse Machine Equipment and Operation
AS 1072 - Sleeve Hose Assembly, Fire Protection
ARP 1835 - Preparation for Delivery, General Requirements for Hose Assemblies

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096)

National Aerospace Standards:

NAS 1760 - Fitting End, Flareless Acorn, Standard Dimensions for

(Application for copies should be addressed to National Standards Association, Inc., 5161 River Road, Washington, DC 20016)

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3. REQUIREMENTS:

3.1 Qualification: The hose assemblies furnished under this specification shall be products which are qualified by meeting all the requirements covered by this document.

3.2 Materials: The hose assembly materials shall be uniform in quality, free from defects, consistent with good manufacturing practice and shall conform to applicable specifications and the requirements specified herein shall be of the highest quality and suitable for the purpose intended.

3.2.1 Metals: Metals used in the hose and fittings shall be corrosion-resistant and shall conform to the following specification:

Bars and Forgings:

QQ-S-763 - Class 302 - Cond. A and Cond. B (AMS 5636 and AMS 5637)
QQ-S-763 - Class 304 - Cond. A and Cond. B (AMS 5639)
QQ-S-763 - Class 304L - Cond. A (AMS 5647)
QQ-S-763 - Class 321 - Cond. A (AMS 5645)
QQ-S-763 - Class 347 - Cond. A (AMS 5646)
AMS 5643 - 17-4PH
AMS 5644 - 17-7PH
AMS 5659 - 15-5PH
AMS 5743 - AM-355

Tubing:

MIL-T-8504 - Comp. 304 (AMS 5567)
MIL-T-8505 - Type I, Comp. 321 (AMS 5570)
MIL-T-8808 - Type I or Type II, Comp. 321 (AMS 5557, AMS 5570 or AMS 5576)
MIL-T-8808 - Type I or Type II, Comp. 347 (AMS 5571 or AMS 5575, AMS 5556)

Wire:

QQ-W-423 - Comp. 302 (AMS 5688)
QQ-W-423 - Comp. 304 (AMS 5697)
QQ-W-423 - Comp. 305 (AMS 5685)
QQ-W-423 - Comp. 316 (AMS 5690)
AMS 5689 - Comp. 321 (QQ-W-423, Form 1, Comp. 321)

3.3 Construction: The hose assembly shall consist of a seamless tetrafluoroethylene inner tube, corrosion-resistant steel-wire reinforcement, and corrosion-resistant steel end fittings as required to meet the construction and performance requirements of this specification and as required for its intended use.

3.3.1 Inner Tube: The inner tube shall be of a seamless construction of virgin polytetrafluoroethylene resin of uniform gauge. It shall have a smooth bore and shall be free from pitting, deep scratches or projections on the inner surface. Additives may be included in the compound from which the tube is extruded.

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3.3.2 Reinforcement: The reinforcement shall consist of corrosion-resistant steel wires conforming to the applicable specifications listed in 3.2.1. The wires shall be so arranged over the inner tube as to provide sufficient strength to ensure conformance with the requirements specified herein. Broken reinforcing wires shall be cause for rejection. Crossed-over reinforcing wires shall not be cause for rejection of the hose assembly.

3.3.3 Interlayers: Interlayers, if used, shall be of a suitable material and shall be resistant to pressure pounding and to all fluids with which the hose may come in contact during normal service. They shall be capable to withstanding temperatures of -65 deg. F (-54 deg. C) to 400 deg. F (204 deg. C) and shall not extrude through the outer braid during testing or in service.

3.3.4 Fittings: All fittings shall be proven to meet the requirements herein. Standard hose assemblies shall have flared fittings to mate with MS33656 or flareless fittings according to NAS 1760 to mate with MS33514 in accordance with applicable SAE Standards (see 2.2). Fitting hex portions shall fit standard wrench openings.

3.3.4.1 Standard Fittings: Standard fittings shall be of one piece construction. Weld or braze joints must not be located in the fluid paths, except welded and redrawn tubing in accordance with MIL-T-8504 or MIL-T-8808 may be used.

3.3.4.2 Non-Standard Fittings: Non-standard elbow fittings shall be of one piece construction to the maximum extent possible. However, those made with other than one piece construction can use welded and redrawn tubing in accordance with MIL-T-8504 or MIL-T-8808 and shall employ a butt-weld joint method.

3.3.4.3 End Fitting Collars (Sockets): All end fitting collars (sockets) crimped or swaged, fabricated from Type 304 stainless steel are required to be capable of passing an embrittlement test as specified in ASTM A262 Practice E, prior to assembly to the nipple or swaging operation. Sockets fabricated from stabilized austenitic steel (304 L, 321, or 347) are acceptable without being subjected to the embrittlement test.

3.4 Dimensions: The hose assembly dimensions, except for length, shall be as specified in Figure 6, and Table VI.

3.4.1 Hose Weight: Hose consisting of inner tube, reinforcement and interlayers as outlined in paragraphs 3.3.1 through 3.3.3 shall not exceed the maximum hose weights covered in Table I.

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TABLE I

PHYSICAL REQUIREMENTS

Hose Size	Tube Size Nominal	Hose Wt. Max.		Bend Rad Min Inside of Bend		Volumetric Expansion Max.	
		Lbs/In.	KG/M	In.	MM	CC/In.	CC/CM
-04	.250	.022	.219	3.000	76.2	.080	.032
-06	.375	.037	.498	5.000	127.0	.120	.047
-08	.500	.045	.805	5.750	146.1	.180	.067
-10	.625	.070	1.25	6.500	165.1	.276	.108
-12	.750	.095	1.70	7.750	196.9	.375	.148
-16	1.000	.160	2.56	9.625	244.5	.446	.370

PRESSURE REQUIREMENTS

Operating Max.		Proof Min.		Burst Min.			
				Room Temp.		Elevated Temp.	
PSI	kPa.	PSI	kPa	PSI	kPa	PSI	kPa
4000	27,580	8000	55,160	16,000	110,316	12,000	82,737

3.5 Performance: The hose assembly shall meet the following performance requirements:

3.5.1 Tube:

3.5.1.1 Tube Roll and Proof Pressure Test: The tube shall not leak, split, burst, or show any evidence of malfunction, when rolled to the Table IV flattening and rounding gaps. Test method is specified in 4.6.2.1.

3.5.1.2 Tube Proof Pressure: The tube, without reinforcing wires, shall not leak, burst or show any evidence of malfunction when held at the Table IV proof pressure values for one (1) minute. Test method is specified in 4.6.2.1.

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3.5.1.3 Tensile Strength: The longitudinal tensile strength for all sizes of tubes shall be 2,200 psi (15 168 kPa) minimum at 77 deg.F +/-2 deg.F (25 deg.C +/-1 deg.C). The transverse tensile strength for sizes -10 and larger shall be 1,800 psi (12 411 kPa) minimum at the same temperature. For sizes -8 and smaller the transverse tensile strength need not be tested. Test method is specified in 4.6.2.2.

3.5.1.4 Elongation: Elongation at 77 deg.F +/-2 deg.F (25 deg.C +/-1 deg.C) shall be a minimum of 200 percent. Test method is specified in 4.6.2.3.

3.5.1.5 Specific Gravity: The specific gravity values of the hose inner tube shall not exceed 2.155 apparent and 2.210 specific. Test method is specified in 4.6.2.4.

3.5.2 Hose Assembly: The hose, complete with reinforcing wires and assembled with end fittings, shall meet the following performance requirements:

3.5.2.1 Proof Pressure: The hose assembly shall withstand the proof pressure listed in Table I without malfunction or leakage. Test method is specified in 4.6.3.

3.5.2.2 Elongation and Contraction: The hose assembly shall not change in length by more than +/-0.20 inch (+/-5.1 mm) in 10 inches (254 mm) of hose length, when subjected to the operating pressure in Table I for minimum of 5 minutes. Test method is specified in 4.6.4.

3.5.2.3 Volumetric Expansion: The volumetric expansion of the hose assemblies, shall not exceed the limits specified in Table I. Test method is specified in 4.6.5.

3.5.2.4 Leakage: The hose assembly shall not leak (no external wetting) when subjected to two (2) pressure cycles of 70 percent of minimum room temperature burst pressure. Test method is specified in 4.6.6.

3.5.2.5 Room Temperature Burst Pressure: The hose assembly shall not leak nor burst at any pressure below the burst value specified in Table I. Test method is specified in 4.6.7.

3.5.2.6 Thermal Shock: The hose assemblies shall not leak nor show any evidence of malfunction when subjected to the Table I proof and high temperature burst pressure after being thermally shocked by rapidly increasing hose temperature from -65 deg. F (-54 deg. C) to 400 deg. F (204 deg. C). Test method is specified in 4.6.8.

3.5.2.7 Impulse: The hose assemblies shall show no evidence of leakage from hose or fitting prior to completion of 100,000 pressure impulse cycles. Test method is specified in 4.6.9.

3.5.2.8 Assembly Flexibility: The hose assembly shall not leak nor show any evidence of malfunction when subjected to the Table I proof pressure after 400,000 flexure cycles when tested from -67 deg. F (-54 deg. C) to 400 deg. F (204 deg. C). Test method is specified in 4.6.10.

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3.5.2.9 Stress Degradation (Air Leakage): The air leakage rate from the hose and two end fittings (not including "B" nuts) when held at the Table I operating pressure after completion of the stress degradation test shall not exceed 2.0 cc/in./min. (0.78 cc/cm/min). Test method is as specified in 4.6.11.

3.5.2.10 Pneumatic Surge: There shall be no evidence of inner tube collapse, sponging or shedding of Teflon particles from the inner tube after 16 cycles of rapid reduction of pneumatic pressure from the Table I operating pressure to zero (0) psi. Test method is as specified in 4.6.12.

3.5.2.11 Effusion: The effusion rate for any hose size shall not exceed 8.0 cc/ft. (26 cc/m) of hose length. Test method is as specified in 4.6.13.

3.5.2.12 Overtightening Torque: The fitting shall withstand the overtightening torque values specified in ARP 908 without failure or leakage. Test method is specified in 4.6.14.

3.5.2.13 Conductivity: Hose assembly sizes -4 through -8 shall conduct a direct current equal to or greater than six (6) microamperes and sizes -10 through -16, a direct current equal to or greater than twelve (12) microamperes with a test potential of 1,000 volts dc. Test method is specified in 4.6.15.

3.6 Screw Threads: Coupling nut threads shall be in accordance with MIL-S-8879. Thread tolerance increase of 10 percent during assembly or testing shall not be cause for rejection of the hose assembly.

3.7 Length: Hose assembly length shall be specified in the following increments only:

Under 18 inches (456 mm), not less than 1/8 inch (3.2 mm)
18 to 36 inches (456 to 914 mm), not less than 1/4 inch (6.4 mm)
36 to 50 inches (914 to 1 270 mm), not less than 1/2 inch (12.7 mm)
Over 50 inches (1 270 mm), not less than 1 inch (25.4 mm)

NOTE: Flareless hose assembly lengths shall be made from "gage point" to "gage point."

Tolerances on hose assembly lengths shall be as follows:

+/-1/8 inch (3.2 mm) for lengths under 18 inches (457 mm)
+/-1/4 inch (6.4 mm) for lengths from 18 to 36 inches (457 to 914 mm)
+/-1/2 inch (12.7 mm) for lengths from 36 to 50 inches (914 to 1 270 mm)
+/-1 percent for lengths over 50 inches (1 270 mm)

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3.8 Part Numbering of Interchangeable Parts: All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirement of DOD-STD-1000 shall govern the manufacturer's part numbers and changes thereto.

3.9 Identification of Product: Equipment, assemblies and parts shall be marked for identification in accordance with MIL-STD-130. The following special marking shall be added:

3.9.1 Fittings: The manufacturer's name or trademark shall be permanently marked on all end fittings.

3.9.2 Assembly: A permanent marking on the fitting or a permanent band on the hose shall be used. The band shall be no wider than one inch (25 mm) and shall not impair the flexibility or the performance of the hose. The marking on the fitting or band shall include the following information:

a. Assembly manufacturer's name or trademark, and assembly specification AS 614

b. Complete hose assembly part number.

c. Operating pressure "4000 psi" or "27 580 kPa," as applicable.

d. Operating temperature 400°F or 204°C as applicable.

e. Pressure test symbol "PT."

f. Date of hose assembly manufacture expressed in terms of month and year.

g. Hose manufacturer's federal code number (Handbook H4-1)

3.10 Workmanship: The hose assembly, including all parts, shall be constructed and finished in a thoroughly workmanlike manner. All surfaces shall be free from burrs. All sealing surfaces shall be smooth, except that annular tool marks up to 100 microinches (2.5 micrometers) rms maximum will be acceptable.

3.10.1 Dimensions and Tolerances: All pertinent dimensions and tolerances, where interchangeability, operation or performance of the hose assembly may be affected, shall be specified on all drawings.

3.10.2 Cleaning: All hose assemblies shall be free from oil, grease, dirt or other foreign materials both, internally and externally. Unless otherwise specified, hose assemblies shall be cleaned to Class O of AS 611.

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4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform any of the inspections set forth in the specification, where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Inspections: The examining and testing of hose assemblies shall be classified as:

a. Qualification inspections (see 4.3).

b. Quality conformance inspections (see 4.4).

4.3 Qualification Inspections:

4.3.1 Qualification Test Samples: The number and length of test samples required to qualify each hose size are specified in Table II. All specimens for each hose size are required for qualifying each of the methods of end fitting attachment, permanent or field attachable, and for each method of end fitting construction, bent tube or forged. Simultaneous qualification of flared and flareless end fittings may be accomplished by having fittings on one hose end flared and flareless fittings on the other end. If a supplier qualifies one end fitting outlet design and at a later date desires to qualify the other, two hose assemblies of each size to be qualified shall be subjected to the tests specified in paragraph 4.5.2.2.

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TABLE II

LENGTH OF HOSE ASSEMBLIES FOR TEST (IN INCHES)

HOSE ASSEMBLY SIZE	SIX ASSEMBLIES FOR IMPULSE TEST (4.6.9)		TWO ASSEMBLIES FOR FLEX TEST (4.6.10)		SIX ASSEMBLIES FOR OTHER TESTS 1 2	
	In.	mm	In.	mm	In.	mm
-4	15	381.0	19	482.6	18	457.2
-6	22.5	571.5	26.5	673.1	18	457.2
-8	26.5	673.1	30.0	762.0	18	457.2
-10	30.5	774.7	34.0	863.6	18	457.2
-12	36.0	914.4	39.0	990.6	18	457.2
-16	44.0	1117.6	47.0	1193.8	18	457.2

1 End fitting outlet design shall have flared fittings to mate with MS33656 or flareless fittings according to NAS 1760 to mate with MS33514.

2 The six test specimens required for the impulse test (4.6.9) shall have straight end fittings on one end and 90° elbow end fittings on the other end. All remaining test samples shall have straight-to-straight end fittings.

3 One additional sample of each size in lengths as shown in Figure 5 shall be used for examination and conductivity tests (sample No. 16 Table III).

4 Two additional samples of each size are required if tests in accordance with paragraph 4.5.2.2 are conducted.

4.3.2 Qualification Test Sequence: Test sequence and procedure shall be as specified in Table III and if applicable paragraph 4.5.2.2.

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TABLE III

QUALIFICATION TEST SCHEDULE

SAMPLE NO.	TUBE	ASSEMBLIES									
	1	2	3	4	5	6	7	8	9	10 THRU 15	16
PARA.	4.6.1	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2	4.6.1.2
	4.6.2	4.6.3	4.6.3	4.6.3	4.6.3	4.6.3	4.6.3	4.6.3	4.6.3	4.6.3	4.6.15
		4.6.4	4.6.4	4.6.5	4.6.5	4.6.6	4.6.6	4.6.11	4.6.11	4.6.9	
		4.6.10	4.6.10	4.6.13	4.6.13	4.6.8	4.6.8	4.6.12	4.6.12		
		4.6.14	4.6.14	4.6.7	4.6.7						

1. Production inspection records shall be used to verify tube conformance to 4.6.2 for all assemblies.

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4.3.3 Test Report, Test Samples and Data for the Procuring Activity: When the tests are conducted at a location other than the laboratory of the procuring activity, the following shall be furnished to that activity:

a. Test Report

The test report shall be in accordance with MIL-STD-831 which shall include a report of all tests and outline description of the tests and conditions.

b. Test Samples

Test samples when requested by the procuring activity. Samples subjected to qualification testing shall not be shipped as part of contract or order.

c. Drawings

Three (3) sets of assembly and subassembly drawings. The assembly drawings shall have a cut-away section showing all details in their normal assembly position and shall carry part numbers of all details and subassemblies.

d. Sources

List of sources of hose or hose components, including source's name and product identification for inner tube, hose and assembly.

Note: Log sheets and recorded test data shall remain on file at the source test facility and are not to be sent to the qualifying activity unless specifically requested.

4.3.4 Qualification Inspection Methods: Qualification inspection methods shall consist of all the examinations and tests specified under 4.6.

4.4 Quality Conformance Inspections: Quality conformance inspections shall be sampled in accordance with the procedure in MIL-STD-105 and shall consist of the following tests:

a. Individual tests (see 4.4.1) (100 percent inspection)
b. Sampling tests (see 4.4.2)
c. Periodic control tests (see 4.4.3)

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4.4.1 Individual Tests: Each hose assembly shall be subjected to the following tests:

a. Examination of product (see 4.6.1)

b. Proof pressure test (see 4.6.3)

Note: Production samples that are proof pressure tested with water should be air dryed prior to capping (see cleaning requirements, paragraph 3.10.2)

4.4.2 Sampling Tests: The following inspections and tests shall be performed in the order indicated on eight (8) hose assemblies with straight fittings at each end selected at random from each sampling lot. The sampling lot shall consist of approximately, but not more than, 3000 hose assemblies, all of one dash size manufactured under essentially the same conditions, but not necessarily during one continuous run. One (1) hose assembly tested from each sub lot of 375 hose assemblies is sufficient for protracted or small assembly run conditions.

a. Internal cleanliness (AS 611, Class 0)

b. Leakage tests (see 4.6.6)

c. Room - temperature burst pressure test (see 4.6.7)

d. Specific gravity tests (apparent and relative) (see 4.6.2.4)

4.4.3 Periodic Control Tests: The following inspections and tests shall be performed as indicated on eight (8) hose assemblies manufactured from bulk hose lengths selected at random from each periodic control lot. The periodic control lot shall consist of not more than 20,000 feet (6,096 meters) of hose, all of one dash number size, manufactured under essentially the same conditions but not necessarily during one continuous run. Two (2) hose assemblies manufactured and tested from each lot of 5,000 feet (1,524 meters) of hose is also permitted.

4.4.3.1 Four (4) hose assemblies or one (1) hose assembly from a lot of 5,000 feet (1,524 meters) in accordance with Table II shall be subjected to the following tests in the order indicated.

a. Elongation and contraction test (see 4.6.4)

b. Impulse test (see 4.6.9) (unaged samples only)

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4.4.3.2 Four (4) hose assemblies or one (1) hose assembly from a lot of 5,000 feet (1,524 meters) in accordance with Table II shall be subjected to the following tests in the order indicated:

a. Stress degradation test (see 4.6.11).

b. Conductivity test (see 4.6.15).

4.4.4 Rejection and Retest: Where one or more items selected from a lot fails to meet the specifications, all items in the lot shall be rejected.

4.4.4.1 Resubmitted Lots: Once a lot (or part of a lot) has been rejected by a procuring activity (Government or industry), before it can be resubmitted for tests, full particulars concerning the cause of previous rejection and the action taken to correct the defects in the lot shall be furnished, in writing, by the contractor.

4.4.5 Switching Procedures: Switching inspection severity levels (for example, from normal to tightened inspection) shall be in accordance with MIL-STD-105. All inspection plans shall be single sample plans with an AQL of 1.5 percent at special inspection level S-2.

4.4.6 Destructive Test Sample: Prior to testing, a letter "D" shall be impression-stamped on each end fitting of those assemblies used for destructive tests (4.4.2 and 4.4.3).

4.5 Test Conditions:

4.5.1 Fitting Ends: Qualification tests shall be conducted in accordance with test sequence specified in Table III on test sample configurations as specified in Table II. Satisfactory completion of qualification tests shall also constitute qualification approval for hose assemblies having nonstandard fittings that have an identical attachment method and design and meet the requirements of this specification.

4.5.2 Preparation of Sample:

4.5.2.1 Unless otherwise specified, length of sample assemblies shall be in accordance with Table II.

4.5.2.2 If test samples have all one type end fitting (flared or flareless) and qualification approval is desired for the other type end fitting, two (2) additional hose assemblies with the other type fitting end and of the size to be qualified shall be subjected to the following tests in the sequence indicated.

a. Examination of product - (See 4.6.1)

b. Proof pressure test - (See 4.6.3)

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4.5.2.2 (Continued):

c. Leakage test - (See 4.6.6)

d. Overtightening torque test - (See 4.6.14)

e. Room temperature burst pressure test - (See 4.6.7)

4.5.2.3 Oil Aging: In all the tests using oil aged samples, the hose assemblies shall be filled with a high temperature test fluid and soaked in an air oven at a temperature of 400 deg.F (204 deg.C) for seven (7) days. All air shall be excluded from the bore of the assembly during the test. No pressure shall be applied to the assembly during the aging period.

4.5.2.4 Air Aging: Air aged samples shall be kept in air at a temperature of 400 deg.F (204 deg.C) for seven days.

4.5.2.5 Unaged Samples: Unaged assemblies shall be as shipped from the hose assembly manufacturer.

4.5.3 Test Fluids and Pressure Measurements: Unless otherwise specified, the pressure test fluid shall be hydraulic oil conforming to MIL-H-5606, or water. Where a high temperature test fluid is specified, the test fluid shall be MIL-H-8446 hydraulic fluid, MIL-L-7808 lubricating oil, or one of the following:

a. Dow Chemical F-60 or equal

b. Oronite Chemical 8200 or equal

c. MIL-H-83282 or equal

Unless otherwise specified, all pressures shall have a tolerance of +/-100 psi (+/-689 kPa).

4.5.4 Temperature Measurements: Unless otherwise specified, temperature measurements shall be taken within six inches (152 mm) of the hose assemblies under test. Unless otherwise specified, all temperatures shall have a tolerance of +15 deg.F (+8 deg.C), -5 deg.F (-3 deg.C).

4.5.5 End Connections: Except as otherwise noted, each hose end shall be connected to a steel male fitting end in accordance with MS33656 or MS33514, lubricated with either MIL-H-5606 fluid or the test fluid, with the installation torque range specified in ARP 908.

4.6 Inspection Methods:

4.6.1 Examination of Product:

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4.6.1.1 Inner Tube (TFE): Each length of tubing shall be examined to determine conformance to this specification with respect to material, size, workmanship and dimensions.

4.6.1.2 Hose Assembly: All hose assemblies shall be visually inspected to determine conformance to this specification and inspected for broken or missing reinforcing wires or any evidence of malfunction which shall be cause for rejection. Crossed over reinforcing wires shall not be cause for rejection.

4.6.2 Tube Tests:

4.6.2.1 Tube Roll and Proof Pressure Test: Each length of tubing shall be subjected to a tube roll and proof pressure test in accordance with AMS 3380, except that the flattening gap, rounding gap, and proof pressure shall be as specified in Table IV. The test fluid shall be air or water.

TABLE IV

TUBE ROLL GAP AND PROOF PRESSURE

SIZE	FLATTENING GAP-MAX		ROUNDING GAP-MAX		PROOF PRESSURE	
	INCHES	mm	INCHES	mm	PSI	kPa
-4	.281	7.14	.250	6.35	380	2 620
-6	.281	7.14	.328	8.33	280	1 931
-8	.328	8.33	.469	11.91	220	1 517
-10	.328	8.33	.578	14.68	170	1 172
-12	.328	8.33	.688	17.48	130	896
-16	.328	8.33	.828	21.03	95	655

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4.6.2.2 Tensile Strength: Size -10 tube, and under, shall be subjected to tensile strength tests in accordance with ASTM D412, except that the separation speed shall be two inches (51 mm) per minute. Tubes larger than -10 shall be tested in accordance with ASTM D1457. The longitudinal tensile strength for all sizes shall be a minimum of 2,200 psi (15 168 kPa) at 77 deg.F +/-2 deg.F (25 deg.C +/-1 deg.C). The transverse tensile strength shall be 1,800 psi (12 411 kPa) at the same temperature. In sizes under -10, the transverse tensile strength need not be tested.

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4.6.2.3 Elongation: The tube shall be subjected to the elongation in accordance with the ASTM methods specified in 4.6.2.2. Elongation at a temperature of 77 deg.F +/-2 deg.F (25 deg.C +/-1 deg.C) shall be a minimum of 200 percent.

4.6.2.4 Specific Gravity of the Tube:

4.6.2.4.1 Apparent Specific Gravity: Apparent specific gravity shall be determined in accordance with ARP 1153 (D1505) or ASTM D792, Method A, and shall not exceed 2.155 at 77 deg.F +/-2 deg.F (25 deg.C +/-1 deg.C). Two (2) drops of wetting agent shall be added to the water. When test samples are prepared from braided hose, the braid impression must be removed prior to testing.

4.6.2.4.2 Relative Specific Gravity: Relative specific gravity shall be determined in accordance with the ARP 1153 (D1505) or D792 Method A and shall not exceed a value of 2.210 for all sizes and types of tubes.

4.6.3 Proof Pressure Test: All hose assemblies shall be pressure tested to the values specified in Table I for not less than 30 seconds and not more than five (5) minutes. The test fluid may be either water or hydraulic oil conforming to MIL-H-5606 for tests conducted at room temperature. All assemblies used for the tests described in this specification shall have this proof pressure test applied to them. Any evidence of leakage from hose or fittings, or any other evidence of malfunction shall constitute failure. Proof pressure test of hose assemblies having firesleeves shall use water as the test medium. Proof pressure shall be held for a minimum of two (2) minutes, during which time the firesleeves shall be pulled back from the end fittings.

4.6.4 Elongation and Contraction Test: Two (2) hose assemblies of each size shall be subjected to the elongation and contraction test. The hose shall not change in length by more than +/-0.20 inch (5.1 mm) in 10 inches (254 mm) of length when subjected to the operating pressure shown in Table I for not less than five (5) minutes. With the hose held in a straight position, unpressurized, a 10-inch (254 mm) gage length shall be marked off on the hose and the hose then pressurized. After five (5) minutes, while still pressurized, the gage length shall be measured and the change in length calculated.

4.6.5 Volumetric Expansion Test: Two (2) assemblies of each size shall be tested in accordance with ASTM D571. The volumetric expansion of the test assemblies shall be in accordance with the values shown in Table I. This test shall be performed at operating pressure.

4.6.6 Leakage Test: Two (2) assemblies of each size shall be pressurized to 70 percent of the minimum room temperature burst pressure shown in Table I and held for five (5) minutes minimum. The pressure shall then be reduced to zero (0) psi, after which it shall again be raised to 70 percent of the minimum room temperature burst pressure for a final five (5) minute check. Any evidence of leakage from hose or fitting, hose burst, fitting blow-off or any other evidence of malfunction shall constitute failure.

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4.6.7 Room Temperature Burst Pressure Test: Two (2) hose assemblies of each size shall be subjected to a pressure sufficient to burst the assemblies with a rate of pressure rise equal to 20,000 psi +/-5,000 psi (137 895 kPa +/-34 474 kPa) per minute. The assemblies shall be observed throughout the test and the type of failure and the pressure where failure occurred shall be recorded. The assemblies shall not leak or show any evidence of malfunction at any pressure below the specified pressure listed in Table I.

4.6.8 Thermal Shock Test: The thermal shock test shall be as follows:

a. Two (2) hose assemblies of each size shall be subjected to this test. One (1) assembly shall be air aged and one (1) assembly shall be unaged. The assemblies shall be subjected to the proof pressure specified in Table I for a minimum of five (5) minutes.

b. The test assemblies shall then be mounted, empty, in a low and high temperature test fixture (typical setup shown in Figure 1). The ambient temperature shall be reduced to -65 deg.F +/-2 deg.F (-54 deg.C +/-1 deg.C) for a minimum of two (2) hours. At the end of this period, while still at this temperature, high temperature test fluid at a temperature of 400 deg.F (204 deg.C) shall be suddenly introduced at a minimum pressure of 50 psi (345 kPa). Immediately after the hot oil has filled the assembly, the pressure shall be raised to the proof pressure specified in Table I for a minimum of five (5) minutes. Not more than 15 seconds shall elapse between the introduction of the high temperature oil at 50 psi (345 kPa) and the raising of the pressure to proof pressure.

c. The test assemblies shall then be filled with one of the specified high temperature test fluids at a pressure of 75 psi +/-25 psi (517 +/-172 kPa) and soaked with ambient, and fluid temperature maintained at 400 deg.F (204 deg.C) for one (1) hour. At the end of this period, the assemblies shall be pressurized to the proof pressure specified in Table I for a minimum of five (5) minutes. The pressure shall then be released; and while still maintaining the 400 deg.F (204 deg.C), the pressure shall then be increased at the same rate of rise as specified in 4.6.7 until failure is obtained. The hose assemblies shall be under continuous observation during the preceding test, and the pressure where the failure occurred and the type of failure shall be recorded.

d. During part b. and the proof portion of part c. of the test, any evidence of leakage from the hose or fittings, hose burst, fitting blow-off or any other evidence of malfunction, shall constitute failure. During the burst portion of part c., any of the above occurring below the minimum high-temperature burst pressure shown in Table I shall constitute failure.

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4.6.9 Impulse Test: Impulse testing shall be performed as follows on six (6) straight-to-90 deg. elbow hose assemblies of each size. The impulse test equipment shall conform to ARP 603 and AIR 1228.

a. Two (2) assemblies shall be oil aged, two (2) shall be air aged and two (2) shall be unaged. The assemblies shall then be subjected at room temperature to the proof pressure specified in Table I for a minimum of five (5) minutes.

b. The hose assemblies shall then be pressurized to 4000 psi (27 580 kPa) and while maintaining this pressure at room temperature, the hose assemblies shall be immersed in a 3.5 ± 0.1 percent NaCl solution by weight for 8 to 10 minutes, then allowed to air dry for the remainder of one (1) hour. This sequence of immersion and air drying shall be repeated no less than fifty (50) times. (See Note a)

c. The test assemblies shall be connected to rigid supports and bent in a U-shape with a bend radius at the apex of the bend as specified in Table I.

d. The impulse pattern shall be as specified in ARP 603, with peak pressures of 150 percent measured at the inlet manifold. Impulsing shall occur at a rate of 70 +/-10 cycles per minute. The test fluid shall be one of the high-temperature test fluids. Fluid temperature shall be maintained at 400 deg.F (204 deg.C) for all hose sizes and measured at the test manifold. Ambient temperature shall be 400 deg.F (204 deg.C), measured at a point within six (6) inches from the hose assemblies.

e. Impulse testing shall be run in such a manner that the assemblies are temperature-cycled from room temperature to a specified fluid and ambient air temperatures a minimum of two (2) times, with a minimum of eighty percent (80 percent) of the impulse cycles at 400 deg.F (204 deg.C). Any evidence of leakage from the hose or fittings prior to the completion of 100,000 impulse cycles shall constitute failure. (See note b)

Notes: a) The sodium chloride (NaCl) shall contain on a dry basis not more than 0.1 percent sodium iodine and not more than 0.5 percent total impurities.

b) It is preferred that testing be continuous with a minimum number of shutdowns to accommodate shift schedules and maintenance.

4.6.10 Assembly Flexure Test: Two (2) hose assemblies of each size shall be mounted in the assembly flexure test setup as illustrated on Figure 2 and subjected to the following test sequence. The assemblies shall be filled with oil as specified in 4.5.3. Temperature indicated is both fluid and

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4.6.10 (Continued):

ambient. Flexing shall occur at a rate of 70 ± 10 cpm during portions c., d., and e.

a. The test assemblies shall be soaked with no pressure or flexing at a temperature of -67 deg.F +/-2 deg.F (-55 deg.C +/-1 deg.C) for a minimum of one (1) hour.

b. With no flexing, the test assemblies shall be pressurized to the proof pressure as specified in Table I with the temperature still at -67 deg.F (-55 deg.C) for a minimum of five (5) minutes (first cycle only).

c. Flexing shall begin while the test assemblies are pressurized to the operating pressure as specified in Table I with the temperature still at -67 deg.F (-55 deg.C) for a minimum of 4,000 flexure cycles.

d. With the pressure reduced to zero (0) psi, flexing shall continue for 1,000 flexure cycles at -67 deg.F (-55 deg.C).

e. Increase the temperature to 400 deg.F (204 deg.C) and flex for 1,000 cycles with pressure at zero (0) psi. The pressure shall then be increased to the operating pressure specified in Table I with the temperature held at 400 deg.F (204 deg.C). Flexing shall continue until an accumulated total of 80,000 cycles is reached.

f. Steps a., c., d., and e. shall be repeated for a total of five (5) test sequences (i.e., 400,000 flexing cycles).

g. After completion of step f., and with no flexing, the test assemblies shall be pressurized to the proof pressure specified in Table I with the temperature still at 400 deg.F (204 deg.C) for a minimum of five (5) minutes (last cycle only).

Any leakage from the hose or fittings, hose burst, fitting blow-off, or any other evidence of malfunction during the test, shall constitute failure.

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4.6.11 <u>Stress Degradation Test</u>: Two (2) hose assemblies of each size shall be subjected to the following test sequence:

a. The hose assemblies shall be filled with one of the specified high-temperature test fluid and placed in an oven which shall be maintained at a temperature of 40 deg.F (204 deg.C). Precautions shall be taken to ensure that the hose assemblies do not come in contact with part of the oven that are at higher temperatures. A pressure equal to the operating pressure specified in Table I shall be applied to the hose assemblies.

b. After a minimum of 20 hours at 400 deg.F (204 deg.C), the pressure shall be gradually released and the assemblies removed from the oven, drained, and cooled to room temperature.

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4.6.11 (Continued):

c. The hose assemblies shall then be filled with fluid conforming to MIL-H-5606. A pressure equal to the operating pressure specified in Table I shall be applied and held for a minimum of two (2) hours at room temperature.

d. The procedure specified in steps a., b., and c. shall be repeated a total of three (3) times.

e. After the final (2) hour pressurization period, the hose assemblies shall be drained and flushed with trichloroethylene, conforming to MIL-T-27602, and placed in an oven for one (1) hour. The temperature of the oven shall be maintained at 160 deg.F/-10 deg.F (71 deg.C +/-5 deg.C).

f. The hose assemblies shall be removed from the oven, cooled to room temperature, and then subjected to an air under water test. To conduct this test, the hose assemblies shall be installed in an apparatus constructed similar to that shown in Figure 3.

g. The apparatus with the hose assembly installed, shall be immersed in water containing no wetting agent. A pressure equivalent to the operating pressure specified in Table I shall be applied for 15 minutes to allow any entrapped air in the hose to escape.

h. The pressure shall be held an additional five (5) minute 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 "B" nut. After the five (5) minute period of pressurization, the average rate of effusion through the hose and two (2) fittings shall be computed into cc/in./min.). If the average rate of effusion exceeds 2.0 cc/in./min. (0.78 cc/cm/min.) for any size, it shall be cause for rejection and considered failure to qualify.

4.6.12 Pneumatic Surge Test: Two (2) hose assemblies that were subjected to the stress degradation (4.6.11) shall be used for this test. The hose assemblies shall be installed in the test apparatus in accordance with Figure 4. The assemblies shall be tested using compressed gas to the rated operating pressure specified in Table I, for 25 minutes at room temperature. After this period of pressurization, the exhaust valve shall be opened within 50 milliseconds to permit rapid discharge of the compressed gas. After (5) minutes, the valve shall be closed and the pressure recycled. This sequence of 25 minutes at operating pressure and 5 minutes at zero (0) psi shall be repeated a total of 16 times. At the end of this period, the hose shall be sectioned and examined for evidence of tube collapse, sponging of the inner tube, etc., and the filter downstream of the degradation, as noted, shall constitute failure.

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4.6.13 Pneumatic Effusion Test: Two (2) hose assemblies of each size shall be used for this test. The assemblies shall be subjected to the operating pressure specified in Table I for one (1) hour at room temperature. Air effusion shall be collected, using the water displacement method and an air collecting device similar to that depicted in Figure 3. The total amount of effusion through the hose and the two (2) fittings shall be collected over the last 1/2 hour of testing. Total effusion shall not exceed 8.0 cc/ft. (26 cc/m) of hose assembly for any size hose.

4.6.14 Overtightening Torque Test: Two (2) hose assemblies of each size shall be subjected to the test procedure and torque values in accordance with ARP 908.

4.6.15 Conductivity Test: One (1) test specimen in accordance with Figure 5 shall be subjected to the conductivity test as follows:

a. The test specimen shall be a length of hose (with braid and one end fitting) as shown in Figure 5. The inner surface of the tube shall be washed first with solvent conforming to P-D-680, and then with isopropyl alcohol conforming to TT-I-735, to remove surface contamination, and thoroughly dried at room temperature. The wire braid shall flare out as shown in Figure 5 to prevent contact with the end of the tetrafluoroethylene tube. One MS21900 steel adapter of appropriate size shall be assembled to the hose end fitting as shown on Figure 5.

b. The test specimen shall then be arranged vertically as shown on Figure 5. The relative humidity shall be kept below 70 percent and room temperature between 60 deg.F (16 deg.C) and 90 deg.F (32 deg.C). A maximum of one thousand (1000) volts dc shall be applied between the upper electrode (salt water solution or mercury) and the lower electrode (MS21900 adapter). The salt water solution shall have a maximum of 450 grams sodium chloride (NaCl) in one liter of chemically pure water.

c. The current shall be measured with an instrument with a sensitivity of at least one (1) microampere (1×10^{-6} ampere). The current measured shall be equal to or greater than, six (6) microamperes for sizes -4 through -8 and equal to or greater than, twelve (12) microamperes for sizes -10 through -16.

5. PREPARATION FOR DELIVERY:

5.1 Preservation and Packaging: Preservation and packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A: Hose assemblies shall be preserved in accordance with method III of MIL-P-116. All openings shall be sealed with caps or plugs conforming to MIL-C-5501. Hose assemblies shall be unit packaged in containers conforming to PPP-B-566, PPP-B-636, PPP-B-665, or PPP-B-676. The gross weight of the boxes shall not exceed the weight limitations of the applicable container specification.

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