SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS4604

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Submitted for recognition as an American National Standard

HOSE ASSEMBLY, POLYTETRAFLUOROETHYLENE, CRES REINFORCED HEAVY-DUTY, 400 °F, 3000 PSI, AIRCRAFT HYDRAULIC SYSTEMS

1. SCOPE:

This SAE Aerospace Standard (AS) defines the requirements for heavy-duty hose assemblies suitable for use in 400 °F, 3000 psi aircraft hydraulic systems. Assemblies are suitable where rapid rate pressure pulsing and torsional/longitudinal flexing may occur, in addition to normal hydraulic system loads.

2. REFERENCES:

2.1 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 document to the extent specified herein.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2486	Conversion Coating of Titanium Alloys, Fluoride-Phosphate Type
AMS 3380	Hose, Polytetrafluoroethylene, TFE Fluorocarbon Resin, Wire Braid Reinforced
AMS 4928	Bars and Forgings - 6Al 4V, Annealed - 120,000 psi
AMS 4945	Tubing, Seamless, Hydraulic, 3Al 2.5V, Texture Controlled, 105,000 psi (724 MPa) Yield Strength
AMS 4965	Bars, Forgings and Rings - 6Al 4V, Sol. and Precip. Heat Treated
AMS 5556	Steel Tubing, Seamless or Welded, Corrosion and Heat-Resistant 18Cr - 11Ni - (Cb+Ta) (SAE 30347) Hydraulic
AMS 5557	Steel Tubing, Seamless or Welded, Corrosion and Heat-Resistant 18Cr - 11Ni (SAE 30321) Hydraulic
AMS 5567	Steel Tubing, Seamless and Welded, Corrosion Resistant 19Cr - 10Ni (SAE 30304) Hydraulic, Solution Treated

2.1.1 (Continued):

AMS 5570	Steel Tubing, Seamless, Corrosion and Heat-Resistant 18Cr - 11Ni - 0.40lTi (SAE 30321)
AMS 5571	Steel Tubing, Seamless, Corrosion and Heat-Resistant 18Cr - Ni - 0.70(Cb+Ta) (SAE 30347)
AMS 5575	Steel Tubing, Welded, Corrosion and Heat-Resistant 18Cr - 10.5Ni - 0.70(Cb+Ta) (SAE 30347)
AMS 5576	Tubing, Welded, 18Cr - 11Ni - 0.40Ti
AMS 5639	Steel Bars, Forgings, Tubing, and Rings, Corrosion-Resistant, 19Cr - 10Ni (SAE 30304)
AMS 5643	Steel Bars, Forgings, Tubing, and Rings, Corrosion-Resistant, 16.5Cr - 4.0Ni - 4.0Cu
AMS 5644	Steel Bars and Forgings, Corrosion and Heat Resistant 17Cr - 7Ni - 1Al
AMS 5645	Steel Bars, Forgings, Tubing and Rings, Corrosion and Heat Resistant 18Cr - 10Ni - 0.40Ti (SAE 30321)
AMS 5646	Steel Bars, Forgings, Tubing and Rings, Corrosion and Heat Resistant 18Cr - 11Ni - 0.60(Cb+Ta) (SAE 30347)
AMS 5647	Steel Bars, Forgings, Tubing and Rings, 18Cr - 8Ni
AMS 5659	Steel Bars, Forgings, and Rings, Corrosion Resistant 15Cr - 4.5Ni - 0.30(Cb+Ta) - 3.5Cu Consumable Electrode Melted
AMS 5688	Steel Wire, Corrosion-Resistant, 18Cr - 9.0Ni (SAE 30302) Spring Temper
AMS 5689	Steel Wire, Corrosion and Heat-Resistant, 18Cr - 9.5Ni - Ti (SAE 30321) Solution Heat Treated
AMS 5743	Steel Bars and Forgings, Corrosion and Moderate Heat-Resistant 15.5Cr - 4.5Ni - 2.9Mo - 0.10N, Solution Heat-Treated, Sub-Zero Cooled, Equalized and Over-Tempered
ARP603	Impulse Testing of Hydraulic Hose Assemblies, Tubing and Fittings
AS611	Polytetrafluoroethylene Hose Assembly Cleaning Methods
ARP908	Torque Requirements, Installation and Qualification Test, Hose and Tube Fitting
AS1055	Fire Testing of Flexible Hose Tube Assemblies, Coils, Fittings, and Similar Systems
AS1072	Sleeve, Hose Assembly, Fire Protection
ARP1153	Method for Determining Relative Specific Gravity of Polytetrafluoroethylene Tubing
AIR1228	Standard Impulse Machine Equipment and Operation
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
ARP1835	Preparation for Delivery, General Requirements for Hose Assemblies
AS4265	Impulse Testing of Hydraulic Tubing and Fittings, S-N Curve
AIR4298	Impulse Test Machine, Sine Wave, Equipment and Operation of
AS4488	Tubular Assemblies, Fusion Welded, Inspection Processes and Acceptance Standards for
AS4605	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, St-St
AS4606	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, St-45°

2.1.1 (Continued):

AS4607	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, St-90°
AS4608	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, 45°-45°
AS4609	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, 90°-90°
AS4610	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flareless, 45°-90°
AS4611	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, St-St
AS4612	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, St-45°
AS4613	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, St-90°
AS4614	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, 45°-45°
AS4615	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, 90°-90°
AS4616	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Flared, 45°-90°
AS4617	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, St-St
AS4618	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, St-45°
AS4619	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, St-90°
AS4620	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, 45°-45°
AS4621	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, 90°-90°
AS4622	Hose Assembly, 3000 psi, Polytetrafluoroethylene, Heavy Duty, Beam Seal, 45°-90°
AS4658	Fitting End, External Thread, Short Flareless, Design Standard
AS4703	Fitting End, Acorn, Short Flareless, Design Standard

2.1.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 262	Detecting Susceptibility to Intergranular Attack on Stainless Steel
ASTM A 313	Specification for Chromium-Nickel Stainless and Heat-Resisting Steel Spring Wire
ASTM A 580	Standard Specification for Stainless and Heat Resisting Steel Wire
ASTM B 348	Specification for Titanium and Titanium Alloy Bars and Billets, Grade 2
ASTM D 380	Rubber Hose for Automotive Hydraulic Brake Systems
ASTM D 792	Specific Gravity and Density of Plastics by Displacement
ASTM D 4895	Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion

2.1.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

P-D-680	Dry Cleaning Solvent
QQ-P-35	Passivation Treatments for Corrosion - Resistant Steel
QQ-S-763	Steel Bars, Wire Shapes, and Forgings, Corrosion-Resisting
TT-I-735	Isopropyl Alcohol
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft Missile, and Ordnance
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-8504	Tubing, Steel, Corrosion-Resisting (304) Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-T-8808	Tubing, Steel, Corrosion-Resistant (18-8 Stabilized), Aircraft Hydraulic Quality
MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification of
MIL-H-83282	Hydraulic Fluid, Fire-Resistant, Synthetic, Hydrocarbon Base, Aircraft
MIL-F-85421	Dynamic Beam Fitting
MIL-STD-100	Engineering Drawing Practices for Inspection
MIL-STD-105	Sampling Procedures and Tables by Attributes
MIL-STD-129	Marking for Shipping and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
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

2.1.4 National Aerospace Standards: Available from Aerospace Industries Association, 1250 Eye Street N.W., Washington, DC 20005.

NAS1760	Fitting End, Flareless Acorn, Standard Dimensions for

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

The hose assemblies furnished under this document shall be products which are qualified by meeting all the requirements covered by this document, such as AS4605 through AS4622.

3.2 Material and Finish:

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. All materials not specifically described 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 applicable specifications as follows:

a. Bars and Forgings:

QQ-S-763	Class 304 - Condition A and Condition B (AMS 5639)
QQ-S-763	Class 304L - Condition A (AMS 5647)
QQ-S-763	Class 321 - Condition A (AMS 5645)
QQ-S-763	Class 347 - Condition A (AMS 5646)
AMS 2486	Conversion Coating of Titanium - Fluoride - Phosphate Type
AMS 4928	6Al-4V Titanium - Annealed
AMS 4965	6Al-4V Titanium - Solution Treated
AMS 5643	17-4 PH Solution Heat Treated
AMS 5644	17-7 PH Solution Heat Treated
AMS 5659	15-5 PH Solution Heat Treated
AMS 5743	AM 355 - Solution Heat Treated

b. Tubing:

MIL-T-8504	Composition 304 (AMS 5567)
MIL-T-8808	Type I or Type II, Composition 321 (AMS 5570 or AMS 5557)
MIL-T-8808	Type I or Type II, Composition 347 (AMS 5571 or AMS 5575, AMS 5556)
AMS 4945	3Al-2.5V Titanium, Texture Controlled

c. Wire:

ASTM A 313	Stainless, Heat-Resisting
ASTM A 580	Stainless, Heat-Resisting
AMS 5688	Composition 302
AMS 5689	Composition 321

3.2.2 Finish:

a. Cres: Passivate per QQ-P-35

b. Titanium: When applicable, fluoride phosphate conversion coat per AMS 2486

3.3 Design and Fabrication:

The hose assembly shall consist of a seamless polytetrafluoroethylene inner tube, multilayered corrosion-resistant steel-wire reinforcement, and corrosion-resistant steel and/or titanium end fittings as required to meet the construction and performance requirements of this document 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 gage. It shall have a smooth bore and shall be free from pitting or projections on the inner surface. Additives may be included in the compound from which the tube is extruded.

3.3.2 Reinforcement: The reinforcement shall consist of multiple layers 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.

NOTE: High density (plait consist of more than 12 wires) braid construction is not permitted.

3.3.3 Fittings: All fittings shall be proven to meet the requirements herein. Standard hose assemblies shall have flared fittings to mate with MS33656, flareless fittings according to NAS1760 to mate with MS33514 or short flareless fittings according to AS4703 to mate with AS4658 or beam seal fittings to mate with male fittings per MIL-F-85421. Fitting hexagonal portions shall fit standard wrench openings.

3.3.3.1 Insert Fittings: Standard insert fittings shall be of one piece construction. Welded or brazed joints must not be located in the fluid path.

3.3.3.2 Nonstandard Fittings: Other fittings including elbow fittings shall be of one piece construction to the maximum extent possible. Those made with other than one piece construction can use welded and redrawn CRES tubing per MIL-T-8808 or titanium tubing per AMS 4945 and shall employ a butt-weld joint method in accordance with AS4488.

3.3.3.3 Sockets: Crimped or swaged sockets of 304 steel shall pass testing per ASTM A 262, practice E prior to crimping or swaging.

NOTE: This requirement does not apply to sockets of 321, 347 or 304L corrosion resistant steel or titanium.

Titanium sockets are per ASTM B 348 - Grade 2.

3.4 Assembly Dimensions:

The hose assembly dimensions, except for length, shall be as specified in Figure 1 and Table 1.

3.4.1 Hose Weight: Hose consisting of inner tube and reinforcement as outlined in 3.3.1 through 3.3.3 shall not exceed the maximum hose weights covered in Table 2.

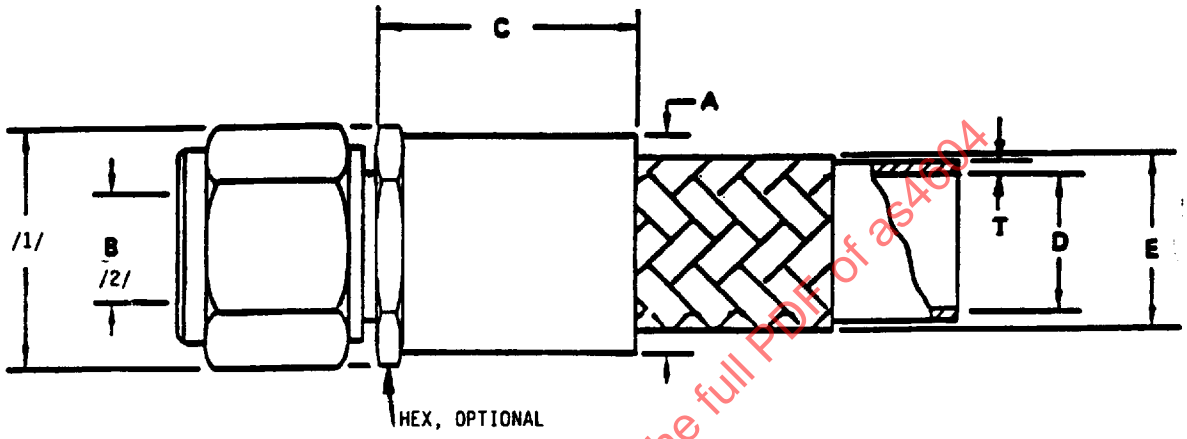

FIGURE 1 - Hose and Fitting Dimensions

TABLE 1 - Hose and Fitting Dimensions

Hose Size	Rigid Tube OD (Ref) in	Fitting OD A Max in	Fitting ID B Min in	Socket Length C Max in	Hose ID D Min in	Hose OD E Min in	Hose OD E Max in	Unbraided PTFE Wall Thickness T Min in
04	.250	.875	.135	2.25	.212	.425	.495	.035
06	.375	1.000	.240	2.50	.298	.530	.600	.035
08	.500	1.200	.340	2.75	.391	.660	.730	.040
10	.625	1.406	.410	3.00	.485	.835	.905	.045
12	.750	1.687	.510	3.25	.602	1.015	1.085	.045
16	1.000	2.000	.760	3.75	.852	1.270	1.340	.050
20	1.250	2.100	.925	3.88	1.101	1.560	1.630	.050

/1/ Cross corners of nut and socket hex may exceed "A" dimension

/2/ Minimum specified inside diameter shall be verified by passing a spherical ball through the hose assembly

3.4.1 (Continued)

TABLE 2 - Physical Requirements of Hose Assemblies and Weight of Hose

Hose Size	Hose Weight Max /1/ lb/in	Operating Pressure psi	Proof Pressure psi	Burst Pressure Room Temperature Min psi	Burst Pressure High Temperature Min psi	Bend Radius at Inside of Bend Min in	Volumetric Expansion Max cm^3/in
04	.022	3000	6000	16 000	12 000	3.00	.065
06	.037	3000	6000	14 000	10 500	5.00	.085
08	.045	3000	6000	14 000	10 500	5.75	.135
10	.070	3000	6000	12 000	9 000	6.50	.220
12	.095	3000	6000	12 000	9 000	7.75	.300
16	.160	3000	6000	12 000	9 000	9.63	.750
20	.210	3000	6000	12 000	9 000	12.00	1.000

/1/ Hose weight shall be determined on a minimum length of 12 in

3.5 Performance:

The inner tube and hose assembly shall meet the following performance requirements:

3.5.1 Tube:

3.5.1.1 Tube Roll: The tube shall not leak, split, burst, or show any evidence of malfunction, when tested through the sequence as 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 for 1 min at the proof pressure values as specified in Table 3 and under 4.6.2.1.

TABLE 3 - Tube Roll Gap and Proof Pressure

Size	Flattening Gap Max in	Rounding Gap Min in	Proof Pressure psi
04	.281	.250	380
06	.281	.328	280
08	.328	.469	220
10	.328	.578	170
12	.328	.688	130
16	.328	.828	95
20	.538	1.000	95

3.5.1.3 Tensile Strength: The longitudinal tensile strength for all sizes of tubes shall be 2200 psi min at 77 °F ± 2 when tested in accordance with 4.6.2.2. The transverse tensile strength for sizes -10 and larger shall be 1800 psi minimum at the same temperature. For sizes under -10 the transverse strength need not be tested.

3.5.1.4 Elongation: Elongation at 77 °F ± 2 shall be a min of 200% when tested in accordance with 4.6.2.3.

3.5.1.5 Specific Gravity: The apparent specific gravity of the hose inner tube shall not exceed 2.155; the relative specific gravity shall not exceed a value of 2.190 when tested as 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 2 without malfunction or leakage, when tested as specified in 4.6.3.

3.5.2.2 Elongation and Contraction: The hose assembly shall not change in length by more than 2%, when subjected to the operating pressure in Table 2 for a minimum of 5 min. Hose assemblies shall be tested in accordance with 4.6.4.

3.5.2.3 Volumetric Expansion: The volumetric expansion of the hose assemblies, when tested in accordance with 4.6.5, shall not exceed the limits specified in Table 2.

3.5.2.4 Leakage: The hose assembly shall not leak when subjected to two pressure cycles of 70% of minimum room temperature burst pressure, when tested in accordance with 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 2, when tested in accordance with 4.6.7.

3.5.2.6 Thermal Shock: The hose assemblies shall not leak nor show any evidence of malfunction when pressure tested as specified in 4.6.8 after thermal shock of -65 to 400 °F.

3.5.2.7 Torsion - Impulse: The hose assemblies shall be capable of withstanding 250 000 (ARP603) impulse cycles including torsion for the last 50 000 cycles and one million rapid rate impulse cycles when tested in accordance with 4.6.9. Any hose or fitting leakage, hose burst, fitting blowout, or any other evidence of malfunction during the test shall constitute failure.

3.5.2.8 Assembly Flexibility: The hose assembly shall not leak when flex cycle tested from -65 to 400 °F as specified in 4.6.10. Any leakage from the hose or fittings, hose burst, fitting blowout, or any other evidence of malfunction during the test shall constitute failure.

3.5.2.9 Stress Degradation: When tested in accordance with 4.6.11, the hose assembly shall not exceed an average effusion rate of 2.0 cm^3/in/min for any size.

3.5.2.10 Repeated Assembly: The fitting shall withstand, without leakage or failure, the repeated assembly test as described under 4.6.12. There shall be no leakage, galling or other malfunction in proof testing, or pneumatic testing after the last assembly cycle.

3.5.2.11 Conductivity: When tested as specified in 4.6.13, hose assemblies of sizes -4 through -8 shall be capable of conducting a DC equal to or greater than 6 μA, and sizes -10 through -20 a current equal to or greater than 12 μA, with a test potential of 1000 V DC.

3.6 Screw Threads:

Fitting threads shall be in accordance with MIL-S-8879. For inspection purposes, the thread shall be categorized "other thread". Fitting nut thread tolerance increase of 10% 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:

a. Under 18 in, not less than .125 in
b. 18 to 36 in, not less than .250 in
c. 36 to 50 in, not less than .500 in
d. Over 50 in, not less than 1 in

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

Tolerances on hose assembly lengths shall be as follows:

a. $\pm$.125 in for lengths under 18 in
b. $\pm$.250 in for lengths under 18 to 36 in
c. $\pm$.500 in for lengths from 36 to 50 in
d. $\pm$1% for lengths over 50 in

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 MIL-STD-100 shall govern the manufacturers' 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 manufacturers'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 1 in 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 specification number AS4604
b. Cage code - hose assembly part number
c. Operating pressure "3000 psi" as applicable
d. Operating temperature "400 °F" as applicable
e. Pressure test symbol "PT"
f. Date of hose assembly manufacture expressed in terms of month and year
g. Hose manufacturer's cage code number (Required only when hose manufacturer is different than the hose assembly manufacturer)

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 μin will be acceptable.

3.10.1 Dimensions and Tolerance: All pertinent dimensions and tolerances, where interchangeability, operation, or performance of the hose assembly may be affected, shall be specified on all drawings. Internal passages of hose assemblies and elbow fittings shall be dimensioned to allow spherical balls per MS19059 per Table 4 to roll through.

TABLE 4 - Spherical Ball Size for Verifying Minimum Hose Assembly and Fitting Inside Diameter

Hose Size	MS19059 Dash No.	Diameter in
04	4807	.109
06	4812	.188
08	4816	.313
10	4818	.375
12	4821	.469
16	4829	.719
20	4834	.875

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 0 of AS611.

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 purchaser 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 Inspection:

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

a. Qualification inspections (4.3)
b. Quality conformance inspections (4.4)

4.3 Qualification Inspections:

4.3.1 Qualification Test Samples: Test samples shall consist of the number of samples and lengths specified in Table 5. The end fitting outlet design for the samples shall have flared fittings to mate with MS33656 or flareless fittings according to NAS1760 to mate with MS33514, short flareless fittings in accordance with AS4703 to mate with AS4658, or beam seal fittings to mate with male fitting per MIL-F-85421.

If a supplier qualifies one end fitting outlet design and at a later date desires to qualify others, four hose assemblies of each size and type to be qualified shall be subjected to the tests specified in 4.5.2.2.

TABLE 5 - Length of Hose Assemblies for Test

Hose Assembly Size	Six Assemblies for Impulse Test (4.6.9) in	Two Assemblies for Flex Test (4.6.10) in	Six Assemblies for Other Tests /1/ in
04	17.0	20	18
06	24.5	28	18
08	28.5	32	18
10	32.0	35.5	18
12	39.0	43.0	18
16	30.0 (90°)	50.0	18
20	35.0 (90°)	58.0	18

/1/ One additional sample of each size in lengths as shown in Figure 5 shall be used for examination and conductivity tests (sample No. 16 of Table 6)

4.3.2 Qualification Test Sequence: The tests shall be conducted in the sequence shown in Table 6.

TABLE 6 - Qualification Test Schedule

Sample No.	PTFE Tube 1 /1/	Hose Assemblies 2, 3	Hose Assemblies 4, 5	Hose Assemblies 6, 7	Hose Assemblies 8, 9	Hose Assemblies 10 through 15 /2/	Hose Assemblies 16
Paragraph 4.6:	1.1 .2	1.2 .3 .4 .10 .12	1.2 .3 .5 .7	1.2 .3 .6 .8	1.2 .3 .11	1.2 .3 .9	1.2 .13

NOTE: End fitting outlet design shall have flared, flareless, or beam seal straight end fittings except /2/.

/1/ Production lot records may be used to verify conformance to 4.6.1 and 4.6.2 when the tube being used is an established production item.

/2/ These samples shall have a 90° elbow fitting on one end of the hose, and a straight-type fitting on the other end of the hose. If approval is being sought for both the bent-tube and the forged-elbow configuration, then one-half of the samples (three) shall use one type of configurated elbow, while the other half of the samples use the other type.

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

a. Test Report: Three copies of a test report in accordance with MIL-STD-831, which shall include a report of all tests and outline description of the tests and conditions.

b. The samples which were tested, only when especially requested by the purchaser.

c. Three sets of engineering data in the form of subassembly and assembly 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 subassemblies.

d. 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 Inspections: Qualification inspections 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 - 4.4.1 (100% inspection)
b. Sampling tests - 4.4.2
c. Periodic control tests - 4.4.3

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

a. Examination of product - 4.6.1
b. Proof pressure test - 4.6.3

NOTE: Production samples that are proof pressure tested with water should be air dried prior to capping (see cleaning requirements, 3.10.2).

4.4.2 Sampling Tests: The following inspections or tests shall be performed in the order indicated on eight hose assemblies, selected at random from each inspection lot. The inspection lot shall consist of no more than 3000 hose assemblies, all of one dash number size, and manufactured under essentially the same conditions. One hose assembly tested from each lot of 375 hose assemblies is also permitted. The hose assemblies may have straight end fittings on both ends.

a. Internal cleanliness (AS611, Class 0)
b. Leakage test - 4.6.6
c. Room - temperature burst pressure test - 4.6.7

4.4.3 Periodic Control Tests: The following inspections and tests shall be performed as indicated on eight hose assemblies manufactured from bulk hose lengths selected at random from each inspection lot. The inspection lot shall consist of not more than 20 000 ft of hose, all of one dash number size, and manufactured under essentially the same conditions. Two hose assemblies manufactured and tested from each lot of 5000 ft of hose is also permitted. The hose assemblies may have straight end fittings on both ends.

4.4.3.1 Pressure Tests: Four hose assemblies (or one hose assembly from a lot of 5000 ft) in accordance with Table 2 shall be subjected to the following tests in the order indicated:

a. Elongation and contraction - 4.6.4
b. Impulse test (unaged samples only) - 4.6.9

4.4.3.2 Material Tests, Inner Tube: Four hose assemblies (or one hose assembly from a lot of 5000 ft) in accordance with Table 2 shall be subjected to the following tests in the order indicated:

a. Stress degradation test - 4.6.11
b. Conductivity test - 4.6.15
c. Specific gravity tests (apparent and relative) - 4.6.2.4

4.4.4 Rejection and Retest: Where one or more items selected from a lot fails to meet the specification, 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 industrial), and 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 Changing Inspection Procedures: Changing 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 1.0% 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 on assemblies using straight type swivel ends, except samples 10 through 15 shall have a 90° elbow fitting on one end. Satisfactory qualification tests on these hose assemblies shall constitute qualification approval on hose assemblies using other fittings that have an identical hose attachment method and design.

4.5.2 Preparation of Sample:

4.5.2.1 Unless otherwise specified, the length of sample assemblies shall be in accordance with Table 5.

4.5.2.2 Qualification test hose assemblies may be made up of one style connection on both ends, or a combination of two styles, each assembly including both styles. Both tested styles would then be qualified.

Qualification of fitting styles which are not subjected to the entire qualification test sequence shall be as follows:

Four additional assemblies shall be tested for each fitting style to be qualified. The additional assemblies shall be made up with one qualified fitting style and one fitting style which is to be qualified. These samples may have straight end fittings on both ends. The assemblies shall be subjected to the following tests in the sequence indicated:

4.5.2.2 (Continued):

a. Examination of product (4.6.1) - Sample No. 1, 2, 3, 4
b. Proof pressure test (4.6.3) - Sample No. 1, 2, 3, 4
c. Leakage test (4.6.6) - Sample No. 1, 2
d. Repeated assembly test (4.6.1.4) - Sample No. 1, 2
e. Room temperature burst pressure test (4.6.7) - Sample No. 1, 2
f. Torsion-impulse test (4.6.9) (unaged samples) - Sample No. 3, 4

4.5.2.3 Oil Aging: In all the tests using aged samples, the hose assemblies shall be filled with a high temperature test fluid and aged for 7 days in an air oven at a temperature of 400 °F. 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 for 7 days in air at a temperature of 400 °F.

4.5.2.5 Unaged Samples: Unaged assemblies shall be as manufactured.

4.5.3 Test Fluids: Unless otherwise specified, the pressure test fluid shall be hydraulic oil conforming to MIL-H-5606, or water. For 400 °F testing, the test fluid shall be MIL-L-7808 or MIL-H-83282 hydraulic fluid, or equivalent, unless otherwise specified by the user.

4.5.4 Temperature Measurements: Unless otherwise specified, temperature measurements shall be taken within 6 in of the hose assemblies under test. Unless otherwise specified, all temperatures shall have a tolerance of +15° -5 °F.

4.5.5 End Connections: Except as otherwise noted, each hose end shall be connected to a cres male fitting end in accordance with MS33656, AS4658, MS33514, or MIL-F-85421 lubricated with either MIL-H-5606 fluid or the test fluid, with the installation torque range specified in ARP908. Beam seal fittings shall be torqued per MIL-F-85421.

4.5.6 Pressure Measurements: Unless otherwise specified, all pressures shall have a tolerance of ±100 psi.

4.6 Inspection Methods:

4.6.1 Examination of Product:

4.6.1.1 Inner Tube: Each length of tubing shall be examined to determine conformance to this document 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 document and shall be 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. Minimum inside diameters of end fittings shall be verified by passing a MS19059 ball per Table 4 through the assembly.

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 3. The test fluid shall be air or water. See 3.5.1.1 and 3.5.1.2.

4.6.2.2 Tensile Strength: The tube shall be subjected to tensile strength tests in accordance with ASTM D 4895. See 3.5.1.3.

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. See 3.5.1.4.

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 the ARP1153 or ASTM D 792, method A, at 77 °F ± 2. Two drops of wetting agent shall be added to the water. When test samples are prepared from braided hose, the braid impressions must be removed prior to testing. See 3.5.1.5.

4.6.2.4.2 Relative Specific Gravity: Relative specific gravity shall be determined in accordance with the ARP1153 or ASTM D 792, method A for all sizes and types of tubes. See 3.5.1.5.

4.6.3 Proof Pressure Test: All hose assemblies shall be pressure tested to the values specified in Table 2 for not less than 30 s and not more than 5 min. 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 document 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 2 min, during which time the firesleeves shall be pulled back from the end fittings. See 3.5.2.1.

4.6.4 Elongation and Contraction Test: Two hose assemblies of each size shall be subjected to the elongation and contraction test. The hose shall not change in length by more than 2% when subjected to the operating pressure shown in Table 2 for not less than 5 min. With the hose held in a straight position, unpressurized, a minimum gage length of 10 in shall be marked off on the hose and the hose then pressurized. After 5 min, while still pressurized, the gage length shall be measured and the change in length calculated in percent of the initial gage length. See 3.5.2.2.

4.6.5 Volumetric Expansion Test: Two assemblies of each size shall be tested in accordance with ASTM D 380. The volumetric expansion of the test assemblies shall be in accordance with the values shown in Table 2. This test shall be performed at operating pressure. See 3.5.2.3.

4.6.6 Leakage Test: Two assemblies of each size shall be pressurized to 70% of the minimum room temperature burst pressure shown in Table 2 and held for 5 min minimum. The pressure shall then be reduced to zero, after which it shall again be raised to 70% of the minimum room temperature burst pressure for a final 5 min check. See 3.5.2.4.

4.6.7 Room Temperature Burst Pressure Test: Two 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/min ± 5000. The assemblies shall be observed throughout the test. The type of failure and the pressure where failure occurred shall be recorded. See 3.5.2.5.

4.6.8 Thermal Shock Test: The thermal shock test shall be as follows (see 3.5.2.6):

a. Two hose assemblies of each size shall be subjected to this test. One assembly shall be aged and one assembly shall be unaged. The assembles shall be subjected to the proof pressure specified in Table 1 for a min of 5 min.

b. The test assemblies shall then be mounted, empty, in a high temperature test fixture (typical setup shown in Figure 2), and the ambient temperature reduced to -65 °F ± 2 for a minimum of 2 h. At the end of this period, while still at this temperature, high temperature test fluid at a temperature of 400 °F shall be suddenly introduced at a minimum pressure of 50 psi. Immediately after the hot oil has filled the assembly, the pressure shall be raised to the proof pressure specified in Table 2 for a minimum of 5 min. Not more than 15 s shall elapse between the introduction of the high temperature oil at 50 psi and the raising of the pressure to proof pressure.

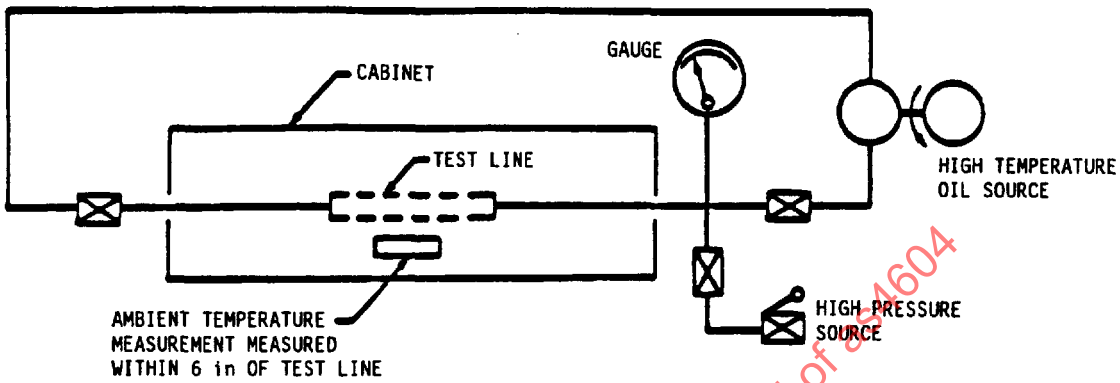

FIGURE 2 - Typical Setup for Thermal Shock Testing

4.6.8 (Continued):

c. The test assemblies shall then be filled with one of the high temperature test fluids at a pressure of 75 psi ± 25 and soaked with ambient, and fluid temperature maintained at 400 °F for 1 h. At the end of this period, the assemblies shall be pressurized to the proof pressure specified in Table 2 for a minimum of 5 min. The pressure shall then be released; and while still maintaining the maximum temperature, 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 testing, and the pressure where the failure occurred and the type of failure shall be recorded.

4.6.9 Torsion-Impulse Test: Impulse testing shall be performed as follows on six straight-to-90° elbow hose assemblies of each size. The impulse test equipment shall conform to ARP603 and AIR1228.

a. Two assemblies shall be oil aged, two shall be air aged, and two shall be unaged. The assemblies shall then be subjected at room temperature to the proof pressure specified in Table 1 for a minimum of 5 min.

b. The hose assemblies shall then be pressurized to 3000 psi and while maintaining this pressure at room temperature, the hose assemblies shall be immersed in a 3.5% ± 1% NaCl solution by weight for 8 to 10 min, then allowed to air dry for the remainder of 1 h. This sequence of immersion and air drying shall be repeated no less than 50 times.

4.6.9 (Continued):

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 2. For sizes -16 and -20 the assemblies may be bent 90°.

d. One air aged, one oil aged, and one unaged sample shall be impulsed as specified in ARP603 with peak pressures of 150% measured at the inlet manifold. Impulsing shall occur at a rate of 70 cpm ± 10 for a minimum of 250 000 cycles. During the last 50 000 cycles of the 250 000 cycles, the straight end of the assembly shall be rotation cycled ±5° for sizes -4, -6, -8, and ±2° for sizes 10 and 12 at 15 cpm. The test fluid shall be one of the high temperature test fluids. Fluid temperature shall be maintained at 400 °F for all hose sizes and measured at the test manifold. Ambient temperature shall be 400 °F, measured at a point within 6 in from the hose assembly. No rotation cycles on sizes -16 and larger is required.

e. Three unaged samples shall be subjected to one million cycles of rapid rate impulse testing sizes -4 through -12 0(0 to 300 psi maximum)-5500 ±200 psi and sizes -16 and larger at 0(0 to 300 psi maximum)-4500 ±200 psi at 600 cpm ± 30 using the AS4265 test procedure and AIR4298 test method. The test fluid shall be one of the high temperature test fluids. Fluid temperature shall be maintained at 400 °F for all hose sizes and measured at the test manifold. Ambient temperature shall be 400 °F, measured at a point within 6 in from the hose assembly.

f. Impulse testing shall be run in such a manner that the hose assemblies are temperature-cycled from room temperature to a specific fluid and ambient air temperature a minimum of two times, with a minimum of 80% of the impulse cycles at 400 °F.

NOTE: The sodium chloride shall contain on a dry basis not more than .1% sodium iodine and not more than .5% total impurities.

4.6.10 Assembly Flexibility Test: Two hose assemblies of each size shall be mounted in the assembly flex test setup as illustrated on Figure 3 and Table 7, 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 ambient. Flexing shall occur at a rate of 70 cpm ± 10 during portions (c), (d), and (e). See 3.5.2.8.

a. The test assemblies shall be soaked with no pressure or flexing at a temperature of -65 °F ± 2 for a minimum of 1 h.

b. With no flexing, the test assemblies shall be pressurized to the proof pressure as specified in Table 2 with the temperature still at -65 °F ± 2 for a minimum of 5 min (first cycle only).