E-14-16

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE STANDARD

AS604

Issued 12-15-59 Rev.
Revised 5-17-89 B

Submitted for recognition as an American National Standard

HOSE ASSEMBLY, TETRAFLUOROETHYLENE, 400°F 3000 PSI HYDRAULIC, HEAVYWEIGHT

1. SCOPE:

This specification covers heavy braid hose assemblies intended for use in high-temperature, 400°F (204°C), high-pressure, 3000 psi (210 bar) aircraft hydraulic systems, also for use in pneumatic systems which allow some gaseous diffusion through the PTFE wall. The -20 size operating temperature is limited to 275°F (57°C) maximum.

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:

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-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal, General Specification for
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance

MIL-T-8504	Steel, Corrosion-Resisting (304) Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-8808	Tubing, Steel, Corrosion-Resistant (18-8 Stabilized), Aircraft Hydraulic Quality
MIL-F-8815	Filter and Filter Elements, Fluid Pressure, Hydraulic Lines, 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-H-83282	Hydraulic Fluid, Fire-Resistant, Synthetic, Hydrocarbon Base, Aircraft
MIL-F-85421	Fittings, Tube, Fluid Systems, Separable, Dynamic Beam Seal
MIL-C-81302	Cleaning Compound, Solvent, Trichlorotrifluoroethane

2.2 Standards

2.2.1 Military:

DOD-STD-100	Engineering Drawing Practices
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment 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	Adaptor, 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 may be obtained from the procuring activity or as directed by the contracting officer.

2.3 Industry Publications:

American Society for Testing and Materials:

ASTM A 262	Detecting Susceptibility to Intergranular Corrosion in Austenitic Stainless Steels
ASTM A 313	Chromium-Nickel Stainless and Heat-Resisting Steel Spring Wire
ASTM D 380	Testing Rubber Hose
ASTM A 580	Stainless and Heat-Resisting Steel Wire
ASTM D 412	Rubber Properties in Tension
ASTM D 792	Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 1457	PTFE Molding and Extrusion Materials

Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

Society of Automotive Engineers:

Material Specifications:

AMS 5556E	Tubing, Seamless or Welded, Hydraulic - 18Cr 11Ni 0.70 (Cb + Ta), Hydraulic, Solution Heat Treated
AMS 5557F	Tubing, Seamless or Welded, Hydraulic, Sol. Heat Treated, 18.5Cr 10.5Ni 0.40Ti
AMS 5567C	Tubing, Seamless or Welded - 19Cr 10Ni, Hydraulic, Annealed
AMS 5570L	Tubing, Seamless, 18Cr 11Ni 0.40Ti, Sol. Heat Treated
AMS 5571F	Tubing, Seamless, 18Cr 10.5Ni 0.70 (Cb + Ta), Solution Heat Treated
AMS 5575K	Tubing, Welded, 18Cr 10.5Ni 0.70 (Cb + Ta), Solution Heat Treated
AMS 5639E	Bars, Forgings, Tubing and Rings - 19Cr 10Ni, Sol. Heat Treated
AMS 5643M	Bars, Forgings, Tubing and Rings, 16Cr 4.0Ni 0.30 (Cb + Ta) 4.0Cu, Solution Heat Treated
AMS 5644C	Bars and Forgings, 17Cr 7Ni 1Al

2.3 (Continued):

AMS 5645L	Bars, Forgings, Tubing, and Rings, 18Cr 10Ni 0.40Ti, Sol. Heat Treated
AMS 5646H	Bars, Forgings, Tubing, and Rings, 18Cr 11Ni 0.60 (Cb + Ta), Sol. Heat Treated
AMS 5647E	Bars, Forgings, Tubing and Rings, 19Cr 9.5Ni, Sol. Heat Treated
AMS 5688H	Wire, 18Cr 9.0Ni, Spring Temper
AMS 5689C	Wire, 18Cr 9.5Ni - 0.40Ti, Solution Heat Treated
AMS 5690J	Wire - 17Cr 12Ni 2.5Mo, Sol. Heat Treated
AMS 5697C	Wire, 19Cr 9.5Ni
AMS 5743F	Bars and Forgings - 15.5Cr 4.5Ni - 2.9Mo - 0.10N, Solution Heat Treated, Sub-zero Cooled, Equalized, and Over-Tempered

Aerospace Recommended Practices:

ARP603F	Impulse Testing of Hydraulic Hose, Tubing and Fitting Assemblies
ARP611C	Tetrafluoroethylene Hose Assembly Cleaning Methods
ARP908B	Hose and Tube Fitting - Installation and Qualification Test Torque Requirements
ARP1153	Method for Determining Relative Specific Gravity of PTFE Tubing
ARP1835	Preparation for Delivery, General Requirements for Hose Assemblies

Aerospace Standards:

AS621	Hose Assembly, 3000 psi, TFE, Flareless, Straight to Straight, Heavyweight
AS622	Hose Assembly, 3000 psi, TFE, Flareless, Straight to 45°, Heavyweight
AS623	Hose Assembly, 3000 psi, TFE, Flareless, Straight to 90°, Heavyweight
AS624	Hose Assembly, 3000 psi, TFE, Flareless, 45° to 45°, Heavyweight

AS625	Hose Assembly, 3000 psi, TFE, Flareless, 45° to 90°, Heavyweight
AS626	Hose Assembly, 3000 psi, TFE, Flareless, 90° to 90°, Heavyweight
AS627	Hose Assembly, 3000 psi, TFE, Flared, Straight to Straight, Heavyweight
AS628	Hose Assembly, 3000 psi, TFE, Flared, Straight to 45°, Heavyweight
AS629	Hose Assembly, 3000 psi, TFE, Flared, Straight to 90°, Heavyweight
AS630	Hose Assembly, 3000 psi, TFE, Flared, 45° to 45°, Heavyweight
AS631	Hose Assembly, 3000 psi, TFE, Flared, 45° to 90°, Heavyweight
AS632	Hose Assembly, 3000 psi, TFE, Flared, 90° to 90°, Heavyweight
AS1055B	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings and Similar System Components
AS1072C	Sleeve, Hose Assembly, Fire Protection
AS4352	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, Straight to Straight
AS4353	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, Straight to 45°
AS4354	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, Straight to 90°
AS4355	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, 45° to 45°
AS4356	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, 45° to 90°
AS4357	Hose Assembly, Nonmetallic, 3000 psi, TFE, Heavyweight, Beam Seal, 90° to 90°

Copies may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

National Aerospace Standards:

NAS1760	Fitting End, Flareless Acorn, Standard Dimensions for

Copies may be obtained from the National Standards Association, Inc., 5161 River Road, Washington, DC 20016.

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, such as:

AS621	AS624	AS627	AS630	AS4352	AS4355
AS622	AS625	AS628	AS631	AS4353	AS4356
AS623	AS626	AS629	AS632	AS4354	AS4357

3.2 Material: 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:

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 5643	17-4 PH QQ-S-763 Class 304L - Condition A (AMS 5647)
AMS 5644	17-7 PH
AMS 5743	AMS 355

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)

Wire:

ASTM A313	Chromium-Nickel Stainless and Heat Resisting Steel Spring Wire
ASTM A580	Stainings and Heat Resisting Steel Wire
AMS 5689	Composition 321 (QQ-W-423, Form 1, Composition 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 tetrafluoroethylene 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 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 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 beam seal 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 and redrawn tubing per MIL-T-8504 or MIL-T-8808 may be used.

3.3.3.2 Nonstandard Fittings: Nonstandard fitting nipples shall be of one piece construction to the maximum extent possible. Those made with other than one piece construction can use welded and redrawn tubing per MIL-T-8808 and shall employ a butt-weld joint method.

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.

3.4 Assembly Dimensions: The hose assembly dimensions, except for length, shall be as specified in Fig. 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.

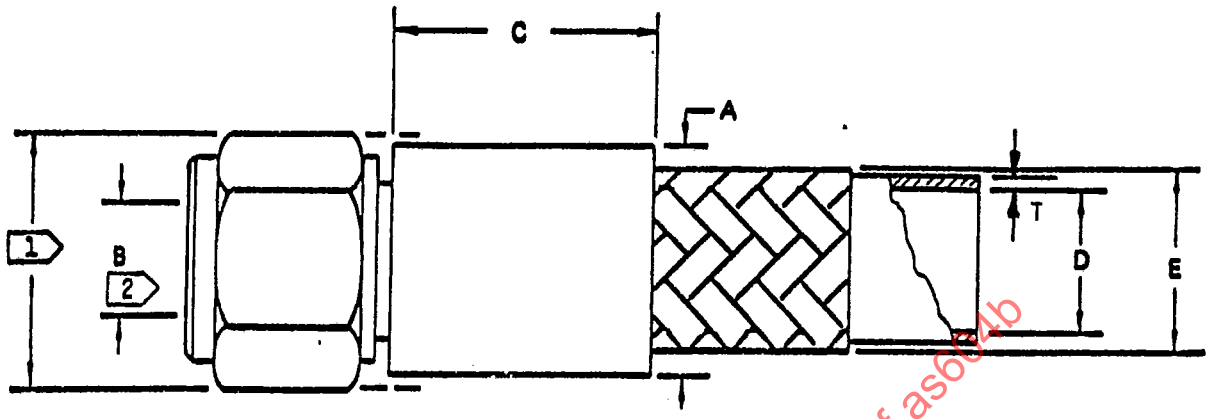

FIGURE 1 - Hose and Fitting Dimensions

TABLE 1 - Hose and Fitting Dimensions

Hose Size	Rigid Tube O.D. (Ref)	Fitting O.D. A	Fitting I.D. B	Socket Length C	Hose I.D. D	Hose O.D. E		Unbraided PTFE Wall Thickness T
	in	Max in	Min in	Max in	Min in	Min in	Max in	Min in
04	0.250	0.875	0.135	2.25	0.212	0.405	0.465	0.035
06	0.375	1.000	0.240	2.50	0.298	0.535	0.595	0.035
08	0.500	1.200	0.340	2.75	0.391	0.675	0.735	0.045
10	0.625	1.406	0.410	3.00	0.485	0.875	0.935	0.045
12	0.750	1.687	0.510	3.25	0.602	1.030	1.090	0.045
16	1.000	2.000	0.760	3.75	0.852	1.350	1.410	0.050
20	1.250	2.100	0.925	3.88	1.101	1.560	1.650	0.050

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.

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

Hose Size	Hose Weight Maximum [1]	Operating Pressure	Proof Pressure	Burst Pressure		Bend Radius at Inside of Bend Minimum	Volumetric Expansion Maximum
				Room Temperature Minimum	High Temperature Minimum		
	lbs/in	psi	psi	psi	psi	in	cm^3/in
-04	0.012	3000	6000	16 000	12 000	3.00	0.065
-06	0.028	3000	6000	14 000	10 500	5.00	0.085
-08	0.040	3000	6000	14 000	10 500	5.75	0.135
-10	0.062	3000	6000	12 000	9000	6.50	0.220
-12	0.086	3000	6000	12 000	9000	7.75	0.300
-16	0.140	3000	6000	12 000	9000	9.63	0.750
-20	0.180	3000	6000	12 000	9000	12.00	1.000

[1] Hose weight shall be determined on a minimum length of 12 inches.

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 Maximum In	Rounding Gap Minimum In	Proof Pressure PSI
-04	0.281	0.250	380
-06	0.281	0.328	280
-08	0.328	0.469	220
-10	0.328	0.578	170
-12	0.328	0.688	130
-16	0.328	0.828	95
-20	0.538	1.000	95

3.5.1.3 Tensile Strength: The longitudinal tensile strength for all sizes of tubes shall be 2200 psi minimum at 77 ± 2°F 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 ± 2°F shall be a minimum 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 2.210 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 requirement:

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 minutes. 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 in sizes through -16, and -65 to 275°F in the -20 size.

3.5.2.7 Impulse: The hose assemblies shall be capable of withstanding 250 000 impulse cycles when tested in accordance with 4.6.9.

3.5.2.8 Assembly Flexibility: The hose assembly shall not leak when flex cycle tested from -65 to 400°F in sizes through -16 and -65 to 275°F in the -20 size 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 Pneumatic Surge: The inner tube of the hose assembly shall not collapse nor show evidence of degradation when tested in accordance with 4.6.12.

3.5.2.11 Pneumatic Effusion: The hose assemblies, when tested in accordance with 4.6.13, shall not exceed a total effusion rate of 8.0 cm^3/ft.

3.5.2.12 Repeated Assembly: The fitting shall withstand, without leakage or failure, the repeated assembly test as described under 4.6.14. There shall be no leakage, galling or other malfunction in proof testing, or pneumatic testing after the last assembly cycle.

3.5.2.13 Conductivity: When tested as specified in 4.6.15, hose assemblies of sizes -4 through -8 shall be capable of conducting a direct current 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 volts, direct current.

3.6 Screw Threads: Fitting threads shall be in accordance with MIL-S-8879. 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:

Under 18 in, not less than 1/8 in
18-36 in, not less than 1/4 in
36-50 in, not less than 1/2 in
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:

±1/8 in for lengths under 18 in
±1/4 in for lengths under 18-36 in
±1/2 in for lengths from 36-50 in
±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 DOD-STD-100 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 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 (AS604)

b. Complete hose assembly part number

c. Operating pressure "3000 psi" as applicable

d. Operating temperature "400°F" as applicable (275°F in the -20 size)

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). (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 I.D.

Hose Size	MS19059 Dash NO.	Diameter In
04	4807	0.109
06	4812	0.188
08	4816	0.313
10	4818	0.375
12	4821	0.469
16	4829	0.719
20	4834	0.875

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 ARP611.

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 for each method of fitting attachment, permanent and reusable. The end fitting outlet design for the samples shall have flared fittings to mate with MS33656, flareless fittings according to NAS1760 to mate with MS33514 or beam seal fittings per MIL-F-85421.

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 2 In
-04	16	20	18
-06	21	27	18
-08	24	30	18
-10	30	33	18
-12	33	37	18
-16	41	45	18
-20	52	56	18

2 One Additional sample of each size in lengths as Shown in Fig. 6 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	Hose Assemblies									
	1 [3]	2	3	4	5	6	7	8	9	10 through 15 [4]	16
Paragraph 4.6:	1.1 0.2	1.2 0.3 0.4 0.10 0.14	1.2 0.3 0.4 0.10 0.14	1.2 0.3 0.5 0.10 0.7	1.2 0.3 0.5 0.13 0.7	1.2 0.3 0.6 0.8	1.2 0.3 0.6 0.8	1.2 0.3 0.11 0.12	1.2 0.3 0.11 0.12	1.2 0.3 0.9	1.2 0.15

NOTE: All assemblies to have a flared fitting on one end and a flareless fitting on the other, except [4].

[3] 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.

[4] These samples shall have a 90 deg 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.

4.3.3 (Continued):

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, manufactured under essentially the same conditions. One hose assembly tested from each lot of 375 hose assemblies is also permitted.

a. Internal cleanliness (ARP611, 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, manufactured under essentially the same conditions. Two hose assemblies manufactured and tested from each lot of 5000 ft of hose is also permitted.

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 (flared on one end, flareless on the other), except samples 14 through 19 shall have a 90 deg 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 The test hose assemblies may be made up using one fitting, flared, flareless (NAS1760) or beam, or both ends of each assembly. The assemblies may be made up using any combination of two-fittings styles. When two fittings are being qualified, assemblies shall be made up with one of each fitting style.

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

Two 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. The assemblies shall be subjected to the following tests in the sequence indicated:

a. Examination of product - 4.6.1

b. Proof pressure test - 4.6.3

c. Leakage test - 4.6.6

d. Repeated assembly test - 4.6.14

e. Room temperature burst pressure test - 4.6.7

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 soaked for seven days in an air oven at a temperature of 400°F for sizes through -16 and 275°F for the -20 size. 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 seven days in air at a temperature of 400°F for sizes through -16 and of 275°F for the -20 size.

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 or MS33514, lubricated with either MIL-H-5606 fluid or the test fluid, with the installation torque range specified in ARP908. Beam seal fitings 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 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 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: Size -10 tube, and under, shall be subjected to tensile strength tests in accordance with ASTM D 412, except that the separation speed shall be 2 in/min. Tubes larger than -10 shall be tested in accordance with ASTM D 1457. 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 ± 2°F. 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 method 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 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 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 minutes. 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. Any evidence of leakage from the hose or fitting, hose burst, fitting blow-off, or any other evidence of malfunction shall constitute failure. 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 ± 5000 psi per minute. The assemblies shall be observed throughout the test. The type of failure and the pressure where failure occurred shall be recorded. The assemblies shall not leak or show other evidence of malfunction at any pressure below the specified room temperature burst pressure listed in Table 2. 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 air aged and one assembly shall be unaged. The assemblies shall be subjected to the proof pressure specified in Table 1 for a minimum of 5 minutes.

4.6.8 (Continued):

b. The test assemblies shall then be mounted, empty, in a high-temperature test fixture (typical setup shown in Fig. 2), and the ambient temperature reduced to -65 ± 2°F for a minimum of 2 hours. At the end of this period, while still at this temperature, high-temperature test fluid at a temperature of 400°F for sizes through -16 and 275°F for the -20 size, 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 minutes. 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.

c. The test assemblies shall then be filled with one of the high-temperature test fluids at a pressure of 75 ± 25 psi and soaked with ambient, and fluid temperature maintained at 400°F for 1 h for sizes through -16 and 275°F for the -20 size. At the end of this period, the assemblies shall be pressurized to the proof pressure specified in Table 2 for a minimum of 5 minutes. 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.

d. Any evidence of leakage from the hose or fittings, fitting blow-off, or any other evidence of malfunction prior to final burst per c. above, shall constitute failure.

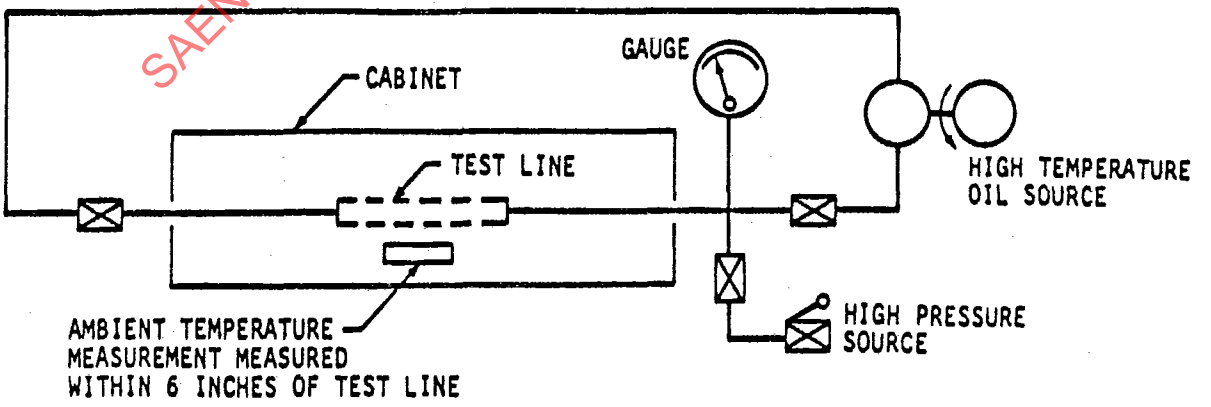

FIGURE 2 - Typical Setup for Thermal Shock Testing

4.6.9 Impulse Test: Impulse testing shall be performed as follows on six straight-to-90 deg elbow hose assemblies of each size. The impulse test equipment shall conform to ARP603. See 3.5.2.7.

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 2 for a minimum of 5 minutes. The pressure shall then be released.

b. The hose assemblies shall then be pressurized to 3000 psi. While maintaining this pressure at room temperature, the hose assemblies shall be immersed in a 3.5 ± 0.1% NaCl solution for 8 to 10 min, then allowed to air dry for the remainder of 1 hour. This subsequent immersion and air drying process shall be repeated no less than 50 times.

NOTE: The NaCl solution shall contain a dry basis of not more than 0.1% sodium iodine and 0.5% total impurities.

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.

d. The impulse pattern shall be as specified in ARP603, with peak pressures of 150% 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°F for hose sizes through -16 and 275°F for the -20 size and measured at the test manifold. Ambient temperature shall be 400°F for hose sizes through -16 and 275° for the -20 size, measured at a point within 6 in from the hose assemblies.

e. Impulse testing shall be run in such a manner that the assemblies are temperature-cycled from room temperature to specified fluid and ambient air temperatures a minimum of two times, with a minimum of 80% of the impulse cycles at 400°F. Any evidence of leakage from the hose or fittings prior to the completion of 250 000 impulse cycles shall constitute failure.

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

4.6.10 Assembly Flexibility Test: Two hose assemblies of each size shall be mounted in the assembly flex test setup as illustrated on Fig. 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 ± 10 cycles per minute 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 ± 2°F for a minimum of 1 hour.

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 ± 2°F for a minimum of 5 min (first cycle only).

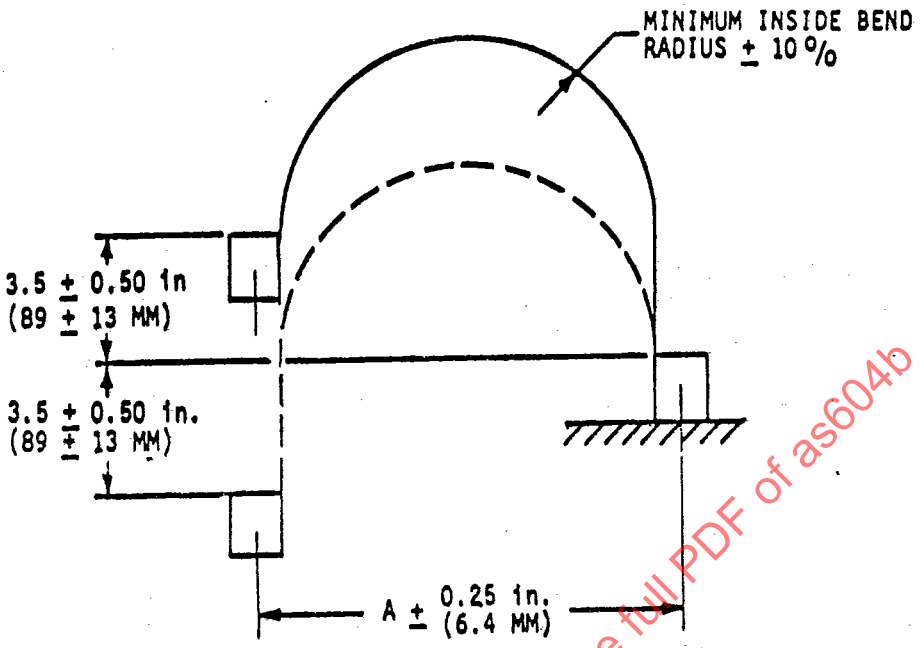

FIGURE 3 – Assembly Flexure Test Setup

TABLE 7 – Flexure Test Dimensions

Hose Size	A In
-04	6.50
-06	10.63
-08	12.25
-10	14.00
-12	16.63
-16	20.75
-20	25.75