SAE Aerospace
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AEROSPACE STANDARD

SAE AS5960A

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Superseding AS5960

(R) Hose Assembly, Polytetrafluoroethylene, Metallic Braid Reinforced, 5080 psi (35 000 kPa), 400 °F (204 °C), Aircraft Hydraulic Systems

RATIONALE

Revised to reflect the current mating fitting standards, flareless fitting torques, and impulse test requirements.

1. SCOPE

This document defines the requirements for polytetrafluoroethylene (PTFE) lined, metallic braid reinforced, hose assembly suitable for use in 400 °F (204 °C), 5080 psi (35 000 kPa) aircraft hydraulic systems.

NOTE: The SI metric units defined herein are soft conversion units.

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies
AS611	Hose Assembly and Tubing, Polytetrafluoroethylene, Cleaning Methods for
ARP908	Torque Requirements, Installation and Qualification Test, Hose and Tube Fitting
AS1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings and Similar System Components

AS1072	Sleeve, Hose Assembly, Fire Protection
AIR1228	Standard Impulse Machine Equipment Operation
ARP1835	Preparation for Delivery, General Requirements for Hose Assemblies
AS2078	Test Methods, Hose Assemblies, Polytetrafluoroethylene (PTFE)
AS4207	Fitting End, External Thread, Beam Seal, Design Standard
ARP4266	Hole Contour, Fluid Passage, Tube Fitting
AS5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting, Procurement Specification
AS5685	Steel, Corrosion Resistant, Safety Wire, 18Cr – 11.5Ni (UNS S30500) Solution Heat Treated, Cold Finished
AS5827	Fitting End, Flareless, Extra Fine Thread, Design Standard
AS7003	Nadcap Program Requirements
AS8879	Screw Threads - UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter
AS85720	Fittings, Tube, Fluid Systems, Separable, High Pressure, Dynamic Beam Seal, General Specification for
AS85720/1	Fittings, Tube, Fluid Systems, Separable, High Pressure, Dynamic Beam Seal, Design Standard for Male End
AMS2486	Conversion Coating of Titanium Alloys, Fluoride-Phosphate Type
AMS2487	Anodic Treatment of Titanium and Titanium Alloys Solution pH 12.4 Maximum
AMS2700	Passivation of Corrosion Resistant Steels
AMS4928	Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes 6Al-4V Annealed
AMS4965	Titanium Alloy, Bars, Wire, Forgings, and Rings 6.0Al - 4.0V Solution Heat Treated and Aged
AMS5637	Steel, Corrosion Resistant, Bars and Wire 18Cr - 9.0Ni (SAE 30302) Solution Heated Treated and Cold Drawn 125 ksi (862 MPa) Tensile Strength
AMS5639	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing, and Rings 19Cr - 10Ni Solution Heated Treated
AMS5645	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings 18Cr - 10Ni - 0.40Ti (SAE 30321) Solution Heated Treated
AMS5646	Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings 18Cr - 11Ni - 0.60Cb (SAE 30347) Solution Heated Treated
AMS5647	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing, and Rings 19Cr - 9.5Ni Solution Heat Treated

AMS5656 Steel, Corrosion Resistant, Bars, Wire, Forgings, Extrusions, and Rings 9.0Mn - 20Cr - 6.5Ni - 0.27N Solution Heat Treated

AMS5659 Steel, Corrosion-Resistant, Bars, Wire, Forgings, Rings, and Extrusions 15Cr - 4.5Ni - 0.30Cb(Nb) - 3.5Cu Consumable Electrode Melted, Solution Heat Treated, Precipitation Hardenable

AMS5666 Nickel Alloy, Corrosion and Heat-Resistant, Bars, Forgings, Extrusions, and Rings 62Ni - 21.5Cr - 9.0Mo - 3.65(Cb[Nb]+Ta)

AMS5688 Steel, Corrosion-Resistant, Wire 18Cr - 9.0Ni (SAE 30302) Spring Temper

AMS5689 Steel, Corrosion and Heat Resistant, Wire, 18Cr-10.5Ni-0.40Ti (SAE 30321) Solution Heat Treated

AMS5690 Steel, Corrosion and Heat Resistant, Wire 17Cr - 12Ni - 2.5Mo (SAE 30316) Solution Heat Treated

AMS5697 Steel, Corrosion-Resistant, Wire 19Cr - 9.5Ni (SAE 30304) Solution Heat Treated

AMS5731 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V Consumable Electrode Melted, 1800 °F (982 °C) Solution Heat Treated

AMS5732 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V Consumable Electrode Melted, 1800 °F (982 °C) Solution and Precipitation Heat Treated

AMS5734 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, and Tubing 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V Consumable Electrode Melted, 1650 °F (899 °C) Solution Heat Treated

AMS5737 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, and Tubing 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V Consumable Electrode Melted, 1650 °F (899 °C) Solution and Precipitation Heat Treated

AMS-QQ-P-35 Passivation Treatments for Corrosion-Resistant Steel

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 262 Detecting Susceptibility to Intergranular Attack on Stainless Steel

ASTM A 313 Standard Specification for Stainless Steel Spring Wire

ASTM B 348 Specification for Titanium and Titanium Alloy Bars and Billets, Grade 2

ASTM A 580 Specification for Stainless and Heat Resistant Steel Wire

2.1.3 U.S. Government Publications

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

MIL-PRF-680 Dry Cleaning Solvent

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordinance

MIL-HDBK-831 Preparation of Test Reports

MIL-PRF-83282 Hydraulic Fluid, Fire-Resistant, Synthetic, Hydrocarbon Base, Aircraft

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant, Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

2.1.4 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 847 Caps and Plugs, Protective, Dust and Moisture Seal

NAS 1760 Fitting End, Flareless Acorn, Standard Dimensions for

2.1.5 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME B46.1 Surface Texture

ASME Y14.100 Engineering Drawing Practices

2.1.6 PRI Publications

Available from Performance Review Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7527, Tel: 724-772-1616, www.pri-network.org.

AC7112 National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components

PD2001 Qualified Product Management Council Procedures for Qualified Products Group

PD2101 Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

2.1.7 RTCA Publications

Available from Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

3. TECHNICAL REQUIREMENTS

3.1 Qualification

Hose assemblies supplied in accordance with this document shall be representative of products which have been subjected to and which have successfully passed the qualification tests specified in this performance specification.

3.1.1 Manufacturer Qualification

A manufacturer producing a product in conformance to this performance specification shall be accredited in accordance with the requirements of PD2101, AS7003 and AC7112, and shall be listed in a Performance Review Institute (PRI) Qualified Manufacturers List (QML).

3.1.2 Product Qualification

All products shall conform to the requirements of this procurement specification and shall be approved in accordance with the requirements of PD2001, and PD2101, for listing in a Performance Review Institute (PRI) Qualified Parts List (QPL). When this performance specification is specified on design activity controlled drawings, the approved source of supply shall be defined by the design activity.

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.

3.2.1 Metals

Metals used in the hose and fittings shall be corrosion resistant steel, nickel alloy, or titanium and shall conform to the following specifications:

3.2.1.1 Bars and Forgings

(1) AMS4928 6Al-4V Titanium - Annealed

(2) AMS4965 6Al-4V Titanium - Solution Treated

(3) AMS5637 302 CRES

(4) AMS5639 304 CRES

(5) AMS5645 321 CRES

(6) AMS5646 347 CRES

(7) AMS5647 304L CRES

(8) AMS5656 21-6-9 CRES

(9) AMS5659 15-5PH Solution Treated

(10) AMS5666 Nickel Alloy type 625

(11) AMS5731 A286 Solution Heat Treated

(12) AMS5732 A286 Solution and Precipitation Heat Treated

(13) AMS5734 A286 Solution Heat Treated

(14) AMS5737 A286 Solution and Precipitation Heat Treated

(15) ASTM B 348 Grade 2 Titanium Alloy

3.2.1.2 Wire

(1) ASTM A 580/313 Comp. 302 (AMS 5688)

(2) ASTM A 580/313 Comp. 304 (AMS 5697)

(3) ASTM A 580/313 Comp. 316 (AMS 5690)

(4) ASTM A 580/313 Comp. 321 (AMS 5689)

(5) AS5685 305 CRES

3.3 Design and Construction

The hose assembly shall consist of a seamless PTFE inner tube, corrosion resistant steel wire reinforcement, and corrosion-resistant steel, nickel alloy, and/or titanium end fittings, as required, to meet the construction and performance requirements of this document.

3.3.1 Inner Tube

The inner tube shall be of a seamless construction of virgin PTFE 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 braid(s) and/or wraps conforming to the applicable material specification listed in 3.2.1.2. The reinforcement shall be arranged over the inner tube to provide sufficient strength and protection for ensuring conformance to 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 of withstanding temperatures of -65 to 400 °F (-54 to 204 °C) and shall not extrude through the outer braid during testing or in service.

3.3.4 Fittings

All fittings shall be permanently attached and proven to meet the requirements herein. Standard hose assemblies shall have flareless fittings according to NAS 1760, AS4458, or equivalent, to mate with AS5827, or dynamic beam seal fittings to mate with male end per AS85720/1 or AS4207. Anti-torque hexes or flats shall be provided and shall fit standard wrench openings. All internal surfaces of fitting nuts and retaining wire, when used, shall be dry filmed with dry film per AS5272. Dry film on external surfaces and overspray is not cause for rejection.

3.3.4.1 Straight and Standard Shaped Fittings

Straight fittings shall be machined and standard shapes shall be machined or forged. For elbow fittings, the inside diameter corner shall be a radius in accordance with ARP4266.

3.3.4.2 End Fitting Collars (Sockets)

All end fitting collars (sockets), crimped or swaged, and fabricated from Type 304 stainless steel are required to be capable of passing an embrittlement test as specified in ASTM A 262 Practice E, prior to assembly to the nipple and crimp or swaging operation. Sockets fabricated from stabilized austenitic steel (304L, 321, or 347) and titanium are acceptable without being subjected to the embrittlement test. Titanium collars, if used, shall be per ASTM B 348 - Grade 2.

3.3.5 Finish

3.3.5.1 Corrosion Resistant Steel Fittings

Unless otherwise specified, corrosion resistant steel fittings shall be passivated in accordance with AMS2700 or AMS-QQ-P-35.

3.3.5.2 Titanium Alloy Fittings

Unless otherwise specified, titanium alloy fittings shall be fluoride phosphate coated per AMS2486 or titanium anodized per AMS2487.

3.4 Dimensions

The hose assembly dimensions, except for length, shall be as specified in Figure 1 and Tables 1A or 1B.

3.4.1 Hose Weight

Hose consisting of inner tube, reinforcement, and interlayers, as outlined in 3.3.1 through 3.3.3 shall not exceed the maximum hose weights specified in Table 2.

3.5 Performance

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

3.5.1 Inner Tube

3.5.1.1 Tube Roll

The tube shall not leak, split, burst, or show any evidence of malfunction, when rolled to the flattening and rounding gaps of AS2078. The test method is specified in 4.6.2.1.

3.5.1.2 PTFE Tube Proof Pressure

The tube, without reinforcement, shall not leak, burst, or show any evidence of malfunction when tested to AS2078. Test method is specified in 4.6.2.1.

3.5.1.3 Tensile Strength

The longitudinal tensile strength for all sizes of tubes shall be 2200 psi (15 200 kPa) minimum. The transverse tensile strength for sizes -10 and larger shall be 1800 psi (12 500 kPa) minimum. For sizes -08 and smaller, the transverse tensile strength need not be tested. The test method is specified in 4.6.2.2.

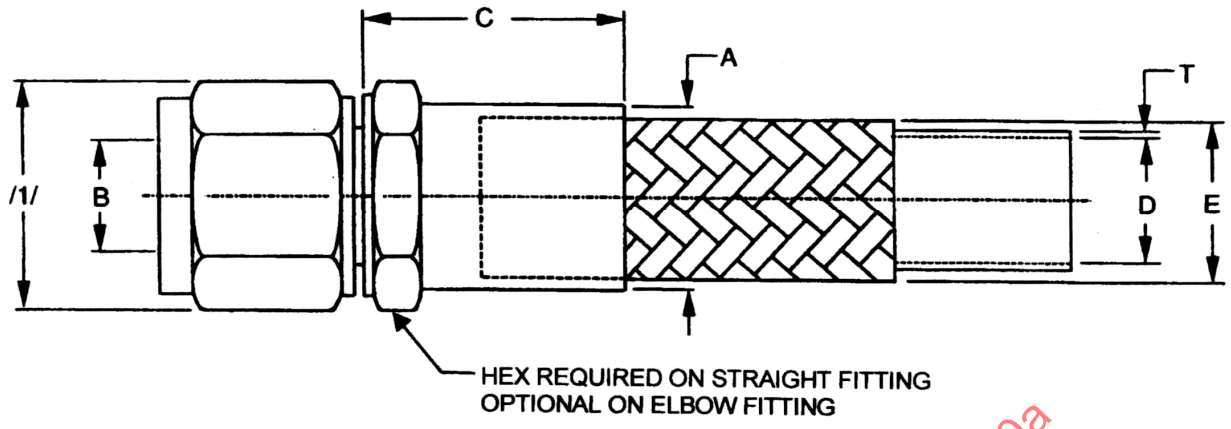

FIGURE 1 - HOSE AND FITTING DIMENSIONS

TABLE 1A - HOSE AND FITTING DIMENSIONS AS SHOWN IN FIGURE 1 - U.S. INCH-POUND UNITS (INCH)

Hose Size	Rigid Tube OD (ref)	Fitting OD A Max.	Fitting ID B (Ref) /2/	Socket Length C Max	Hose ID D Min	Hose OD E Min	Hose OD E Max	Unbraided PTFE Wall Thickness T Min	Spherical Ball Size for Determining Min Hose Assy ID /3/	
									Straight Fittings	Elbow Fittings
04	.250	.875	.133	2.25	.212	.450	.510	.042	.120	.113
06	.375	1.000	.226	2.50	.298	.560	.620	.045	.203	.192
08	.500	1.200	.330	2.75	.391	.700	.760	.045	.297	.281
10	.625	1.406	.410	3.00	.485	.835	.960	.045	.369	.349
12	.750	1.687	.510	3.25	.602	.995	1.120	.050	.459	.434
16	1.000	2.000	.750	3.75	.852	1.305	1.430	.056	.675	.638
20	1.250	2.250	.925	3.94	1.100	1.560	1.685	.060	.833	.786

/1/ Cross corners of nut and anti-torque hex may exceed "A" dimension.

/2/ "Fitting ID B" is the minimum diameter of the machined nipple/insert before assembling to the hose. It is used to calculate the inspection "spherical ball size" to be used after the fitting has been swaged/crimped.

/3/ Minimum hose assembly inside diameter shall be verified by passing the applicable, or larger, spherical ball through the hose assembly.

TABLE 1B - HOSE AND FITTING DIMENSIONS AS SHOWN IN FIGURE 1 - SI UNITS (MM)

Hose Size in	Hose Size (mm) (ref)	Fitting OD A Max	Fitting ID B (Ref) /2/	Socket Length C Max	Hose ID D Min	Hose OD E Min	Hose OD E Max	Unbraided PTFE Wall Thickness T Min	Spherical Ball Size for Determining Min Hose Assy ID /3/	
									Straight Fittings	Elbow Fittings
04	DN06	22.22	3.38	57.15	5.38	11.43	12.95	1.07	3.04	2.87
06	DN10	25.40	5.74	63.50	7.57	14.22	15.75	1.14	5.17	4.88
08	DN12	30.48	8.38	69.85	9.93	17.78	19.30	1.14	7.54	7.12
10	DN16	35.71	10.41	76.20	12.32	21.21	24.38	1.14	9.37	8.86
12	DN20	42.85	12.95	82.55	15.29	25.27	28.45	1.27	11.66	11.02
16	DN25	50.80	19.05	95.25	21.64	33.15	36.32	1.42	17.15	16.20
20	DN32	57.15	23.50	100.08	27.94	39.62	42.80	1.52	21.16	19.96

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

/2/ "Fitting ID B" is the minimum diameter of the machined nipple/insert before assembling to the hose. It is used to calculate the inspection "spherical ball size" to be used after the fitting has been swaged/crimped.

/3/ Minimum hose assembly inside diameter shall be verified by passing the applicable, or larger, spherical ball through the hose assembly.

3.5.1.4 Elongation

Elongation shall be a minimum of 200%. 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 2.190 relative. The test method is specified in 4.6.2.4.

3.5.2 Hose Assembly

The hose, complete with reinforcing braids and/or wraps and interlayer(s) if used, 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 3. The 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 ±2% in 10 in (250 mm) of hose length, when subjected to the maximum operating pressure in Table 3 for a minimum of 5 min. The test method is specified in 4.6.4.

3.5.2.3 Volumetric Expansion

The volumetric expansion of the hose assembly shall not exceed the limits specified in Table 2. The 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 pressure cycles of 70% of minimum room temperature burst pressure. The test method is specified in 4.6.6. For -16 and -20 sizes only 66% of minimum room temperature burst is required.

TABLE 2 - PHYSICAL REQUIREMENTS OF HOSE ASSEMBLIES

Hose Size	Hose Weight Max /1/ lb/in	Hose Weight Max /1/ kg/cm	Bend Radius at Inside of Bend Min in	Bend Radius at Inside of Bend Min cm	Volumetric Expansion cm^3/in	Volumetric Expansion cm^3/cm
04	.022	.039	3.00	7.62	.10	.04
06	.037	.066	5.00	12.70	.15	.06
08	.046	.082	5.75	14.60	.23	.09
10	.070	.125	6.50	16.51	.35	.14
12	.105	.188	7.75	19.69	.48	.19
16	.170	.304	9.63	24.45	.75	.30
20	.220	.393	12.00	30.48	1.25	.49

/1/ Hose weight shall be determined on a minimum length of 12 in (30 cm)

TABLE 3 - PRESSURE REQUIREMENTS OF HOSE ASSEMBLIES

Operating Pressure Max	Proof Pressure Min	Burst Pressure Room Temp. Min	Burst Pressure High Temp. Min
5080 psi (35 000 kPa)	10 160 psi (70 000 kPa)	20 320 psi (140 000 kPa)	15 240 psi (105 000 kPa)

3.5.2.5 Room Temperature Burst Pressure

The hose assembly shall not leak nor burst at any pressure below the room temperature burst value specified in Table 3. The test method is specified in 4.6.7.1.

3.5.2.6 High Temperature Burst Pressure

The hose assembly shall not leak nor burst at any pressure below the high temperature burst value specified in Table 3. The test method is specified in 4.6.7.2.

3.5.2.7 Thermal Shock

The hose assemblies shall not leak nor show any evidence of malfunction when subjected to the Table 3 proof and high temperature burst pressure, after being thermally shock tested per AS2078. The test method is specified in 4.6.8.

3.5.2.8 Impulse

The hose assembly shall withstand 300 000 impulse cycles when tested in accordance with 4.6.9. Any hose or fitting leakage, hose burst, fitting blowoff, or any other evidence of malfunction during the test shall constitute failure.

3.5.2.9 Assembly Flexibility

The hose assembly shall not leak nor show any evidence of malfunction when subjected to the Table 3 proof pressure after 400 000 flexure cycles. The test method is specified in 4.6.10.

3.5.2.10 Stress Degradation (Air Leakage)

The air leakage rate from the hose and two end fittings (not including "B" nuts) when held at the Table 3 operating pressure after completion of the stress degradation test shall not exceed 4.0 cc/in/min (1.57 cc/cm/min). The test method is specified in 4.6.11.

3.5.2.11 Vibration

The hose assembly shall be capable of withstanding vibration testing without leakage or other malfunction. The test method is specified in 4.6.12.

3.5.2.12 Repetitive Assembly Torque

The dynamic beam seal fitting shall withstand the repetitive torque values specified in AS85720, and the flareless fittings per Table 8, without failure or leakage. There shall be no leakage, galling, or other malfunction of the fitting nut and interface connection during the specified pressure test. The test method is specified in 4.6.13.

3.5.2.13 Fitting Continuity

A resistance of 10 mΩ maximum is permissible at each connection. The test method is specified in 4.6.14.

3.5.2.14 Hose Assembly Electrical Conductivity

The hose assembly sizes up to -08 shall conduct a direct current equal to or greater than 6 μA and sizes -10 and larger shall conduct a direct current equal to or greater than 12 μA with a test potential of 1000 V DC. The test method is specified in 4.6.15.

3.6 Screw Threads

Coupling nut threads shall be in accordance with AS8879. Thread tolerance increase of 10% during assembly or testing shall not be cause for rejection of the hose assembly.

3.7 Length Tolerance

Tolerance on the hose assembly length shall be as follows:

a. ±0.125 in (3.2 mm) for lengths under 18 in (457 mm)

b. ±0.250 in (6.4 mm) for lengths from 18 to 36 in (457 to 914 mm) exclusive

c. ±0.500 in (12.7 mm) for lengths from 36 to 50 in (914 to 1270 mm) exclusive

d. ±1% for lengths of 50 in (1270 mm) and over.

3.8 Marking

3.8.1 Part Numbering and Interchangeable Parts

All parts having the same SAE or manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirement of ASME Y14.100 shall govern the manufacturer's part numbers and changes thereto.

3.8.2 Identification of Product

Assemblies and parts shall be marked for identification in accordance with 3.8.2.1 and 3.8.2.2.

3.8.2.1 Fittings

The manufacturer's name or trademark shall be permanently marked on one component of the end fitting.

3.8.2.2 Assembly

A permanent marking shall be on a stainless steel (CRES) band, or bands, securely attached on the hose, or other location when defined on a design activity controlled drawing. The band(s) shall be no wider than 1 in (25 mm) and shall not impair the flexibility or the performance of the hose. The marking method used shall be in accordance with AS478. Unless otherwise specified, the marking shall include the following information:

a. Assembly manufacturer’s name or trademark, and assembly specification number AS5960

b. AS part number (when applicable)

c. CAGE code and manufacturer’s assembly part number

d. Operating pressure "5080 psi" (35 000 kPa) Max"

e. Operating temperature "400 °F (204 °C) Max"

f. Pressure test symbol “PT”

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

h. Hose manufacturer’s CAGE code number (Required only when hose manufacturer is different than the hose assembly manufacturer)

j. Fire resistant or fireproof type per AS1055, Type and Class (when applicable)

k. Additional information as required

3.9 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 (2.5 µm) Ra maximum per ASME B46.1 will be acceptable.

3.9.1 Dimensions and Tolerance

All pertinent dimensions, tolerances, materials and processing document numbers, where interchangeability, operation, or performance of the hose assembly may be affected, shall be specified on all drawings.

3.9.2 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, using approved alkaline cleaners only. Do not use chlorinated solvents.

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 testings (see 4.4)

4.3 Qualification Inspections

4.3.1 Test samples shall consist of the number of samples and lengths specified in Table 4. All specimens for each hose size are required for qualifying each of the methods of end fitting attachment, for each method of end fitting construction, machined straights, machined plate shapes or machined forged shapes, and for each type of fitting materials. Simultaneous qualification of two (flareless or beam seal) types of end fitting sealing design may be accomplished by having different type fittings on each end of the hoses. If a supplier qualifies one fitting sealing type and at a later date desires to qualify another type, two hose assemblies of each size, and fitting type to be qualified, shall be subjected to the tests specified in 4.5.1.1.

4.3.2 Qualification Test Sequence

Test sequence and procedure shall be as specified in Table 5 and, if applicable, 4.5.1.1

TABLE 4 - LENGTH OF HOSE ASSEMBLIES FOR TEST

Hose Size	Six Assys for Impulse Test /1/		Two Assys for Flex Test		Three Assys for Vibration Test /1/		One Assy. for Conductivity Test /3/		Assys for Other Tests	
	in	mm	in	mm	in	mm	in	mm	in	mm
04	15	381	19	483	13	330	13	330	18	457
06	23	584	27	686	20	508	13	330	18	457
08	27	686	30	762	25	635	13	330	18	457
10	31	787	34	864	30	762	13	330	18	457
12	36 (24)/2/	914 (610)/2/	39	991	36	914	13	330	18	457
16	44 (31)/2/	1118 (787)/2/	47	1194	47	1194	13	330	18	457
20	53 (36)/2/	1346 (914)/2/	55	1397	59	1499	13	330	18	457

NOTE:
/1/ The test specimens required for impulse (4.6.9) and vibration (4.6.12) tests shall have a straight end fitting on one end and a 90 degree elbow fitting on the other end. All remaining samples shall have a straight fitting on both ends.
/2/ Reduced assembly length if testing is performed with a 90 degree bend.
/3/ 13 in (330 mm) of hose with one end fitting.

4.3.3 Test Report, Test Samples, and Data

The following data shall be available and submitted when requested:

a. Test Report: The test report shall include a report of all tests and outline description of the tests and conditions, according to MIL-HDBK-831.

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

c. Drawings: Three sets of assembly and subassembly shall have a cut-away section showing all details in their normal assembly position and shall identify all details and subassemblies.

d. Sources: A list of sources of hose or hose components, including source's name and product identification for inner tube, hose, and assembly shall be supplied.

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.

TABLE 5 - QUALIFICATION TEST SCHEDULE

SAMPLE No.	PTFE Tube 1, 2 /1/	Hose Assys 3, 4	Hose Assy 5	Hose Assy 6	Hose Assys 7, 8	Hose Assys 9, 10	Hose Assys 11, 12	Hose Assys 13, 14	Hose Assys 15, 16	Hose Assy 17	Hose Assys 18,19,20	Hose Assys 21, 22, 23
EXAMINATION OF PRODUCT /2/	X											
PROOF PRESSURE /2/	X											
TUBE ROLL /2/	X											
TENSILE STRENGTH /2/	X											
ELONGATION /2/	X											
SPECIFIC GRAVITY /2/	X											
EXAMINATION OF PRODUCT		X	X	X	X	X	X	X	X	X	X	X
PROOF		X	X	X	X	X	X	X	X	X	X	X
ELONGATION AND CONTRACTION		X										
VOLUMETRIC EXPANSION			X	X								
LEAKAGE					X							
THERMAL SHOCK					X							
IMPULSE – UNAGED							X					
IMPULSE - AIR AGED								X				
IMPULSE - OIL AGED									X			
ASSEMBLY FLEXIBILITY		X										
STRESS DEGRADATION						X						
ROOM TEMPERATURE BURST			X			X						
HIGH TEMPERATURE BURST				X								
VIBRATION											X	
REPEATED ASSEMBLY TORQUE		X										
ELECTRICAL CONDUCTIVITY										X		
FITTING CONDUCTIVITY										X		
FIRE TEST (AS REQUIRED)												X

/1/ Tube only
/2/ Production lot records may be used to verify conformance to these tests when the PTFE tubing being used is an established production item.

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 Testing

Quality conformance testing shall consist of the following tests:

a. Inner tube (PTFE) tests (see 4.6.1.1 and 4.6.2)

b. Individual hose assembly tests (see 4.4.1) (100% inspection)

c. Sampling tests (see 4.4.2)

d. Periodic control tests (see 4.4.3)

4.4.1 Individual Hose Assembly Tests

Each hose assembly shall be subjected to the following tests:

a. Examination of product (see 4.6.1.2)

b. Proof pressure test (see 4.6.3)

NOTE: Production assemblies that are proof pressure tested with water should be air dried prior to capping (see cleaning requirements in 3.9.2).

4.4.2 Sampling Tests

The following inspections and tests shall be performed on eight hose assemblies with straight fittings on each end, selected at random from each inspection lot. Initially, an inspection lot shall be hose made from each of the first four reinforcement setups for the construction of each dash size. After successfully testing four consecutive reinforcement setups (lots), an inspection lot shall consist of no more than 3000 hose assemblies, all of one hose size, manufactured under essentially the same conditions, but not necessarily during one continuous run. One hose assembly tested for each lot of 375 hose assemblies is also permitted for protracted or small assembly runs.

a. Internal cleanliness (AS611, Class 0)

b. Leakage test (see 4.6.6)

c. Room temperature burst test (see 4.6.7.1)

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, but not necessarily during one continuous run. Two hose assemblies may be tested for each lot of 5000 ft of hose is also permitted.

4.4.3.1 Assembly

Four hose assemblies or one hose assembly from a lot of 5000 ft in accordance with table 4 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, may have straight fittings on both ends, at room temperature, and may be terminated after completion of 300 000 cycles).

4.4.3.2 Assembly and Inner Tube

Four hose assemblies or one hose assembly from a lot of 5000 ft in accordance with Table 4 shall be subjected to the following tests in the order indicated:

a. Stress degradation test (see 4.6.11)

b. Electrical conductivity test (see 4.6.15)

c. Specific gravity test, PTFE tube only (see 4.6.2.4)

NOTE: Production test records of PTFE inner tube, used in the hose assemblies tested, may be used.

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 industry), and before it can be resubmitted for tests, full particulars concerning the cause of rejection, and the action taken to correct the defects in the lot, shall be furnished in writing by the contractor.

4.4.5 Inspection Procedures

All inspection plans shall be single sample plans with an accept number of zero.

4.4.6 Destructive Test Sample

Prior to testing, a letter "D" shall be permanently marked on each end fitting of those hose assemblies used for destructive tests (see 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 for impulse and vibration test samples requiring a 90 degree elbow fitting on one end. Satisfactory completion of qualification tests shall also constitute qualification approval for hose assemblies having other fittings that have an identical attachment method, design and materials, and meet the requirements of this document.

4.5.1.1 Additional Fitting End Designs

If qualification approval is desired for other type of end fitting outlet designs, two additional hose assemblies, utilizing the same hose construction design and fitting attachment method previously qualified, shall be subjected to the following tests in the sequence indicated. The hose assemblies shall be 18 in (457 mm) in length from fitting end to fitting end and incorporate straight to straight fitting design.

a. Examination of product (see 4.6.1)

b. Proof pressure test (see 4.6.3)

c. Leakage test (see 4.6.6)

d. Repetitive assembly torque test (see 4.6.13)

e. Room temperature burst pressure test (see 4.6.7.1)

4.5.2 Preparation of Samples

4.5.2.1 Test Sample Length

Unless otherwise specified, the length of test assemblies shall be in accordance with Table 4.

4.5.2.2 Oil Aging

In all 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 °F (204 °C) for 168 h. 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.

4.5.2.3 Air Aging

Air aged samples shall be kept in air at a temperature of 400 °F (204 °C) for 168 hours.

4.5.2.4 Unaged Samples

Unaged assemblies shall be as manufactured.

4.5.3 Test Fluids

Unless otherwise specified, the pressure test fluid shall be hydraulic fluid conforming to MIL-PRF-5606, MIL-PRF-87257, or water. Where a high temperature test fluid is required, the test fluid shall be MIL-PRF-83282 hydraulic fluid.

4.5.4 Pressure Measurement

Unless otherwise specified, all pressures shall have a tolerance of -0%, +5%.

4.5.5 Temperature Measurement

Unless otherwise specified, temperature measurements shall be taken within 6 in (152 mm) of hose assemblies under test. Unless otherwise specified, all temperatures shall have a tolerance of +15 °F, -5 °F (+8 °C, -3 °C).

4.5.6 End Connections

Except as otherwise noted, each hose end shall be connected to a male fitting in accordance with 3.3.4 and shall have an installation torque range as specified in Table 8 except dynamic beam seal fittings shall be torqued per AS85720. For qualification testing, a double tightening method shall be used and shall consist of the following steps:

- Tighten to the specified torque values
- Loosen one turn without disconnecting
- Retighten to the original torque value

4.6 Inspection Methods

4.6.1 Examination of Product

4.6.1.1 Inner Tube (PTFE)

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 document with respect to material, size, and workmanship. Broken or missing reinforcing wires, or any evidence of malfunction, 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 tube shall be subjected to a tube roll and proof pressure test in accordance with AS2078. The flattening gap, rounding gap, and proof pressure values shall be as specified for 3000 psi (21 000 kPa) and higher. The test media shall be air or water.

4.6.2.2 Tensile Strength

Test samples from each heat lot of tube shall be subjected to the tensile strength test in accordance with AS2078.

4.6.2.3 Elongation

Test samples from each heat lot of tube shall be subjected to the elongation test in accordance with AS2078.

4.6.2.4 Specific Gravity of the Tube

Test samples from each heat lot of tube shall be subjected to the specific gravity tests.

4.6.2.4.1 Apparent Specific Gravity

Apparent specific gravity shall be determined in accordance with AS2078. 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 AS2078.

4.6.3 Proof Pressure

All hose assemblies shall be pressure tested to the values specified in Table 3 in accordance with AS2078.

4.6.4 Elongation and Contraction Test

Two hose assemblies of each size shall be subjected to the elongation and contraction test in accordance with AS2078.

4.6.5 Volumetric Expansion Test

Two hose assemblies of each size shall be subjected to the volumetric expansion test in accordance with AS2078.

4.6.6 Leakage Test

Two hose assemblies of each size shall be subjected to the leakage test in accordance with AS2078 except the pressure for size code -16 and larger shall be 66% of the room temperature burst pressure shown in Table 2.

4.6.7 Burst Tests

4.6.7.1 Room Temperature Burst Pressure Test

The hose assemblies of each size shall be subjected to the room temperature burst pressure test in accordance with AS2078. The assemblies shall be observed throughout the test and type of failure and the pressure when failure occurred shall be recorded.

4.6.7.2 High Temperature Burst Pressure Test

The hose assemblies of each size shall be subjected to the high temperature burst pressure test in accordance with AS2078 at 400 °F (204 °C). The type of failure and the pressure when failure occurred shall be recorded.

4.6.8 Thermal Shock Test

Two hose assemblies of each size shall be subjected to the thermal shock test in accordance with AS2078. One assembly shall be air aged and one assembly shall be unaged.

4.6.9 Impulse Test

Impulse testing shall be performed as follows on six hose assemblies of each size. The impulse test equipment shall conform to AS603 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 3 for a minimum of 5 min.

b. The hose assemblies shall then be pressurized to 5080 psi and while maintaining this pressure at room temperature, the hose assemblies shall be immersed in a 3.5% ± 0.1% U.S.P. Grade 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

NOTE: The U.S.P. Grade sodium chloride (NaCl) solution shall contain on a dry basis not more than 0.1% sodium iodine and not more than 0.5% total impurities.

c. The test assemblies shall be connected to rigid supports and bent in a U-shape as illustrated in Figure 2 with a bend radius at the apex of the bend as specified in Table 2 except that sizes -12, -16, and -20 may be bent in a 90 degree shape at a reduced length as noted in Table 4 to reduce fluid volume.

d. The hose assemblies shall be impulse tested as specified in AS603 with peak pressures of 150% of Table 3 operating pressure measured at the inlet manifold. Impulsing shall occur at a rate of 70 cpm ± 10 cpm for a minimum of 300 000 cycles. For qualification test only, the test shall be continued until failure occurs or 450 000 cycles is attained. Testing beyond 300 000 cycles is for information purposes only and shall not constitute failure.

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

e. The sequence and duration of impulse testing and temperatures used are shown in Table 6.

TABLE 6 - SEQUENCE AND DURATION OF IMPULSE TESTING

Test Sequence	Number of Cycles (%)	Number of Cycles	Temperature
1	55	165 000	Maximum 400 °F (204 °C)
2	30	90 000	Ambient
3	5	15 000	Minimum -65 °F (-54 °C)
4	10	30 000	Maximum 400 °F (204 °C)
5	-	Beyond 300 000	Ambient