# AEROSPACE STANDARD

| MA614 | REV. A |
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Issued 1994-01
Revised 1998-06
Reaffirmed 2015-07

Superseding MA614

# (R) Hose Assembly, Polytetrafluoroethylene (PTFE), Metallic Reinforced, 28,000 kPa, 204 °C, Hydraulic, Metric

RATIONALE

MA614A has been reaffirmed to comply with the SAE five-year review policy.

## 1. SCOPE:

This SAE Aerospace Standard (AS) establishes the requirements for polytetrafluoroethylene (PTFE) hose assemblies for use in aerospace hydraulic systems at temperatures between -55 °C and 204 °C and at a nominal pressure up to 28,000 kPa (280 bar). The hose assemblies are also suitable for use within the same temperature and pressure limitations in aerospace pneumatic systems where some gaseous diffusion through the wall of the PTFE liner can be tolerated.

The use of these hose assemblies in high pressure pneumatic storage systems is not recommended. In addition, installations in which the limits specified herein are exceeded, or in which the application is not covered specifically by this document, for example oxygen, shall be subject to the approval of the purchaser.

### 1.1 Classification:

Hoses covered by this document shall be of temperature, types and pressures classes covered in MA2001 (ISO 6771).

## 2. REFERENCES:

### 2.1 Applicable Documents:

The following publications form a part of this specification 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 purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption is obtained.





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**http://www.sae.org/technical/standards/MA614A**

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 4928 | Titanium Alloy, Bars, Wire, Forgings, and Rings, 6Al 4V, Annealed |
| AMS 4945 | Titanium Alloy, Tubing, Seamless, Hydraulic, 3Al 2.5v, Texture Controlled, 105 ksi Yield Strength Cold Worked, Stress Relieved |
| AMS 4965 | Titanium Alloy, Bars, Wire, Forgings, and Rings, 6Al 4V, Solution Heat Treated |
| AMS 5556 | Steel, Corrosion and Heat Resistant, Seamless or Welded Tubing, 18Cr 11Ni 0.70(Cb+Ta) (SAE 30347), Hydraulic, Solution Heat Treated |
| AMS 5557 | Steel Tubing, Seamless and Welded, Corrosion and Heat Resistant, 18.5Cr 10.5Ni 0.40Ti (SAE 30321), Hydraulic, Solution Heat Treated |
| AMS 5561 | Steel, Corrosion and Heat Resistant, Welded and Drawn Tubing 9.0Mn 20Cr 6.5Ni 0.28N High-Pressure Hydraulic |
| AMS 5567 | Steel Tubing, Seamless or Welded, Corrosion Resistant, 19Cr 10Ni (SAE 30304), Hydraulic, Annealed |
| AMS 5570 | Steel, Corrosion and Heat Resistant, Seamless Tubing, 18Cr 11Ni 0.40Ti (SAE 30321), Solution Heat Treated |
| AMS 5571 | Steel, Corrosion and Heat Resistant, Seamless Tubing, 18Cr 10.5Ni 0.70(Cb+Ta) (SAE 30347), Solution Heat Treated |
| AMS 5573 | Steel, Corrosion and Heat Resistant, Seamless Tubing, 17Cr 12.5Ni 2.5Mo, Solution Heat Treated |
| AMS 5575 | Steel, Corrosion and Heat Resistant, Welded Tubing, 18Cr 10.5Ni 0.70(Cb+Ta) (SAE 30347), Solution Heat Treated |
| AMS 5576 | Steel, Corrosion and Heat Resistant, Welded Tubing, 18Cr 10.5Ni 0.40Ti (SAE 30321), Solution Heat Treated |
| AMS 5581 | Nickel Alloy, Corrosion and Heat-Resistant, Seamless or Welded Tubing 62Ni 21.5Cr 9.0Mo 3.7(Cb+Ta) Annealed |
| AMS 5636 | Steel, Corrosion Resistant, Bars and Wire, 18Cr 9.0Ni (SAE 30302) Solution Heat Treated and Cold Drawn, 100 ksi Tensile Strength |
| AMS 5637 | Steel, Corrosion Resistant, Bars and Wire, 18Cr 9.0Ni (SAE 30302) Solution Heat Treated and Cold Drawn, 125 ksi Tensile Strength |
| AMS 5639 | Steel Bars, Wire, Forgings, Tubing and Rings, Corrosion Resistant, 19Cr 10Ni (SAE 30304), Solution Heat Treated |
| AMS 5643 | Steel, Corrosion Resistant, Bars, Wire, Forgings, Tubing and Rings, 16Cr 4.0Ni 0.30(Cb+Ta) 4.0Cu (SAE 17-4PH), Solution Heat Treated, Precipitation Hardenable |
| AMS 5644 | Steel Bars and Forgings, Corrosion Resistant, 17Cr 7.0Ni 1.0Al (SAE 17-4PH) |
| AMS 5645 | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr 10Ni 0.40Ti (SAE 30321), Solution Heat Treated |
| AMS 5646 | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr 11Ni 0.60(Cb+Ta) (SAE 30347), Solution Heat Treated |
| AMS 5647 | Steel, Corrosion Resistant, Bars, Wire, Forgings, Tubing and Rings, 19Cr 9.5Ni (SAE 304L), Solution Heat Treated |
| AMS 5648 | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings, 17Cr 12Ni 2.5Mo, Solution Heat Treated |
| AMS 5653 | Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 17Cr 12Ni 2.5Mo, Solution Heat Treated |

2.1.1 (Continued):

| | |
|---|---|
| AMS 5659 | Steel, Corrosion Resistant, Bars, Wire, Forgings, Rings and Extrusions, 15Cr 4.5Ni 0.30Cb 3.5Cu (SAE 15-5PH), Consumable Electrode Melted, Solution Heat Treated, Precipitation Hardenable |
| AMS 5666 | Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings, Extrusions, and Rings, 62Ni 21.5Cr 9.0Mo 3.65(Cb+Ta) Annealed |
| AMS 5688 | Steel, Corrosion Resistant, Wire, 18Cr 9.0Ni (SAE 30302) Spring Temper |
| AMS 5689 | Steel, Corrosion and Heat Resistant, Wire 18Cr 10.5Ni 0.40Ti (SAE 30321), Solution Heat Treated |
| AMS 5690 | Steel, Corrosion and Heat Resistant, Wire 17Cr 12Ni 2.5Mo (SAE 30316), Solution Heat Treated |
| AMS 5697 | Steel, Corrosion Resistant, Wire 19Cr 9.5Ni (SAE 30304), Solution Heat Treated |
| AMS 5743 | Steel, Corrosion and Heat Resistant, Bars and Forgings 15.5Cr 4.5Ni 2.9Mo 0.10N (SAE AM-355), Solution Heat Treated, Sub-Zero Cooled, Equalized, and Over-Tempered |
| AS150 | Hose Assembly, Type Classifications of, Basic Performance and Fire Resistance |
| AS478 | Identification Marking Methods |
| AS611 | Tetrafluoroethylene Hose Assembly Cleaning Methods |
| ARP908 | Hose Fitting - Installation and Qualification Test Torque Requirements |
| AS1055 | Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings and Similar System Components |
| ARP1835 | Preparation for Delivery, General Requirements for Hose Assemblies |
| MA 1370 (ISO 5855) | Screw Threads - MJ Profile, Metric |
| MA 2001 (ISO 6771) | Aerospace Fluid Systems and Components- Pressure and Temperature Classifications |
| MA 2014 | Fitting End, Acorn Flareless, Design Standard, Metric |
| MA 2078 (ISO 8829) | Test Methods, Hose Assemblies, Polytetrafluoroethylene (PTFE), Metric |
| MA 2095 | Fitting Design Standard, 24° Cone |

2.1.2 ASTM Publications: Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

| | |
|---|---|
| ASTM A 262 | Standard Recommended Practices for Detecting Susceptibility to Intergranular Attack in Stainless Steel |
| ASTM A 313 | Standard Specification for Stainless Steel Spring Wire |
| ASTM A 580 | Specification for Stainless and Heat Resisting Steel Wire |

2.1.3 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

| | |
|---|---|
| P-D-680 | Dry Cleaning Solvent |
| QQ-P-35 | Passivation Treatments for Corrosion-Resistant Steels |
| QQ-S-763 | Steel Bars, Wire Shapes, and Forgings, Corrosion-Resisting |
| MIL-F-85421 | Fittings, Tube, Fluid Systems, Separable, Beam Seal, 3000/4000 psi, General Specification for |
| MIL-STD-100 | Engineering Drawing Practices |
| MIL-STD-831 | Test Reports, Preparation of |

2.1.4 ASME Publications: Available from ASME, 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900.

| | |
|---|---|
| ASME B46.1 | Surface Texture |

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 requirements and tests specified in this document.

3.2 Material:

The hose assemblies shall be uniform in quality and free from defects in material as is 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 shall be corrosion-resistant steel and corrosion-resistant steel, nickel alloy or titanium in the fittings and conform to the following specifications:

a. Bars and Forgings:

| | | |
|---|---|---|
| (1) | QQ-S-763 | Class 302 - Cond. A or Cond. B (AMS 5636 or AMS 5637) |
| (2) | QQ-S-763 | Class 304 - Cond. A or Cond. B (AMS 5639) |
| (3) | QQ-S-763 | Class 304L - Cond. A (AMS 5647) |
| (4) | QQ-S-763 | Class 316 - Cond. A (AMS 5648) |
| (5) | QQ-S-763 | Class 316L - Cond. A (AMS 5653) |
| (6) | QQ-S-763 | Class 321 - Cond. A (AMS 5645) |
| (7) | QQ-S-763 | Class 347 - Cond. A (AMS 5646) |
| (8) | AMS 5643 | 17-4PH |
| (9) | AMS 5644 | 17-7PH |
| (10) | AMS 5659 | 15-5PH |
| (11) | AMS 5743 | AM-355 |
| (12) | AMS 4928 | Titanium 6Al-4V Annealed |
| (13) | AMS 4965 | Titanium 6Al-4V Heat Treated |
| (14) | AMS 5666 | Nickel Alloy Type 625 |

b. Tubing:

| | | |
|---|---|---|
| (1) | AMS 5567 | Type 1 or Type 2 Stainless Steel Tubing, 304 |
| (2) | AMS 5573 | Seamless Stainless Steel Tubing, 316 |
| (3) | AMS 5557 | Type 1 or Type 2 Stainless Steel Tubing, 321 |
| (4) | AMS 5570 | Seamless Stainless Steel Tubing, 321 |
| (5) | AMS 5576 | Welded Stainless Steel Tubing, 321 |
| (6) | AMS 5571 | Seamless Stainless Steel Tubing, 347 |
| (7) | AMS 5575 | Welded Stainless Steel Tubing, 347 |
| (8) | AMS 5556 | Type 1 or Type 2 Stainless Steel Tubing, 347 |
| (9) | AMS 5561 | Welded Stainless Steel Tubing, 21-6-9 |
| (10) | AMS 4945 | Titanium 3Al-2.5V Texture Controlled |
| (11) | AMS 5581 | Type 1 or Type 2 Nickel Alloy Tubing, 625 |

c. Wire:

| | | |
|---|---|---|
| (1) | ASTM A 580/ A 313 | Comp. 302 (AMS 5688) |
| (2) | ASTM A 580/ A 313 | Comp. 304 (AMS 5697) |
| (3) | ASTM A 580/ A 313 | Comp. 316 (AMS 5690) |
| (4) | ASTM A 580/ A 313 | Comp. 321 (AMS 5689) |

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 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 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 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 or missing reinforcing wires or buckled wires more than 1.5 mm above the outside diameter surface 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 permanently attached and proven to meet the requirements herein. Unless specified otherwise by the user, the hose assemblies shall have flareless fittings conforming to MA2014 to mate with MA2095 end fittings.

3.3.3.1 Alternate Fittings: Requalification using alternate end connections (flared or dynamic beam seal) is not required if identical hose to fitting attachment design as qualified is used and the fitting otherwise meets the applicable fitting procurement specification such as MIL-F-85421.

3.3.3.2 Insert Fittings: Insert fittings shall be of one piece construction to wherever possible. Those made of other than one piece construction shall be butt welded from corrosion-resistant steel tubing or titanium unless otherwise agreed with the purchaser. Welded and redrawn tubing may be used for corrosion-resistant steel. As an option, fittings may be made from forgings.

3.3.3.3 End Fitting Collars (Sockets): All end fitting collars (sockets) crimped or swaged, fabricated from Type 304 stainless steel are required to be capable of passing an embrittlement test as specified in ASTM A 262 Practice E, prior to assembly to the nipple or swaging operation. Sockets fabricated from stabilized austenitic steel (304L, 321, or 347) are acceptable without being subjected to the embrittlement test. Titanium sockets are not recommended.

3.3.3.4 Fitting Finish:

3.3.3.4.1 Corrosion Resistant Steel Parts: Unless otherwise specified, corrosion resistant steel parts shall be passivated in accordance with QQ-P-35.

3.3.3.4.2 Titanium Alloy Parts: Titanium alloy parts shall be fluoride phosphate coated per AMS 2486.

3.3.4 Inner Tube Requirements:

3.3.4.1 Specific Gravity: The specific gravity values of the hose inner tube shall not exceed 2.155 apparent and 2.210 relative when determined in accordance with MA2078.

NOTE: When test samples are prepared from braided hose, the braid impression must be removed prior to testing.

3.3.4.2 Tensile Strength: When tested in accordance with MA2078 the longitudinal tensile strength for all sizes of tubes shall be 15.1 MPa. The transverse tensile strength for sizes DN16 and larger shall be 12.4 MPa minimum. For sizes DN12 and smaller the transverse tensile strength need not be tested.

3.3.4.3 Elongation: Elongation shall be a minimum of 200% when tested in accordance with MA2078.

3.3.4.4 Tube Roll: The tube shall not leak, split, burst, or show any evidence of malfunction when rolled to the flattening and rounding gaps of MA2078, 21,000 kPa and higher values.

3.3.4.5 Tube Proof Pressure: Following tube roll per 3.3.4.4, the tube, without reinforcing wires, shall not leak, burst, or show any evidence of malfunction when tested to the MA2078 (21,000 kPa and higher) proof pressure values for 1 min. The test media shall be air or water.

3.3.4.6 Electrical Conductivity: When tested in accordance with MA2078, the electrical current shall be equal to or greater than 10 µA for sizes DN06 through DN12, and equal to or greater than 20 µA for sizes DN16 and over.

3.3.5 Hose, Dimensional and Physical Requirements:

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

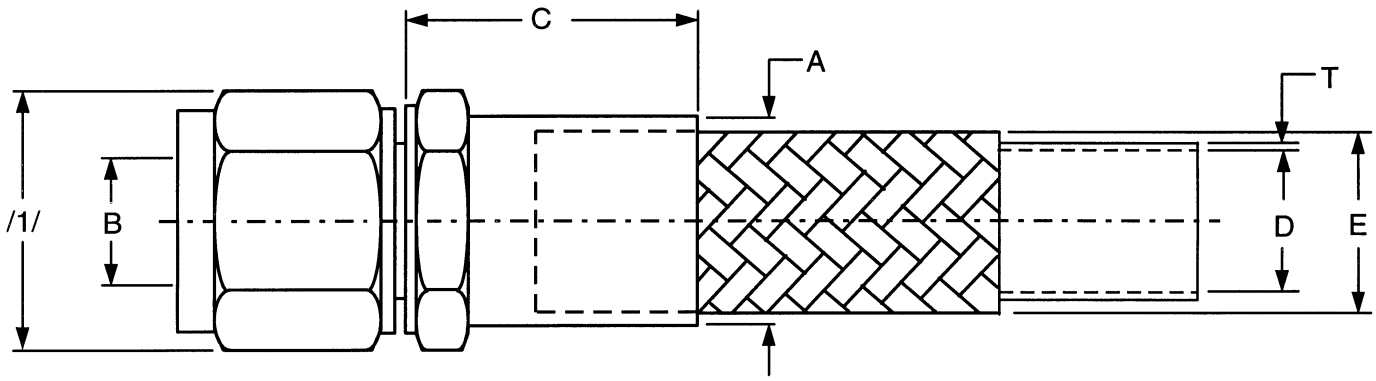


FIGURE 1 - Hose and Fitting Dimensions

TABLE 1 - Hose and Fitting Dimensions as Shown in Figure 1 (mm)

| Hose Size | (Nominal Tube Size) | Fitting OD A Max | Fitting ID B[2] Min | Socket Length C Max | Hose ID D Min | Hose OD E Min | Hose OD E Max | Unbraided Inner Tube Wall T Min | Spherical Ball Size for Determining Min Hose Assy. ID[2] in Straight Fittings | Spherical Ball Size for Determining Min Hose Assy. ID[2] Elbow Fittings |
|---|---|---|---|---|---|---|---|---|---|---|
| DN06 | 6.0 | 23 | 3.4 | 58 | 5.4 | 11.4 | 12.6 | 0.9 | 3.1 | 2.9 |
| DN10 | 10.0 | 26 | 6.1 | 64 | 7.6 | 14.1 | 15.7 | 0.9 | 5.5 | 5.2 |
| DN12 | 12.0 | 31 | 8.6 | 70 | 9.9 | 18.3 | 20.8 | 1.0 | 7.7 | 7.3 |
| DN16 | 16.0 | 36 | 10.4 | 76 | 12.3 | 21.6 | 24.1 | 1.1 | 9.4 | 8.8 |
| DN20 | 20.0 | 43 | 12.9 | 83 | 15.3 | 26.2 | 27.9 | 1.1 | 11.6 | 11.0 |
| DN25 | 25.0 | 51 | 19.3 | 96 | 21.6 | 30.7 | 36.1 | 1.1 | 17.4 | 16.4 |
| DN32 | 32.0 | 54 | 23.5 | 100 | 28.0 | 39.6 | 44.5 | 1.3 | 21.2 | 20.0 |

[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.

3.3.5.2 Physical Requirements: Hose assemblies shall meet the physical and weight requirements per Table 2.

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

| Hose Size | (Nominal Tube Size) | Hose Weight Max[1] kg/m | Operating Pressure kPa | Proof Pressure kPa | Burst Pressure Room Temperature Minimum kPa | Burst Pressure High Temperature Minimum kPa | Bend Radius at Inside of Bend Minimum mm | Volumetric Expansion Maximum mL/m |
|---|---|---|---|---|---|---|---|---|
| DN06 | 6.0 | .40 | 28 000 | 56 000 | 112 000 | 84 000 | 76 | 3.2 |
| DN10 | 10.0 | .66 | 28 000 | 56 000 | 112 000 | 84 000 | 127 | 4.7 |
| DN12 | 12.0 | .81 | 28 000 | 56 000 | 112 000 | 84 000 | 146 | 6.7 |
| DN16 | 16.0 | 1.25 | 28 000 | 56 000 | 112 000 | 84 000 | 165 | 10.8 |
| DN20 | 20.0 | 1.70 | 28 000 | 56 000 | 112 000 | 84 000 | 197 | 14.8 |
| DN25 | 25.0 | 2.86 | 28 000 | 56 000 | 112 000 | 84 000 | 245 | 37.0 |
| DN32 | 32.0 | 3.95 | 28 000 | 56 000 | 112 000 | 84 000 | 305 | 49.2 |

[1] Hose weight shall be determined on a minimum length of 300 mm.

3.3.5.3 Bore Check: When bent to the appropriate minimum bend radius as specified in Table 2, the hose assembly shall permit the free passage of a solid rigid sphere throughout its length. The diameter of the sphere shall be 90% of the appropriate minimum inside diameter “B” of the end fitting as specified in Table 1.

3.3.6 Screw Threads: Unless otherwise specified, coupling nut threads shall be in accordance with MA1370. Thread tolerance increase of 10% following proof testing shall not be cause for rejection of the hose assembly.

3.3.7 Length: Tolerances on hose assembly lengths shall be as follows:

a. ±5 mm for lengths under 500 mm
b. ±10 mm for lengths from 500 to 1000 mm exclusive
c. ±15 mm for lengths from 1000 to 1500 mm exclusive
d. ±1% for lengths of 1500 mm and over

3.3.8 Part Numbering of Interchangeable Parts: All parts complying with this international standard and having the same manufacturer's or standard part number shall be functionally and dimensionally interchangeable. The item identification and part number requirement of MIL-STD-100 shall govern the manufacturer's part numbers and changes thereto.

3.3.9 Identification of Product: The assembly and its components shall be permanently marked in accordance with AS478. The following special marking shall be added:

3.3.9.1 Fittings: The manufacturer's name or trademark shall be permanently marked on one element of all end fittings.

3.3.9.2 Assembly: A permanent marking shall be applied on a fitting or on a permanent band, or bands, securely attached on the hose. The band shall be no wider than 25 mm and shall not impair the flexibility or the performance of the hose. Unless otherwise specified, the marking on the fitting or band shall include the following information:

a. Assembly manufacturer's name or trademark and specification number
b. CAGE code and complete hose assembly part number
c. Operating pressure "28,000 kPa"
d. Operating temperature “204 °C”
e. Pressure test symbol "PT"
f. Date of hose assembly manufacture expressed in terms of month and year or batch number
g. Hose manufacturer's CAGE code number (required only when hose manufacturer is different than hose assembly manufacturer)
h. Fire resistance type per AS1055, Type and Class or AS150 and Type (when applicable)

3.3.10 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 25 µm Ra maximum per ASME B46.1 will be acceptable.

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

3.3.10.2 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.

3.4 Hose Assembly, Test and Performance Requirements:

3.4.1 Proof Pressure: All hose assemblies shall be subjected to the proof pressure test in accordance with MA2078. Each hose assembly shall withstand the proof pressure listed in Table 2 without malfunction or leakage.

3.4.2 Elongation and Contraction: Two hose assemblies of each size shall be subjected to the elongation and contraction test in accordance with MA2078. There shall be no change in length by more than ±2% in 250 mm gauge length.

3.4.3 Volumetric Expansion: Two hose assemblies of each size shall be subjected to the volumetric expansion test in accordance with MA2078. The volumetric expansion shall not exceed the limits specified in Table 2.

3.4.4 Leakage: Two hose assemblies of each size shall be subjected to the leakage test in accordance with MA2078. There shall be no leakage.

3.4.5 Thermal Shock:

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.

b. The hose assemblies shall be subjected to the thermal shock test in accordance with MA2078.

c. The hose assemblies shall not leak nor show any evidence of malfunction during the proof pressure portion of the test. During the burst portion of the test, any of the above occurring below the minimum high temperature burst pressure specified in Table 2 shall constitute failure.

3.4.6 Impulse Test:

a. Six sample hose assemblies shall have a 90° elbow fitting on one end and a straight fitting on the other end shall be used for this test. If approval is being sought for both the bent tube and the forged elbow configuration, then one-half of the samples as shown in Table 3 shall use the bent elbows, while the other half of the samples shall have the forged elbows. Periodic control tests may be performed with a straight fitting on each end.

Preparation:

(1) Two assemblies shall be oil aged, two shall be air aged, and two shall be unaged (see 4.5.2). The assemblies shall then be subjected at room temperature to the proof pressure specified in Table 2 for a minimum of 5 min.

(2) The hose assemblies shall then be pressurized to 28,000 kPa. 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 process 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.

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 1, except that size DN20 and larger may be bent in a 90° shape at a reduced length as noted in Table 5 to reduce fluid volume.

TABLE 3A - Qualification Test Sequence and Number of Samples[1] (Inner Tube and Hose Assemblies 1-9)

| Test (Paragraph Number) | Inner Tube | Inner Tube | Hose Assembly 1 | Hose Assembly 2 | Hose Assembly 3 | Hose Assembly 4 | Hose Assembly 5 | Hose Assembly 6 | Hose Assembly 7 | Hose Assembly 8 | Hose Assembly 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.6.1.1 Examination of Product[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.1 Specific Gravity[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.2 Tensile Strength[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.3 Elongation[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.4 Tube Roll[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.5 Proof Pressure[2] | 0 | 0 | | | | | | | | | |
| 3.3.4.6 Electrical Conductivity[2] | 0 | 0 | | | | | | | | | |
| 4.6.1.2 Examination of Product | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.3.5.3 Bore Check | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.4.1 Proof Pressure | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.4.2 Elongation and Contraction | | | 0 | 0 | | | | | | | |
| 3.4.3 Volumetric Expansion | | | | | 0 | 0 | | | | | |
| 3.4.4 Leakage | | | | | | | 0 | 0 | | | |
| 3.4.5 Thermal Shock | | | | | | | 0 | 0 | | | |
| 3.4.6 Impulse: Unaged<br>Air Aged<br>Oil Aged | | | | | | | | | | | 0 |
| 3.4.7 Assembly Flexibility | | | 0 | 0 | | | | | | | |
| 3.4.8 Stress Degradation | | | | | | | | | 0 | 0 | |
| 3.4.9 Pneumatic Surge | | | | | | | | | 0 | 0 | |
| 3.4.10 Pneumatic Effusion | | | | | 0 | 0 | | | | | |
| 3.4.11 Repetitive Assy Torque | | | 0 | 0 | | | | | | | |
| 3.4.12 Room Temp Burst Pressure | | | | | 0 | 0 | | | | | |
| 3.4.13 Electrical Conductivity | | | | | | | | | | | |
| 3.4.14 Fire Resistance (when required) | | | | | | | | | | | |

[1] One circle "0" means one inspection.
[2] Production lot records may be used to verify conformance to these tests when the PTFE tube or hose assembly being used is an established production item.

TABLE 3B - Qualification Test Sequence and Number of Samples[1] (Hose Assemblies 10-18)

| Test (Paragraph Number) | Hose Assembly 10 | Hose Assembly 11 | Hose Assembly 12 | Hose Assembly 13 | Hose Assembly 14 | Hose Assembly 15 | Hose Assembly 16 | Hose Assembly 17 | Hose Assembly 18 |
|---|---|---|---|---|---|---|---|---|---|
| 4.6.1.1 Examination of Product[2] | | | | | | | | | |
| 3.3.4.1 Specific Gravity[2] | | | | | | | | | |
| 3.3.4.2 Tensile Strength[2] | | | | | | | | | |
| 3.3.4.3 Elongation[2] | | | | | | | | | |
| 3.3.4.4 Tube Roll[2] | | | | | | | | | |
| 3.3.4.5 Proof Pressure[2] | | | | | | | | | |
| 3.3.4.6 Electrical Conductivity[2] | | | | | | | | | |
| 4.6.1.2 Examination of Product | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.3.5.3 Bore Check | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.4.1 Proof Pressure | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| 3.4.2 Elongation and Contraction | | | | | | | | | |
| 3.4.3 Volumetric Expansion | | | | | | | | | |
| 3.4.4 Leakage | | | | | | | | | |
| 3.4.5 Thermal Shock | | | | | | | | | |
| 3.4.6 Impulse: Unaged | 0 | | | | | | | | |
| Air Aged | | 0 | 0 | | | | | | |
| Oil Aged | | | | 0 | 0 | | | | |
| 3.4.7 Assembly Flexibility | | | | | | | | | |
| 3.4.8 Stress Degradation | | | | | | | | | |
| 3.4.9 Pneumatic Surge | | | | | | | | | |
| 3.4.10 Pneumatic Effusion | | | | | | | | | |
| 3.4.11 Repetitive Assy Torque | | | | | | | | | |
| 3.4.12 Room Temp Burst Pressure | | | | | | | | | |
| 3.4.13 Electrical Conductivity | | | | | | 0 | | | |
| 3.4.14 Fire Resistance (when required) | | | | | | | 0 | 0 | 0 |

[1] One circle “0” means one inspection.

[2] Production lot records may be used to verify conformance to these tests when the PTFE tube or hose assembly being used is an established production item.

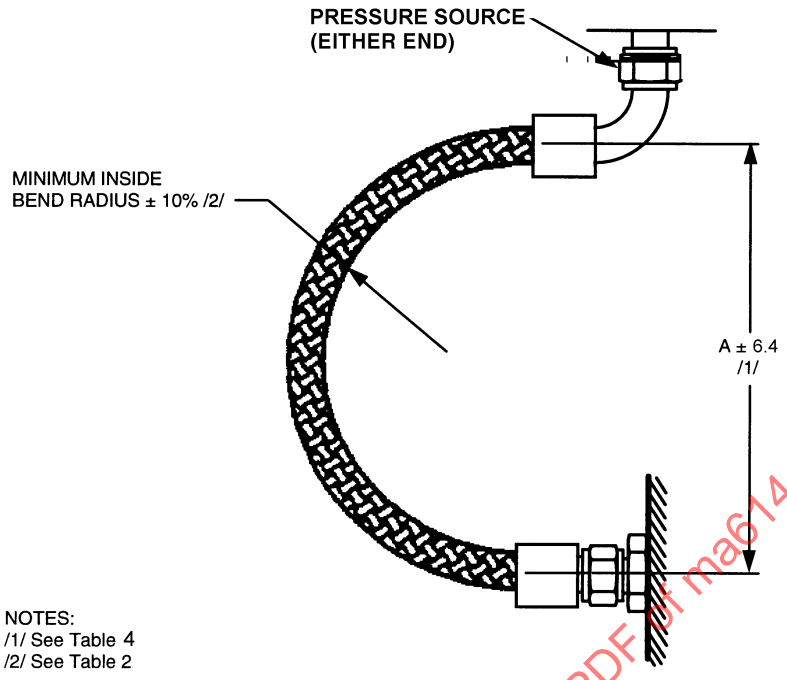


FIGURE 2 - Impulse Test Setup (mm)

3.4.6 (Continued):

The impulse pattern shall be as specified in MA2078 with peak pressures of 150% measured at the inlet manifold. Impulsing shall occur at a rate of 70 cpm ± 10 cpm. The test fluid shall be one of the high temperature test fluids. Fluid temperature shall be maintained at 204 °C for all hose sizes and measured at the test manifold. Ambient temperature shall be 204 °C, measured at a point within 150 mm of the manifold temperature. Units are to be in accordance with 4.5.4.

Impulse testing shall be run in such a manner that the assemblies are temperature cycled from room temperature to a specified fluid and ambient air temperatures at a minimum of two times, with a minimum of 80% of the impulse cycles at 204 °C. Any evidence of leakage from the hose or fittings prior to the completion of 100,000 impulse cycles shall constitute a failure.

3.4.7 Assembly Flexibility: Two hose assemblies of each size shall be subjected to the assembly flexibility test in accordance with MA2078. The hose assembly shall not leak or show any evidence of malfunction when flexure tested. They shall be mounted in a test rig as illustrated in Figure 3 and to the dimensions of Table 4.

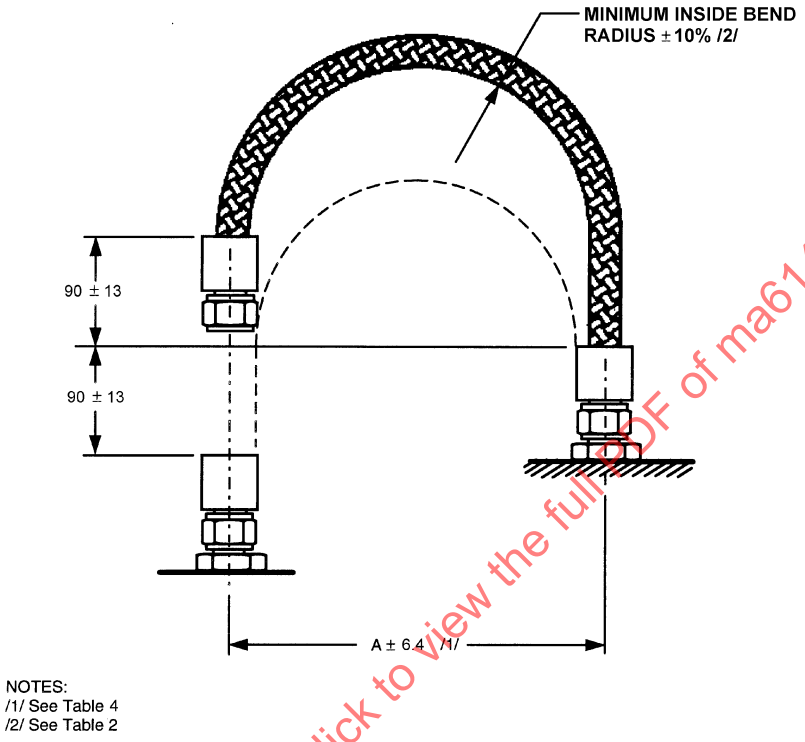


FIGURE 3 - Flexure Test Setup (mm)

TABLE 4 - Flexure Test Dimensions (mm)

| Hose Size | A |
|---|---|
| DN06 | 163 |
| DN10 | 270 |
| DN12 | 310 |
| DN16 | 355 |
| DN20 | 420 |
| DN25 | 530 |
| DN32 | 655 |

3.4.8 Stress Degradation: Two hose assemblies of each size shall be subjected to the stress degradation test in accordance with MA2078 except that the assemblies shall be flushed with solvent per P-D-680 in lieu of trichlorotrifluoroethane. The hose assembly shall not exceed an average effusion rate of 80 mL/m per minute for any size.

3.4.9 Pneumatic Surge: Two hose assemblies of each size shall be subjected to the pneumatic surge test in accordance with MA2078. The inner tube of the hose assembly shall not collapse nor show evidence of degradation.

3.4.10 Pneumatic Effusion Test: Two hose assemblies of each size shall be subjected to the pneumatic effusion test in accordance with MA2078. The hose assemblies shall not exceed a total effusion rate of 26 mL/m of hose length for any size.

3.4.11 Repeated Installation: When tested in accordance with the procedure outlined below, the assembly end fittings shall show no evidence of leakage, galling or other malfunction. Two hose assemblies of each size shall be used for this test. The test procedure shall be as follows: End fittings on hose assemblies shall be screwed to appropriate union adaptors eight times using system fluid or an equivalent lubricant. Each of the eight cycles shall include the complete removal of the hose fitting from the manifold union. Fitting nuts shall be tightened to the torque specified in ARP908. One half shall be tested to the minimum, one half to the maximum tightening torques. Following the first, fourth, and eighth installation, proof pressure tests shall be conducted in accordance with 3.4.1. Following the eighth installation the hose fittings shall be pressure tested with air or nitrogen for 5 min at the nominal operating pressure.

3.4.12 Room Temperature Burst Pressure: Two hose assemblies of each size shall be subjected to the room temperature burst test in accordance with MA2078. The hose assembly shall not leak or burst at any pressure below the room temperature burst value specified in Table 2.

3.4.13 Electrical Conductivity: One sample assembly shall be subjected to the electrical conductivity test in accordance with MA2078 except that optional method of testing per Figure 4 is allowed. Hose assembly sizes DN12 and smaller shall be capable of conducting a direct current equal to or greater than 6 µA and sizes DN16 and larger a direct current equal to or greater than 12 µA with a test potential of 1000 V DC.

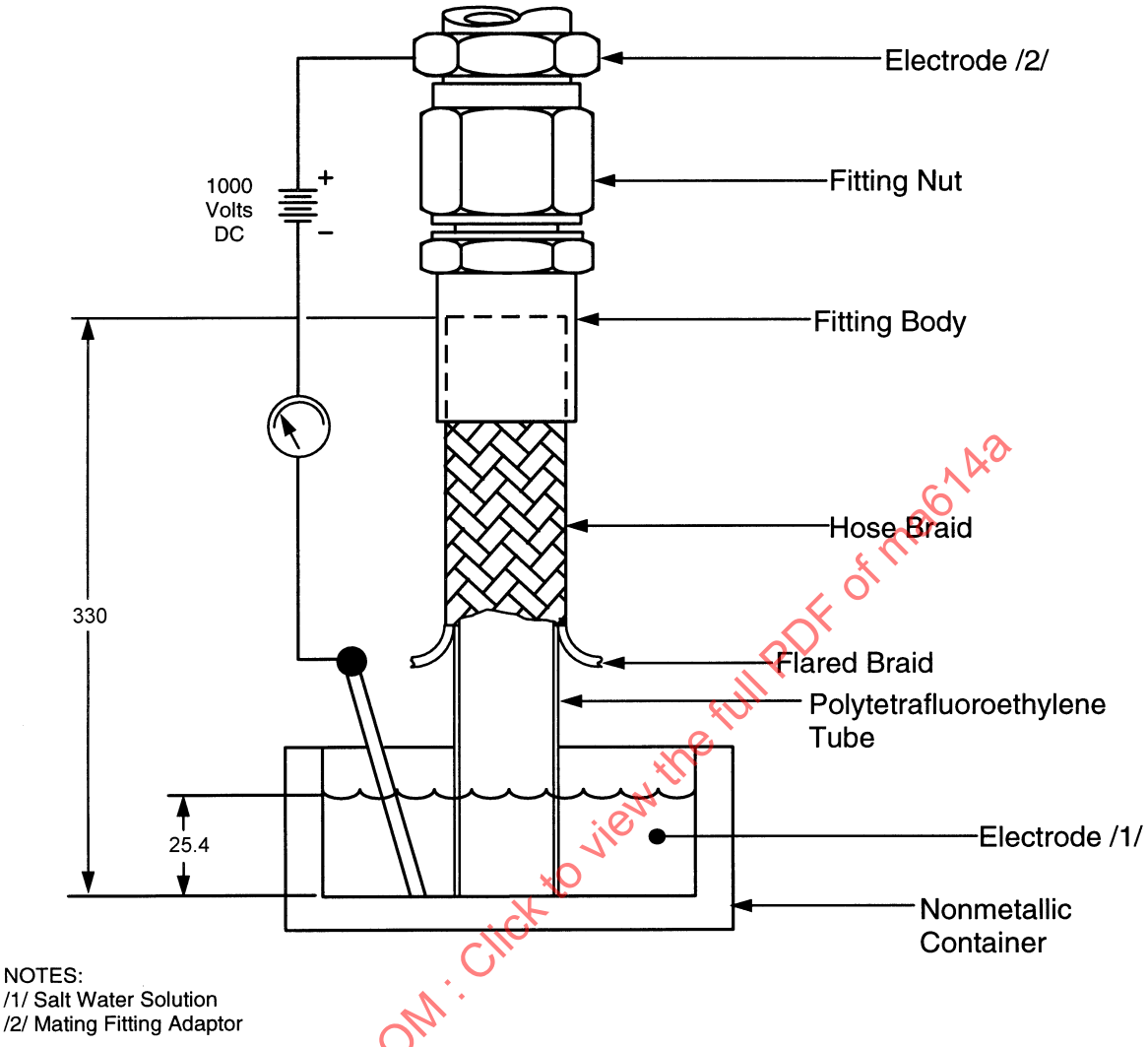


FIGURE 4 - Optional Electrical Conductivity Test Diagram (mm)

3.4.14 Resistance to Fire:

a. When the hose assemblies are required to withstand a specified resistance to fire, three sample hose assemblies, which may be fitted with fire sleeves, shall be tested in accordance with AS1055. Satisfactory qualification to this document and AS1055 meet the requirements of AS150 Type X, as applicable.

b. The hose assemblies shall withstand the effects of the flame without leakage for the following periods as appropriate:

(1) Fire resistant assemblies: 5 min
(2) Fireproof assemblies: 15 min

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 document, where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Inspections:

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

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

4.3 Qualification Inspections:

4.3.1 Qualification Test Samples: Test samples shall consist of the number of samples specified in Table 3 and the specimen numbers and lengths specified in Table 5.