SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS2094 | REV. A

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Superseding AS2094

(R) Test Methods for Tube-Fitting Assemblies

RATIONALE

Update the entire standard to include additional test methods and to support qualification test requirements for operating systems up to 5000 psi.

FOREWORD

This document is equivalent to ISO 10583 except pressure class J, System Pressure Test, Torsion Test and Electrical Bonding Test added. This document has been prepared to standardize on the test methods for qualification of tube-fitting assemblies used in aircraft fluid systems. Compliance with these test methods is necessary for assemblies which are used in systems where a malfunction could affect the safety of flight.

1. SCOPE

This SAE Aerospace Standard (AS) specifies test methods for tube-fitting assemblies used in aircraft fluid systems in the following pressure classes: B (1500 psi or 10500 kPa), D (3000 psi or 21000 kPa), E (4000 psi or 28000 kPa), and J (5000 psi or 35000 kPa) and in temperature types I (-65 to 160 °F or -55 to 70 °C), II (-65 to 275 °F or -55 to 135 °C), and III (-65 to 400 °F or -55 to 200 °C) of AS2001.

This document applies each time that it is referred to in a procurement specification or other definition document.

Fluids and materials used for the tests are listed in Section 2.

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.

AS603 Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies

ARP1185 Flexure Testing of Hydraulic Tubing Joints and Fittings

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

ARP1870 Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety

AS1055 Fire Testing of Flexible Hose, Tube Assemblies, Coils, fittings, and Similar System Components

AS1241 Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

AS2001 Aerospace Fluid Systems and Components - Pressure and Temperature Classifications

AS4265 Impulse Testing of Hydraulic Tubing and Fittings, S-N Curve

MA2003 Rotary Flexure Testing of Hydraulic Tubing Joints and Fittings

MA2004 Thermal Shock Testing of Fluid System Piping and Fittings

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 D 471 Standard Test Fluids, Hydrocarbon

2.1.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-9495, https://assist.daps.dla.mil/quicksearch/.

MIL-C-81302 Cleaning Compound, Solvent, Trichlorotrifluoroethane

MIL-DTL-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5

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

MIL-PRF-680 Degreasing Solvent

MIL-PRF-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric NATO Code Number H-537

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

TT-I-735 Isopropyl Alcohol

2.2 Definitions

AMBIENT TEMPERATURE: Temperature in the test area or test chamber.

ROOM TEMPERATURE: Temperature in the test laboratory 59 to 95 °F (15 to 35 °C).

3. QUALITY CONFORMANCE INSPECTION PROCEDURES

Fitting components and assemblies shall be inspected using the normal tools and procedures.

4. QUALIFICATION AND PERFORMANCE TEST PROCEDURES

4.1 Proof Pressure Test

This test is intended to verify the structural integrity of the tube-fitting assembly prior to its use for other tests or in the production of tube or duct assemblies.

Connect test assemblies to a source of pressure with one end free to move. Bleed all air from the system before any pressure is applied. Proof pressure test at a value as specified by the procurement specification for a minimum period of 3 minutes. The rate of pressure rise for system pressures of 1500 psi (10.5 MPa) and over shall be 250 to 400 psi per second (1724 to 2758 kPa per second). For system pressures under 1500 psi (10.5 MPa), the rate shall be 50 to 80 psi per second (345 to 550 kPa per second). The test shall be conducted at room temperature.

4.2 Pneumatic Pressure Test

This test is intended to verify that the tube-fitting assembly will perform without leakage in pneumatic applications. This test is often used at the start and completion of other tests.

Solvent clean and air dry test fittings prior to testing. Assemble separable fittings using a lubricant or compound on the thread and sleeve/nut shoulder (unless they have a solid film lubrication) and tighten to the maximim torque specified in the procurement specification and allow to sit for 30 seconds, then the nut shall be backed off completely without separation of the sealing surfaces and re-tightened to the torque specified in the procurement specification. Pressurize with nitrogen to nominal operating pressure. Maintain the pressure for 3 minutes minimum while the specimens are immersed in water or suitable oil. Specimens shall be pressure tested at room temperature.

WARNING: Conduct the test in a special device to protect the operator.

4.3 Impulse Test

This test is intended to verify the service life of a tube-fitting assembly when exposed to hydraulic pressure cycling or pressure surging.

4.3.1 Standard test: Impulse test the assemblies in accordance with AS603 at the temperatures listed for Types I, II and III, and in the sequence specified in AS603.

4.3.2 Alternate test: Impulse test the assemblies in accordance with AS4265 as specified in the applicable procurement specification and in the sequence specified in AS4265 at ambient temperature unless otherwise specified in the procurement specification.

4.4 System Pressure Test

This test is intended to verify that the tube-fitting assembly will perform without leakage when the system is unpressurized (low pressure) and pressurized.

Assemble test configuration and then clean and air dry configuration. Pressure test assembly (low pressure) 50 to 60 psi (345 to 414 kPa) for 24 hours then apply nominal operating pressure for 24 hours. The test shall be conducted at room temperature.

4.5 Hydrostatic Burst Pressure Test

This test is intended to verify that a specified overpressure safety factor is being met, also to establish the failure mode under overpressure.

WARNING: Conduct all pressure tests in a special device to protect the operator.

Connect the test assembly to a source of pressure with one end free to move. Bleed all air from the system before any pressure is applied. Increase the pressure to the required minimum burst pressure as listed in the procurement specification at a rate of 250 to 400 psi per second (1724 to 2758 kPa per second) for system pressures of 1500 psi (10.5 MPa) and over. For system pressures under 1500 psi (10.5 MPa), the rate shall be 50 to 80 psi per second (345 to 550 kPa per second). Maintain the pressure for the duration listed in the procurement specification, then unless otherwise specimen, continue to increase the pressure at the same rate until the assembly bursts. Specimens shall be tested at ambient temperature. Specimens tested at maximum operating temperatures need not burst but must be capable of withstanding four times nominal operating pressure for a minimum of 3 minutes.

Specimens from impulse or corrosion testing (or specimens of any non destructive test) may be used for the burst test.

4.6 Flexure Test

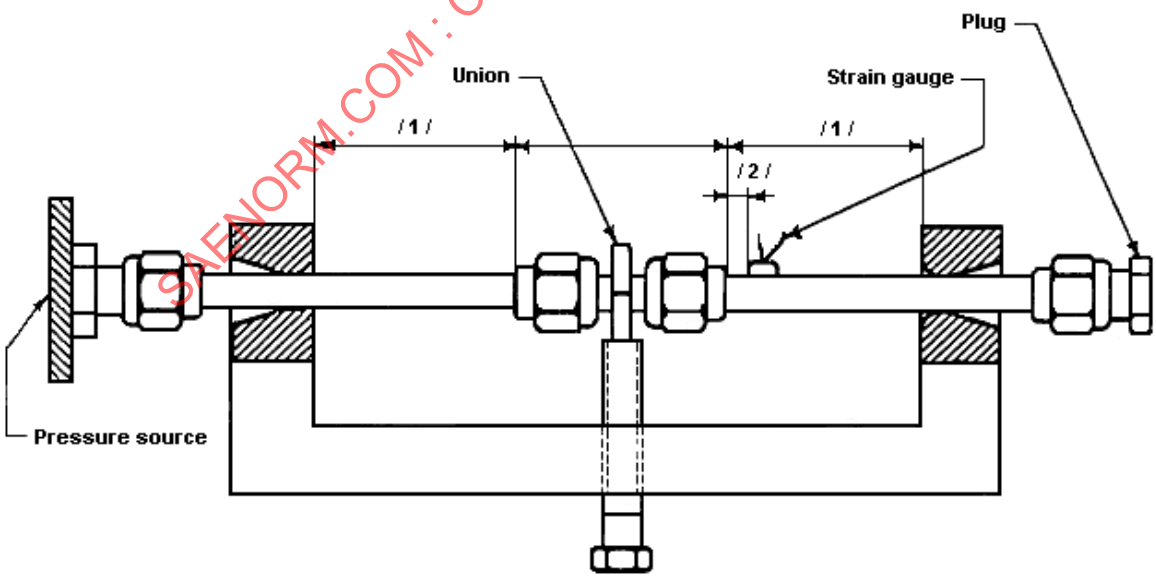
This test is intended to verify the service life of a fitting assembly when exposed to cyclic bending stresses while the assembly is under system pressure.

Unless otherwise specified in the procurement specification, conduct the test in accordance with ARP1185 at ambient temperature. Determine the bending stress in the flexure test specimen prior to the application of internal pressure.

4.7 Stress Corrosion Test

This test is intended to verify that the tube-fitting joining process did not adversely affect the resistance to stress corrosion in the joining area.

Install the test assembly in a test fixture (see Figure 1) which imposes a bending stress level equal to 85% ± 5% of the specified tubing yield strength (0.2% proof stress) minimum at the tube-fitting assembly interface. Apply an internal pressure equal to the nominal system pressure without removing the bending stress. Then subject the assembly to test procedure MIL-STD-810 (salt spray test) for the duration listed in the procurement specification. After exposure, subject the assembly to the burst pressure test at ambient temperature. Clean, section, and metallurgically examine the tube-fitting joint for intergranular or stress corrosion cracking.



/ 1 / Length to be at least 3/4 of tube length between sleeves.
/ 2 / Distance from sleeve end to strain gage shall be 0.12 to 0.20 in (3 to 5 mm).

FIGURE 1 - SCHEMATIC DIAGRAM OF STRESS CORROSION TEST ASSEMBLY

4.8 Reuse Capability

4.8.1 Port Connections: This test is intended to verify that port connections can be repeatedly assembled and disassembled during installation and in service.

Screw together and unscrew specimens eight times. Each of the eight cycles shall include the complete removal of the fitting from the port and of the tube ends from the fitting. Install new elastomeric port seals, unless the reuse of seals is specified at some other interval or prohibited during the 8 cycle times. Following the first, fourth, and eighth installations, conduct further pneumatic tests. Specimens shall pass pneumatic and proof pressure testing after the eighth installation. The specimens may be used for subsequent impulse and burst tests.

NOTE: It is not necessary to perform this test on semi-permanent port connections.

4.8.2 Tube Fittings: This test is intended to verify that fitting components can be repeatedly assembled and disassembled in service.

Test the tube fittings to the tightening torques specified in the procurement specification, one half of the fitting connections using the minimum, the other half using the maximum tightening nut torques. Do not mix the two groups. Following the first, fourth, and eighth installations, conduct additional pneumatic tests. Specimens shall pass pneumatic and proof pressure testing after the eighth installation. The specimens may be used for subsequent impulse and burst tests.

4.9 Tensile Test

This test is intended to verify that the tube-fitting assembly may be exposed to axial loads in service.

Mount assembled specimens in a tensile machine and strain to rupture at a speed of 0.15 in/min ± 0.01 in/min (4.0 mm/min ± 0.3 mm/min). This test shall be performed with no pressure, but tube-fitting assemblies may be tensile tested while system pressure is maintained in the specimen, using adequate safety precautions.

4.10 Thermal Shock Test

This test is intended to verify that the fitting or coupling assembly will not leak if the temperature of the fluid flowing through the fitting or coupling changes between extremes, as can occur, for example, in certain fuel system applications.

Unless otherwise specified in the procurement specification, mount and test the test assemblies in accordance with MA2004.

4.11 Fire Test

This test is intended to verify that the fitting assembly will not leak if exposed to an intense fire.

Mount and test the assembly in accordance with AS1055 or as specified in the procurement specification.

4.12 Electrical Bonding Test

This test is intended to verify electrical conductivity across a tube-fitting assembly and to ensure adequate performance when exposed to environmental conditions.

Assemble fittings using the minimum torque values specified in the procurement specification. The electrical resistance shall be measured from tube to tube across the tube-fitting assembly using a four point device in accordance with ARP1870 at the location shown in Figure 2 or the purchaser's instructions. If the assembly is subjected to salt spray test per MIL-STD-810, electrical resistance measurement shall be repeated at the same location.

The contact points on the tubes for the resistance measuring device may be cleaned to base metal. However the tube to fitting interface may not be modified in any manner.

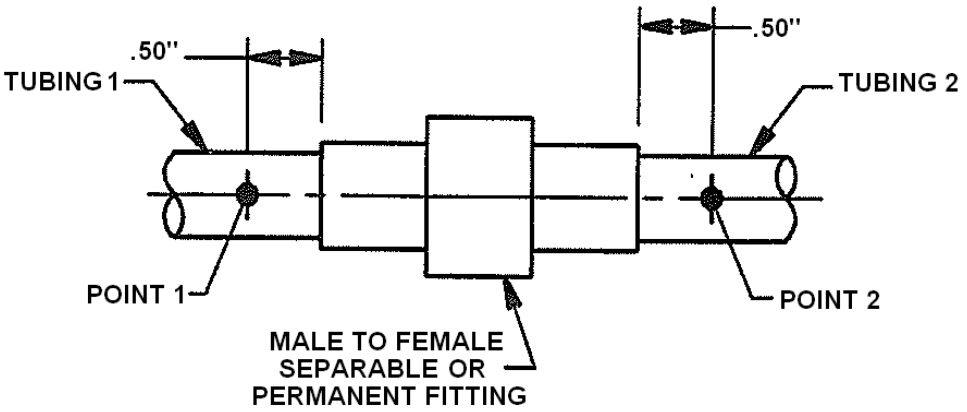


FIGURE 2 – ELECTRICAL BONDING TEST SETUP

4.13 Torsion Test

This test is intended to verify that the fitting or coupling assembly will not leak after the displacement of the tube or the tube-fitting joint through the application of torque. The test is used to simulate assembly conditions that could occur during service.

Assemble fittings using the torque values specified in the procurement specification.

Scribe or draw a line along the length of the assembly to be tested, crossing the tube-fitting interface at tested and either end. This line is to be used to detect slippage or twisting of the assembly.

Clamp one end of the assembly into a test fixture or vise and apply increasing moments on the free end of the specimen using a dial-indicator type torque wrench. Continue loading until tube slippage in the fitting or twisting of at least 5° occurs between the two ends of line across the assembly, or after a maximum torque of 400 Ft-Lbs$_f$ is applied. After twisting or slippage, subject the assembly to pneumatic and proof tests.

5. TEST SPECIMENS AND TEST FLUID

5.1 Test Specimens

Unless otherwise specified by the purchaser, the tube specimens shall be as illustrated in Figure 3. Specimen lengths for the various tests shall be as shown in Table 1A or Table 1B.

5.2 Test Fluid

Unless otherwise specified, tests shall be conducted using a petroleum base or synthetic hydraulic fluid for Types I and II system fititngs and a silicate ester base hydraulic fluid for Type III system fittings (see AS2001). Water may be used, whenever practical, for proof, burst, stress corrosion, and repeated assembly (reuse) testing. Dry compressed air or nitrogen shall be used for the pneumatic leak tests. Leakage and proof tests for pneumatic system applications shall be conducted with air or nitrogen.

Test fluids shall be in accordance with the following specifications:

a. AS1241

b. ASTM D 471

c. MIL-PRF-5606

d. MIL-DTL-5624

e. MIL-PRF-7808

f. MIL-PRF-83282

5.3 Cleaning Fluid

Cleaning fluids shall be in accordance with the following specifications:

a. MIL-C-81302

b. MIL-PRF-680

c. TT-I-735

5.4 Test Temperature

Tests shall be conducted at room temperature, unless otherwise specified.