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400 COMMONWEALTH DRIVE WARRENDALE, PA 15096

# AEROSPACE INFORMATION REPORT

**AIR 1378A**  
Superseding AIR 1378

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## STANDARD WORDS FOR TEST PARAGRAPHS FOR TUBE FITTINGS AND TUBE ASSEMBLIES

1. **SCOPE:** This Aerospace Information Report (AIR) is written as a guide for the wording recommended for use, when applicable, in design and procurement specifications for tube fittings and tube assemblies, both for general aerospace fluid power applications and for specific applications.

- NOTES:**
1. A comprehensive writeup of the Impulse, Flexure and Fire Tests is included in Appendix A, Section 3.
  2. The companion metric documents are indicated in Appendix B, Section 4.

- 1.1 **Index:** This document contains the recommended standard words for the following test paragraphs:

Burst Pressure	-	See 2.1
Fire	-	See 2.2
Flexure	-	See 2.3
Impulse	-	See 2.4
Pneumatic Leakage	-	See 2.5
Proof Pressure	-	See 2.6
Repeat Connection	-	See 2.7
Stress Corrosion	-	See 2.8
Tensile Strength	-	See 2.9
Thermal Shock	-	See 2.10

## 2. PROPOSED STANDARD WORDS FOR TEST PARAGRAPHS:

### 2.1 Burst Pressure:

- 2.1.1 **Requirement:** The test assembly shall not rupture or show evidence of leakage at any pressure up to and including the specified burst pressure of the system (see X.X.X) when tested in accordance with X.X.X. Tubing expansion is permissible.

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2.1.2 Procedure: The test assembly shall be connected to a source of pressure with one end free to move. The pressure shall be increased at a rate of 20,000 psi  $\pm$  5000 (138,000 kPa  $\pm$  34,000) per minute until the assembly bursts, leaks or reaches the specified burst pressure. One half of the assemblies shall be tested at room temperature and the other half at the maximum rated temperature. For Type I system testing, the maximum rated temperature testing shall be conducted at room temperature. It is not essential that the assembly actually be pressurized to burst, but it must be capable of withstanding four times nominal system operating pressure at the specified temperature extremes. (See Figure X for typical test setup.)

## 2.2 Fire:

2.2.1 Requirement: The test assembly shall withstand a 2000°F (1093°C), 4500 BTU/HR. (1320 watts) flame for 15 minutes if rated fireproof (5 minutes if rated fire resistant) when tested in accordance with X.X.X. Heat input shall be measured by a 1/2-inch (12.7-mm) copper tube per AIR 1377. There shall be no leakage detected by visual observation or failure of the test assembly prior to the specified time.

2.2.2 Procedure: The test assembly shall be tested in accordance with the test procedure for AS 1055 for the applicable type and class requirement. Equipment used for this test shall be in accordance with AIR 1377.

NOTE: A comprehensive writeup of this test is included in the Appendix.

## 2.3 Flexure:

2.3.1 Requirement: The test assembly shall not exhibit leakage from the fitting or the fitting-tube junction before completing the number of cycles, at the test level specified, required per ARP 1258 when tested in accordance with X.X.X. If ARP 1258 does not provide specific requirements, a group of assemblies may be tested similar to MIL-F-18280 to a minimum stress level for 10 million cycles without failure.

2.3.2 Procedure: The test assembly shall be tested per ARP 1258. The testing procedure shall be in accordance with ARP 1185.

NOTE: A comprehensive writeup of this test is included in the Appendix.

## 2.4 Impulse:

2.4.1 Requirement: The test assembly shall withstand 200,000 impulse pressure cycles without leakage from the fitting or the fitting-tube junction when tested in accordance with X.X.X.

2.4.2 Procedure: The test assembly shall be tested in accordance with ARP 603.

NOTE: A comprehensive writeup of this test is included in the Appendix.

**2.5 Pneumatic Leakage:**

2.5.1 Requirement: The test assembly shall withstand pneumatic pressure equal to the nominal operating pressure for five minutes at room temperature without any visible air bubbles after one minute at pressure when tested in accordance with X.X.X.

2.5.2 Procedure: The test assembly shall be tested at room temperature at a value equal to the nominal operating pressure for a minimum period of five minutes while submerged under water. The test fluid shall be dry compressed air or nitrogen. The test assemblies shall be prepared without use of oil during assembly and shall be solvent cleaned and air dried prior to testing.

**2.6 Proof Pressure:**

2.6.1 Requirement: The test assembly shall withstand pressure equal to twice the nominal pressure of the system (see X.X) for five minutes without leakage, evidence of permanent deformation, or, in the case of separable connectors, other malfunction that would affect assembly or disassembly using the specified range of torque values when tested in accordance with X.X.X.

2.6.2 Procedure: Test assemblies shall be connected to a source of pressure with one end free to move and proof pressure tested at a value equal to two times the nominal system operating pressure for a minimum period of five minutes. Rate of pressure rise shall be 20,000 psi  $\pm$  5000 (138,000 kPa  $\pm$  34,000) per minute. The test shall be conducted at room temperature.

**2.7 Repeated Connection:**

2.7.1 Requirement: The test assembly shall withstand YY repeated connections at the manufacturer's recommended minimum and maximum torque values when tested in accordance with X.X.X., without:

1. Pneumatic leakage at any of the proof pressure tests.
2. Leakage or burst at a value less than four times the nominal operating pressure during the burst pressure testing.
3. Inability to reassemble the fitting to the point of interface by hand.
4. Nut deformation preventing engagement of nut hex with open end wrench.
5. Visible damage to any seals used in the correction.

2.7.2 Procedure: The test assembly shall be tested with one end torqued to maximum torque and the other end torqued to minimum torque per manufacturer's recommendation with no additional lubricant permitted for the first tightening. Each connection shall then be disconnected, with

## 2.7.2 Continued:

the sealing face then rotated 60 to 90 degrees, the fitting then lubricated with MIL-H-5606, or MIL-H-83282, hydraulic fluid and retorqued to the original torque a total of YY times. Every eight cycles the assembly shall be subjected to the Pneumatic Leakage Test. Assemblies may require cleaning before being tested with high pressure oil. After the last tightening, the assembly shall be subjected to the burst pressure test per paragraph X.X.X. No additional lubricant, other than MIL-H-5606 or MIL-H-83282, permitted at any point during test.

The test fixture shall be such as to assure that all forces to join the assembly are induced into the joint assembly.

Assemblies incorporating elastomeric seals shall reuse the seals unless the use of new seals is specified after each use.

## 2.8 Stress Corrosion:

2.8.1 Requirement: The test assembly shall withstand 50 hours of salt spray exposure when tested in accordance with X.X.X without:

1. Indication of cracking or pitting of the exposed surfaces of fittings and tubing within one diameter of end fitting greater than that exhibited on the remainder of the tubing when visually examined with 10 power magnification.
2. Leakage or burst at a value less than the specified burst pressure.
3. Indications of inter- or transgranular corrosive attack during metallurgical examination of longitudinal and transverse sections of the fitting and fitting-tube junction.

2.8.2 Procedure: The test assembly shall be installed in a test fixture which imposes a calculated (using nominal outside tube dimensions) bending stress level equal to  $85 \pm 5\%$  tubing yield strength minimum (per applicable tubing specification) at the tubing/fitting assembly interface. The test assembly with an internal pressure equal to the nominal system operating pressure and without removing the bending stress shall then be subjected to the standard salt spray test per Federal Test Method Standard No. 151, Method 811.1, for 50 hours.

After exposure, the assembly shall be subjected to the burst pressure test at room temperature. The tube fitting joint shall then be cleaned and metallurgically examined, including sectioning of fitting and tubing.

## 2.9 Tensile Strength:

2.9.1 Requirement: The test assembly shall withstand a tensile load equal to or greater than the burst pressure times the area of tubing based on nominal O.D., without leakage at the fitting-tube junction when tested in accordance with X.X.X.

2.9.2 Procedure: The test assembly shall be mounted in a tensile test machine. Pressure equal to the system operating pressure shall be applied and maintained. The tensile loading shall be increased at a head travel rate of  $0.15 \pm 0.10$  in./min ( $3.8 \pm 2.4$  mm/min) until failure is obtained.

2.10 Thermal Shock:

2.10.1 Requirement: The test assembly shall not leak or burst during temperature and pressure cycling from the minimum system temperature to the maximum system temperature when tested in accordance with X.X.X.

2.10.2 Procedure:

- A. The test assembly shall be mounted in an environmental chamber, connected to a pressure source and completely filled with the specified test fluid. See Figure X for typical test setup.
- B. The test assembly shall be pressurized to the maximum system operating pressure and the ambient temperature raised to the maximum temperature requirement for the specified system and held at this temperature for a minimum of two hours. At the end of this period, while still at temperature, the hot test fluid shall be released and replaced within 20 seconds with test fluid at the minimum temperature requirement of the specified system. Then, within an additional 20 seconds, the fluid pressure shall be raised to 2 times the maximum system operating pressure and maintained at this pressure for one minute and then reduced to a maximum of 100 psi (700 kPa) for an additional one-minute period. During the two one-minute pressurization periods, the assembly shall be checked for leakage or indication of malfunction. Restabilize the test system to room temperature.
- C. The test assembly shall then be pressurized to the maximum system operating pressure and the ambient chamber temperature lowered to the minimum temperature requirement of the specified system and held at this temperature for a minimum of two hours. At the end of this period, while still at low temperature, the cold fluid shall be released and replaced within 20 seconds with test fluid at the maximum temperature requirement of the specified system; and within an additional 20 seconds, the fluid pressure shall be raised to 2 times the maximum system operating pressure. This pressure shall be maintained for one minute while checking the test assemblies for leakage or indication of malfunction.

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## 2.10.2 Continued:

D. Repeat testing per paragraphs B and C in sequence for a total of three times.

## 3. APPENDIX A: The following Standard Word Paragraphs are recommended:

Fire Test	See 3.1
Flexure Test	See 3.2
Impulse Test	- See 3.3

### 3.1 Fire:

3.1.1 Requirement: See Paragraph 2.2.1.

3.1.2 Procedure: The test assembly shall be mounted in a horizontal plane that lies on the axis of the burner.

The portion of the flame in which the assembly is to be tested shall deliver a minimum heat output of 4500 BTU per hour (1320 watts) as measured by a 1/2-inch (12.7 mm) copper tube mounted per AIR 1377. Width of the flame shall be such that the 2000°F (1100°C) temperature shall occur (as measured by thermocouple) for a minimum distance of eight inches (203 mm). The entire fitting connection, plus a length of tubing shall be subjected to the flame. During the test, the end connection subjected to the flame shall be subjected to inline vibration at the rate of 2000 cycles per minute through a total amplitude of not less than 1/8 inch (3.2 mm) i.e. a displacement of 1/16 inch (1.6 mm) each side of the neutral position. The assembly shall be tested with SAE No. 20 oil at a flow rate in gallons per minute equal to  $1 \times I.D.^2$  measured in inches (flow rate in liters per minute equal to  $1 \times 59 \times I.D.^2$  measured in centimetres). Test pressure shall be equal to the rated system pressure, and the oil temperature shall be 200° - 230°F (93° - 110°C).

### 3.2 Flexure:

3.2.1 Requirement: When tested with cold worked corrosion resistant steel tubing, the test assembly shall withstand ten million flexure cycles at a combined stress level as specified, composed of stresses due to bending, system pressure and dynamic load.

Fitting assemblies of other materials and tubing shall perform as well as, or better than a similar group of test assemblies with cold worked corrosion resistant steel tubing when:

A. Tested to failure and their flexure test performance, expressed as deflection, is compared, or when

B. Tested for ten million cycles to a value equivalent to that of 304 1/8 hard tubing.