SAE Aerospace
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AEROSPACE STANDARD

SAE AS5620
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Titanium Hydraulic Tubing, Ti-3Al-2.5V Cold Worked and Stress Relieved, Up to 35,000 kPa (5080 psi) and 200 °C (400 °F) Requirements for Qualification Testing and Control

1. SCOPE:

This Aerospace Standard shall be used in conjunction with AMS 4946 to provide requirements for qualification testing and for Qualified Products Listing (QPL) and Qualified Manufacturer Listing (QML) for Ti-3Al-2.5V cold worked and stress relieved hydraulic system tubing. The basic tubing shall comply with the requirements of AMS 4946.

1.1 Classification:

The AMS 4946 Type designations for this tubing are repeated here for reference.

1.1.1 Types:

Type I - Tubing with 105 ksi (724 MPa) minimum yield strength

Type II - Tubing with 95 ksi (655 MPa) minimum yield strength

Type III - Tubing with 70 ksi (433 MPa) minimum yield strength

2. 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 standard and references cited herein, the text of this standard takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
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SAE WEB ADDRESS: **http://www.sae.org**

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096 (www.sae.org)

ARP603	Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies
AS4265	Impulse Testing of Hydraulic Tubing and Fittings, S-N Curve
AS4444	Fittings, 24 Degree Cone, Flareless, Fluid Connection, 5000 psi
AS7003	National Aerospace and Defense Contractors Accreditation Plan
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components
AS7112/6	National Aerospace and Defense Contractors Accreditation Program, Requirements for Titanium Hydraulic Tubing
AS18280	Fittings, 24 Degree Cone, Flareless, Fluid Connection, 3000 psi
AS33611	Tube Bend Radii
AS85421	Fittings, Tube, Fluid Systems, Separable, Beam Seal, 3000/4000 psi, General Specification for
AS85720	Fittings, Tube, Fluid Systems, Separable, High Pressure, Dynamic Beam Seal, General Specification for
AMS 4946	Titanium Alloy Tubing, Seamless, Hydraulic, 3Al - 2.5V, Texture Controlled, Cold Worked, Stress Relieved

2.2 PRI Publications

Available from Performance Review Institute, 161 Thornhill Road, Warrendale, PA 150086-7527 (www.pri.sae.org)

PD 2001	Qualified Product Management Council Procedures for Qualified Products Group
PD 2101	Aerospace Quality Assurance, Product Standard, Qualification Procedure, Fluid Systems

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094 (http://assist.daps.dla.mil).

MIL-HDBK-831 Preparation of Test Reports

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

Tubing supplied under this Aerospace Standard shall meet all requirements specified in AMS 4946, and the hydraulic qualification test requirements of this specification.

3.1.1 Manufacturer Qualification: A manufacturer producing a product in conformance with this procurement specification shall be accredited in accordance with the requirements of PD 2101, AS7003, AS7112, and AS7112/6. The accredited manufacturer shall be listed in a Performance Review Institute (PRI) Qualified Manufacturer 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 PD 2001, and PD2101, for listing in a Performance Review Institute (PRI) Qualified Part List.

3.1.3 Configuration Control: All products shall conform to the materials and procedures used for fabricating qualification test samples. All changes shall be reported to PRI, major changes require approval by PRI prior to implementation. Examples for major changes:

a. Source of supply of starting (raw) material

b. Acceptance criteria and conditioning practice for tube hollows

c. Reduction schedule, number of reduction steps, and total reduction achieved during cold working

NOTE: Change in reduction of up to 5% of total reduction is considered a minor change

d. Heat treatment parameters and pyrometry procedures

e. Inspection methods - Ultrasonic and surface roughness

3.2 Burst and Flexure Test:

The tubing shall meet hydraulic burst and flexure test requirements as specified in AS4444, AS18280, AS85720, or AS85421.

NOTE: The AS4444, AS18280, AS85720, and AS85421 refer to different fitting designs. The basic hydraulic qualification test methods are the same for these fittings.

3.3 Hydraulic Impulse Test:

3.3.1 Tube Bends, Qualification: Bent tube assemblies as shown in Figure 1 or Figure 2 shall not show leakage after 400,000 cycles when tested in accordance with ARP603.

3.3.2 Straight Tubing, S-N Testing: Sinusoidal impulse testing may be conducted to establish impulse fatigue properties and verify impulse fatigue performance. Testing shall be conducted in accordance with AS4265 except that the cyclic rate may be 15 Hz using straight tube specimens as shown in Figure 3. S-N test data is to be reported and approved by user. Such data may be used in periodic control testing (4.2.3) to verify that impulse fatigue properties are the same as of the tubing that was initially qualification tested.

Notes:

1. In the event of a fitting leakage, or of tube leakage within one half inch from the sleeve or weld connection, the fitting may be replaced and testing of tube bends continued.

2. Testing of coils may require different bend radii and qualification tests, as specified by the user.

3. Qualification testing of tubing for nominal pressures of 2000 psi and 4000 psi in military applications may be based on qualification testing of straight tubes, without bends, using fittings to AS85720 or AS85421, and testing to 200,000 cycles.

S-N Testing is useful for evaluating fatigue properties of tube material, tube fabrication, and finishing methods.

3.4 Composition:

Shall conform to AMS 4946.

3.5 Melting Practice:

Shall conform to AMS 4946.

3.6 Conditon:

Shall conform to AMS 4946.

3.7 Properties:

Shall conform to AMS 4946.

3.7.1 Tensile Properties: Shall conform to AMS 4946.

3.7.2 Flarability: Shall conform to AMS 4946.

3.7.3 Bending: Shall conform to AMS 4946.

3.7.4 Flattening: Shall conform to AMS 4946.

3.7.5 Microstructure: Shall conform to AMS 4946.

3.7.6 Contractile Strain Ratio (CSR): Shall conform to AMS 4946.

NOTE: Class III tubing shall conform to AMS 4946 except that Class III tubing does not require CSR measurement

3.7.7 Ultrasonic: Shall conform to AMS 4946

NOTE: Ultrasonic testing shall conform to AMS 4946 with the following exception - Indications equal to or greater than one half of the established reject amplitude shall be further evaluated for disposition

3.8 Quality:

Shall conform to AMS 4946.

3.9 Tolerances:

Shall conform to AMS 4946.

TABLE 1 - Hydraulic Tubing Used in Various Pressure Classes

Nominal Tube Outer Diameter	Tube Wall Thickness	Material Type	Nominal Pressure
0.250	0.016	Type II	3000
0.250	0.018	Type I	4000
0.250	0.022	Type I	5000
0.250	0.022	Type II	5000
0.250	0.028	Type III	5000
0.250	0.042	Type III	Coil / 5000
0.375	0.019	Type I	3000
0.375	0.022	Type I	2000
0.375	0.028	Type I	4000
0.375	0.032	Type I	5000
0.375	0.042	Type I	Coil / 5000
0.500	0.022	Type I	2000
0.500	0.026	Type I	3000
0.500	0.035	Type I	4000
0.500	0.043	Type I	5000
0.500	0.056	Type I	Coil / 5000
0.625	0.023	Type I	2000
0.625	0.032	Type I	3000
0.625	0.044	Type I	4000
0.625	0.054	Type I	5000
0.750	0.027	Type I	2000
0.750	0.039	Type I	3000
0.750	0.052	Type I	4000
0.750	0.065	Type I	5000
0.875	0.032	Type I	2000
0.875	0.061	Type I	5000
1.000	0.036	Type I	2000
1.000	0.051	Type I	3000
1.000	0.070	Type I	4000
1.000	0.088	Type I	5000
1.250	0.045	Type I	2000
1.250	0.070	Type I	3000
1.250	0.087	Type I	4000
1.250	0.105	Type I	5000
1.500	0.054	Type I	2000
1.500	0.125	Type I	5000

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The supplier of the product shall be responsible for performing all acceptance tests required under 3.4 through 3.9. Results of such tests shall be reported to the purchaser as required under 4.4. The purchaser has the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Qualification Tests: Each size and wall thickness of hydraulic tubing listed in Table 1 shall be inspected to Technical Requirements of AMS 4946 and impulse tested as specified under 4.3, unless the user specifies other tests and qualification testing in fitting assemblies.

4.2.2 Acceptance Tests: All technical requirements under 3.4 through 3.9 are acceptance tests and shall be performed in accordance with AMS 4946.

4.2.3 Periodic Tests: Hydraulic impulse testing per ARP603 or S-N testing to AS4265 (3.3) should be conducted by the user at a frequency selected by the user.

4.3 Sampling and Hydraulic Test Methods:

Sampling for Technical Requirement tests shall be in accordance with AMS 4946. Test specimen numbers and test methods for hydraulic testing shall be as follows:

4.3.1 Qualification Testing:

4.3.1.1 Tube Assembly Qualification Test: Tests of tubing in the lengths and quantities as specified in AS4444, AS18280, AS85720, AS85421 (See 3.2)

4.3.1.2 Hydraulic Impulse Test: Qualification testing shall be performed on six 160 degree bent U-shaped specimens, bent to a radius as shown in Figure 1, and to dimensions in Table 2; or on three S-shaped specimens each having two 160 degree bends as shown in Figure 2 and to the dimensions shown in Table 2. Tests are to be conducted at room temperature. Specimens shall be fabricated from different tubes in the lot (See 3.3.1).

4.3.1.3 S-N Testing: Qualification S-N testing shall be in accordance with AS4265. Specimens shall be as shown in Figure 3 and Table 2, and shall be tested at room temperature in quantites as specified in AS4265. Specimens shall be fabricated from different tubes in the lot (see 3.3.2).

4.3.2 Periodic Testing: Periodic impulse testing to ARP603 shall be done using two S-shaped specimen or four U -shaped specimens. Periodic tests to AS4265 may be conducted using three specimens each at two stress levels selected by the user or PRI.

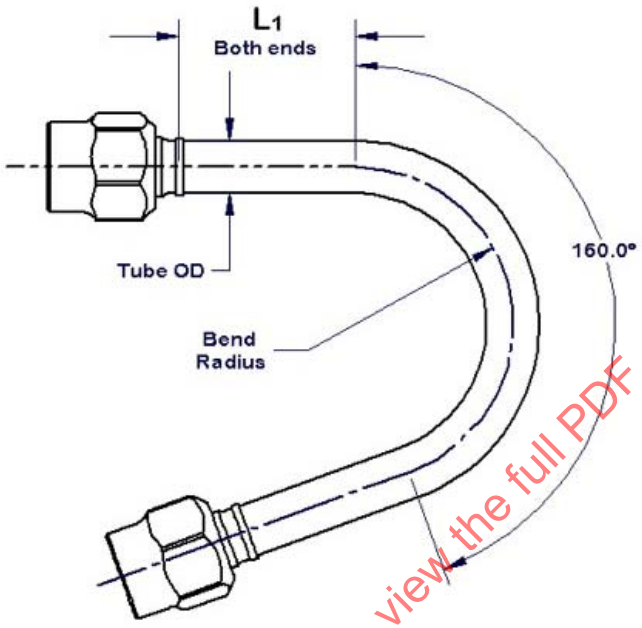

FIGURE 1 - ARP603 Impulse Test Specimen, U-Shape