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Superseding AS4459A	

(R) Fittings, Tube, Fluid System
3000 psig (21 000 kPa) Rated Pressure,
Externally Swaged, Specification For

RATIONALE

Complete update of the procurement specification to prepare for QPL listing of part standards listed in Table 10 including corrections of material specification numbers, tube materials, wall thicknesses in Table 7, description of back-up seal, and updating quality conformance plans.

1. SCOPE

This SAE Aerospace Standard (AS) establishes the requirements for externally swaged tube-fitting assemblies used in aircraft fluid systems in the following pressure classes: B (1500 psi or 10 500 kPa), and D (3000 psi or 21 000 kPa), and in temperature types I (-65 to 160 °F or -55 to 70 °C), and II (-65 to 275 °F or -55 to 135 °C) of AS2001.

This specification covers a common Cres, titanium, and aluminum fittings that may be used for a range of operating pressures up to 3000 psi with different tubing materials and tubing wall thicknesses, and is assembled with the same tooling in accordance with AS5902. Table 10 shows applicable aerospace fitting part number standard and tubing materials and operating pressures.

1.1 Classification

Fittings shall be of the following types and system pressure classes as specified:

Classes:

Class B (1500 psi): Maximum supply pressure is 1500 psig (10 500 kPa).

Class D (3000 psi): Maximum supply pressure is 3000 psig (21 000 kPa).

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 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.

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2.1 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.

AMS2700	Passivation Treatments for Corrosion-Resistant Steel
AMS4083	Tube, Aluminum Alloy, Seamless, Round, Drawn 6061, Aircraft Hydraulic Quality
AMS4117	Aluminum Alloy 6061, Bar, Rod, Wire, and Special Shapes; Rolled, Drawn, or Cold Finished
AMS4127	Aluminum Alloy, Forgings, Heat Treated
AMS4921	Titanium Bars, Forgings, and Rings, Annealed, 70,000 psi Yield Strength
AMS4945	Titanium Alloy Tubing, Seamless Hydraulic 3Al - 2.5V, Texture Controlled, 105,000 psi (724 MPa) Yield Strength
AMS5561	Steel Tubing, Welded and Drawn Corrosion Resistant, 9Mn - 20Cr - 6.5Ni - 0.27N High Pressure Hydraulic
AMS5569	Tubing, Steel, Corrosion Resisting (304) Aerospace Vehicle Hydraulic System, 1/8 Hard Condition
AMS5656	Steel Bars, Forgings, and Rings, Corrosion Resistant 9.0Mn - 20Cr - 6.5Ni - 0.27N
AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS1376	Wrench Pads for Fluid Fittings Machined from Alternate Shapes of Material
AS2001	Aerospace Fluid Systems and Components - Pressure and Temperature Classifications
AS2094	Test Methods for Tube-Fitting Assemblies
AS4215	Fitting, Adapter, Beam Seal, External Thread, Eexternal Swage Tube End, Hydraulic, 3000 psi
AS4217	Fitting, Adapter, Beam Seal, Bulkhead, External Swage Tube End, Hydraulic, 3000 psi
AS4218	Fitting, Elbow, 45 Degree, Beam Seal, External Thread, External Swage Tube End, Hydraulic, 3000 psi
AS4219	Fitting, Elbow 45 Degree, Beam Seal, Bulkhead, External Swage Tube End, Hydraulic, 3000 psi
AS4225	Fitting, Elbow, 90 Degree, Beam Seal, External Thread, External Swage Tube End, Hydraulic, 3000 psi
AS4226	Fitting, Elbow, 90 Degree, Beam Seal, Bulkhead, External Swage Tube End, Hydraulic, 3000 psi
AS4234	Fitting, Adapter, Beam Seal, Swivel Nut, External Swage Tube End, Hydraulic, 3000 psi
ARP4784	Performance and Evaluation Criteria, Surface Defects, Requirements

AS5008	Fitting, Union, External Swage, Hydraulic, 3000 psi
AS5009	Fitting, Elbow, 90 Degree, External Swage, Hydraulic, 3000 psi
AS5010	Fitting, Tee, External Swage, Hydraulic, 3000 psi
AS5011	Fitting, Cross, External Swage, Hydraulic, 3000 psi
AS5012	Fitting, Sleeve, Straight, Flared, External Swage, Hydraulic, 3000 psi
AS5013	Fitting, Adapter, Straight, Flareless, External Swage, Hydraulic, 3000 psi
AS5014	Fitting, Sleeve, Straight, Flareless, External Swage, Hydraulic, 3000 psi
AS5266	Fitting, Adapter, Straight, Flared, External Swage, Hydraulic, 3000 psi
AS5267	Fitting, Adapter, Straight, Flareless, External Swage, Hydraulic, 3000 psi
AS5902	Installation of Externally Swaged Fittings
AS6468	Fitting, 45° Elbow, Female Flareless, External Swage, Hydraulic, 3000 psi
AS6469	Fitting, 90° Elbow, Male Flareless, Bulkhead Sealing, External Swage, Hydraulic, 3000 psi
AS6470	Fitting, Tee, Male Flareless on The Side, External Swage on The Run, Hydraulic, 3000 psi
AS6471	Fitting, Tee, External Swage, Female Flareless on the Run, External Swage on the Side, Hydraulic, 3000 psi
AS6472	Fitting, Union, Bulkhead, External Swage, Hydraulic, 3000 psi
AS6473	Fitting, 90° Elbow, Male Flareless, External Swage, Hydraulic, 3000 psi
AS6474	Fitting, Union, Bulkhead Sealing, External Swage, Hydraulic, 3000 psi
AS6475	Fitting, 90° Elbow, Female Flareless, External Swage, Hydraulic, 3000 psi
AS6478	Fitting, Adapter, Straight, Bulkhead Flareless, External Swage, Hydraulic, 3000 psi
AS6482	Fitting, Tee, Bulkhead Flareless on The Side, External Swage on the Run, Hydraulic, 3000 psi
AS6483	Fitting, Adapter, Straight, Welded Flange, Male Flareless, External Swage, Hydraulic, 3000 psi
AS6484	Fitting, 90° Elbow, Bulkhead Flareless, External Swage, Hydraulic, 3000 psi
AS6485	Fitting, Tee, External Swage, Male Flareless on the Run, External Swage on the Side, Hydraulic, 3000 psi
AS6486	Fitting, 45° Elbow, Bulkhead Flareless, External Swage, Hydraulic, 3000 psi
AS6487	Fitting, Adapter, Bulkhead Sealing, Flareless, External Swage, Hydraulic, 3000 psi
AS6488	Fitting, Tee, External Swage, Bulkhead Flareless on the Run, External Swage on the Side, Hydraulic, 3000 psi
AS6489	Fitting, Tee, External Swage on the Run, Female Flareless on the Side, Hydraulic, 3000 psi

AS6490	Fitting, Elbow, 45°, External Swage, Hydraulic, 3000 psi
AS6491	Fitting, 45° Elbow, Female Flared, External Swage, Hydraulic, 3000 psi
AS6492	Fitting, Adapter, Straight, Flanged Sealing, Male Flareless, External Swage, Hydraulic, 3000 psi
AS6493	Fitting, Tee, Female Flareless, External Swage on the Run, Male Flareless on the Side, Hydraulic, 3000 psi
AS6494	Fitting, Tee, Female Flareless, Male Flareless on the Run, External Swage on the Side, Hydraulic, 3000 psi
AS7003	National Aerospace and Defense Contractors Accreditation Program (NADCAP)
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components
ARP9013	Statistical Product Acceptance Requirements

2.2 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 (Surface Roughness, Waviness, and Lay)
ANSI/ASME Z1.4	Sampling Procedures & Tables for Inspection by Attributes

2.3 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 E8	Tension Testing for Metallic Materials
ASTM E1417	Standard Practice for Liquid Penetrant Inspection
ASTM E112	Standard Test Methods for Determining Average Grain Size

2.4 PRI Publications

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

PD2001	Qualified Product Management Council Procedures for Qualified Products Group
PD2101	Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

2.5 U.S. Government Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>.

FED-STD-595	Colors
MIL-DTL-5541	Chemical Conversion Coating on Aluminum and Aluminum Alloys
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance (Inactive for New Design as of 29 March 1996)
AMS-H-81200	Heat Treatment of Titanium and Titanium Alloys
MIL-PRF-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Testing
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base
MIL-PRF-87257	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-HDBK-831	Preparation of Test Reports

3. TECHNICAL REQUIREMENTS

3.1 Qualification

Fittings 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 standard.

3.1.1 Manufacturer Qualification

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of PD2101, AS7003, and AS7112, 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).

3.2 Materials

Fittings shall be manufactured from materials listed in Table 1 as specified on the applicable AS standard.

3.2.1 Aluminum Alloy

Fittings shall be manufactured from material per Table 1 except that the tensile yield strength shall be in the range of 28 000 to 33 000 psi (193 053 to 227 527 kPa) (intermediate temper, sometimes referred to as -T7). Overaging to this strength level may be accomplished as a separate process or in a combination with the PTFE (polytetrafluoroethylene) curing operation. Material code letter is "D".

3.2.2 Commercially Pure (CP) Titanium

Titanium fittings shall be manufactured from material per Table 1 except that tensile yield strength shall be within the range of 70 000 to 95 000 psi (482 633 to 655 002 kPa) with a grain size of ASTM # 5 or finer in accordance with ASTM E112. In addition, material of fittings may be vacuum annealed to remove excess hydrogen. Hydrogen content in finished parts shall not exceed 30 ppm in either forged or bar stock fittings. Oxygen equivalency shall not exceed 0.47 as defined in Equation 1. Fitting surfaces shall be clean and free from contaminants. Vacuum annealing shall meet all applicable requirements of AMS-H-81200. Material code letter is "E".

$$O_{eq} = O + 2N + Fe / 4 + 2C / 3 \quad (\text{Eq. 1})$$

3.2.3 Corrosion Resistant Steel 21-6-9

Fittings shall be manufactured from material per Table 1 except that they shall be fully annealed and the tensile yield strength shall not exceed 65 000 psi (448 159 kPa). The material code letter is "-".

TABLE 1 - MATERIALS

Fitting Type	Material	Form	Specification
Straight (Couplings)	Aluminum Alloy	Bars	AMS4117 (6061) (see 3.2.1)
Straight (Couplings)	Com. Pure Titanium	Bars	AMS4921 (see 3.2.2)
Straight (Couplings)	CRES (21-6-9)	Bars	AMS5656 (see 3.2.3)
Shapes	Aluminum Alloy	Forgings	AMS4127 (6061) (see 3.2.1)
Shapes	Com. Pure Titanium	Forgings	AMS4921 (see 3.2.2)
Shapes	CRES (21-6-9)	Forgings	AMS5656 (see 3.2.3)

3.2.4 Tube Requirements

Tubing utilized in the qualification program shall conform to the specifications listed in Table 7.

3.3 Design and Dimensions

Design and dimensions shall be such that fittings will meet all requirements of this specification and the associated aerospace standard part drawings.

3.4 Fabrication

3.4.1 Fluid Passages

3.4.1.1 Drill Offset

In the run, tees where the fluid passage is bored from each end, the offset between the bores at the meeting point shall not exceed 0.015 inch. A sphere with a 0.020 smaller diameter shall be capable of traversing the bore intersection. The cross sectional area of the bore junction of angle fittings shall not be less than the cross-sectional area of the smaller passage. The mismatch in straight couplings shall be controlled such that a maximum OD tube (nominal + tolerance) will pass through the entire fitting.

3.4.2 Finish

As specified in the associated aerospace standard part drawings.

3.4.2.1 Aluminum Alloy and CP Titanium Fittings

Aluminum alloy fittings shall be chemical film coated per MIL-DTL-5541 on all surfaces prior to application of elastomeric seals or PTFE coating.

Fittings shall be inspected to ensure that the chemical film coating is properly applied so that PTFE adhesion occurs. Aluminum and titanium fittings shall be coated with PTFE to a baked film thickness of 0.0005 to 0.0015 inch (0.0127 to 0.0381 mm). All external metal surfaces shall be coated and the fitting bore or swaged ends shall be coated to the depth specified in the applicable aerospace standard part drawings.

3.4.2.2 Corrosion Resistant Steel 21-6-9

21-6-9 corrosion resistant steel fittings shall be PTFE coated to a baked film thickness of 0.0005 to 0.0015 inch (0.0127 to 0.0381 mm). The fitting bore of the swaged end only shall be coated to the depth specified in the applicable aerospace standard part drawings. 21-6-9 corrosion resistant steel fittings shall be passivated in accordance with AMS2700.

3.4.2.3 Coating Color

PTFE coatings shall be pigmented as follows:

- a. Aluminum Alloy: Light green (to approximate color numbers 14272 or 24190 of FED-STD-595)
- b. Titanium: Black
- c. CRES 21-6-9: Green as for aluminum alloy

3.4.2.4 Backup Sealing

The fitting bore shall be enforced with heat cured elastomeric Dimethyl siloxane as an additional backup seal. The elastomeric compound shall be cured at a temperature that does not have adverse effect on the fitting material properties, and shall have a Durometer of (54A-60A) and tensile strength of 800 to 1150 psi (5516 to 7930 kPa). The elastomeric compound shall be filled and completely bonded in the internal grooves of the fitting ends. The bonded elastomeric seal level shall be determined using the following "Go Gage" values below (e.g., a plug gage with a diameter equals to the maximum tube diameter (Go Gage) shall be possible to pass through the fitting/ring assembly prior to swage with some friction but not causing any damage to the seal). A minimum of one groove shall be filled with elastomeric Dimethyl siloxane compound for Cres and Titanium fittings. Aluminum fittings shall have a minimum of two grooves filled with the sealing compound as specified on the aerospace standard part drawing.

Tube Size (inch)	Go Gage Diameter (inch)	NO Go Gage Diameter (inch)
3/16	0.188	0.193
1/4	0.250	0.255
5/16	0.313	0.318
3/8	0.375	0.380
1/2	0.500	0.506
5/8	0.625	0.631
3/4	0.750	0.756
1	1.000	1.006
1-1/4	1.250	1.256
1-1/2	1.500	1.511

3.5 Identification of Product

All parts shall be identified in accordance with the instructions specified in 3.5.1, 3.5.2, 3.5.3, and 3.5.4.

3.5.1 AS Standard Symbol and Manufacturer's Trademark

Unless otherwise specified, all fittings shall be marked with the letters "AS" or AS part number. If space permits, the manufacturer's name, Cage Code, or trademark, manufacturer's part number and lot number. Fitting forging blanks shall be marked with the forging's manufacturer's trademark, code number, or letter to identify forging source. Forgings shall also be marked with raw material lot control number and job number.

3.5.2 Marking for Part Number and Size

A numerical equivalent to the dash number indicating size shall be used. All fittings shall be marked with the part number. See part standards for coding.

3.5.3 Material Identification

Corrosion resistant steel fittings shall be marked with the letter "-" (dash) if manufactured from 21-6-9, or the letter "D" shall be used if manufactured from 6061 aluminum alloy. The letter "E" shall be used if produced from commercially pure titanium.

3.5.4 Size, Method, and Location of Marking

Marking shall be accomplished per those permanent methods listed in AS478 which do not cause surface oxidation or other detrimental effects. Heat cured marking (ink, paint) can be used if the marking survives incidental contact with the hydraulic fluids (incidental contact - the mark shall be legible after immersion in hydraulic fluid and wiped dry).

3.6 Performance

Fittings when attached to the applicable tubing in Table 7 using the same tooling per AS5902 or fitting manufacturer's authorized procedures, shall meet the following performance requirements when tested in accordance with the procedures specified in 4.2. Tubing other than listed in Table 7, or higher operating temperatures shall be tested as required in this document or by the procuring activity.

3.6.1 Environmental Conditions

Permanent fittings shall be capable of performance in accordance with this specification when subjected to the natural and induced environments specified herein.