SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS18280

REV. B

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Superseding AS18280A

(R) Fittings, 24° Cone Flareless, Fluid Connection, 3000 psi

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1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) establishes the requirements for 24° cone flareless fluid connection fittings and nuts, internally or externally swaged, preset, or welded sleeves for use in aircraft fluid systems at nominal operating pressures up to and including 3000 psi.

1.2 Classification:

Fittings shall be furnished in the types and styles designated by the applicable AS, MS, NAS or other Prime Manufacturer part standard drawings. This specification includes the requirements for flareless fittings used with externally preset bite type sleeves and also for machined acorn fitting ends such as NAS1760, AS4458, and AS4703. It is intended to serve as a procurement specification for the fittings described herein and in Section 6. The requirements for externally preset bite type sleeves are given in AS18280/1. The requirements for swaged or welded sleeves and tube ends are given in AS18280/2.

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 (www.sae.org).

AMS-QQ-A-225/6	Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished, 2024
AMS-QQ-A-225/9	Aluminum Alloy Bar, Rod, Wire and Special Shapes; Rolled, Drawn, or Cold Finished, 7075
AMS-QQ-P-416	Plating, Cadmium (Electro-deposited)
AMS-QQ-S-763	Steel Bars, Wire, Shapes and Forgings, Corrosion-Resisting

2.1.1 (Continued):

AMS 2472	Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process
AMS 2486	Conversion Coating of Titanium Alloys, Fluoride Phosphate Type
AMS 2488	Anodic Treatment, Titanium and Titanium Alloys
AMS 2658	Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts
AMS 2700	Passivation Treatment for Corrosion Resistant Steel
AMS 2759	Heat Treatment, Steel Parts, General Requirements
AMS 2770	Heat Treatment of Wrought Aluminum Alloy Parts
AMS 4083	Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061, Aircraft Hydraulic Quality
AMS 4112	Aluminum Alloy Bars, Rods, and Wire, Rolled, Drawn, or Cold Finished 4.4Cu - 1.5Mg - 0.60Mn (2024-T6)
AMS 4124	Bars, Rods, and Wire, Rolled, Drawn or Cold Finished, 5.62N 2.5Mg 1.6Cu 0.23Cr (7075-T7351)
AMS 4133	Aluminum Alloy, Forgings and Rolled Rings, 4.4Cu - 0.85Si - 0.80Mn - 0.50Mg (2014-T6) Solution and Precipitation Heat Treated
AMS 4141	Forgings, Die, Aluminum Alloy, 5.6Zn - 2.6Mg - 7.6Cu - 0.23Cr (7075-T73), Solution and Precipitation Heat Treated
AMS 4339	Aluminum Alloy Rolled and Cold Finished Bar 4.4 Cr - 1.5 Mo - 0.60 Mn (2024-T851) Solution Heat Treated, Cold Worked and Aged
AMS 4928	Titanium Alloy Bars and Forgings, 6AL-4V, Annealed, 120,000 PSI (827 MPa) Yield
AMS 4946	Titanium Alloy Tubing, Seamless, Hydraulic 3Al-2.5V, Texture Controlled, Cold Worked, Stress Relieved
AMS 5561	Steel, Corrosion and Heat Resistant, Welded and Drawn or Seamless and Drawn Tubing 9.0Mn 20Cr 6.5Ni 0.28N High-Pressure Hydraulic

2.1.1 (Continued):

AMS 5564	Steel, Corrosion Resistant, Tubing 19Cr 10Ni High-Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless
AMS 5566	Steel, Corrosion Resistant, Seamless or Welded Hydraulic Tubing 19Cr 10Ni, High Pressure, Cold Drawn
AMS 5639	Bars, Wire, Forgings, Tubing and Rings, 19Cr 10Ni Solution Heat Treated
AMS 5645	Bars, Forging, Tubing and Rings, 18Cr 10Ni 0.40Ti Solution Heat Treated
AMS 5648	Bars, Forgings, Tubing and Rings, 17Cr 12Ni 2.5Mo, Solution Heat Treated
AMS 5659	Bars, Wire, Forgings, Rings and Extrusions, 15Cr 4.5Ni 0.30 (Cb + Ta) 3.5Cu, Consumable Electrode Melted, Solution Heat Treated, Precipitation Hardenable
AMS-H-6088	Heat Treatment of Aluminum Alloys
AMS 6370	Steel Bars, Forgings and Rings, 0.95Cr 0.20Mo (0.28-0.30C)
AMS-S-6758	Steel, Chrome-Molybdenum (4130) Bars and Reforging Stock (Aircraft Quality)
AMS-T-6845	Tubing, Steel, Corrosion-Resistant (S30400), Aerospace Vehicle Hydraulic System 1/8 Hard Condition
AMS-H-6875	Heat Treatment of Steel Raw Materials
AMS-T-7081	Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061, Aircraft Hydraulic Quality
ARP603	Impulse Testing of Hydraulic Hose Tubing and Fittings Assemblies
ARP 891	Determination of Aluminum Alloy Tempers by Electrical Conductivity
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
ARP4784	Performance and Evaluation Criteria, Surface Defects, Requirements for

2.1.1 (Continued):

AS478	Identification Marking Methods
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS1376	Alternate Dimensions, Center Body Section, Shape Fluid Fitting, Design Standard
AS2094	Test Methods for Tube-Fitting Assemblies
AS4375	Fitting End, External Thread, Flareless Design Standard
AS4377	Fitting End, Bulkhead, Flareless, Design Standard
AS4444	Fittings, 24° Cone, Flareless Fluid Connection, 5000 psi
AS4458	Fitting End, Flareless, Blunt Nose, Design Standard
AS4658	Fitting End, External Thread, Short Flareless, Design Standard
AS4659	Fitting End, Bulkhead, External Thread, Short Flareless, Design Standard
AS5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting, Procurement Specification
AS5620	Titanium Hydraulic Tubing, Ti-3Al-2.5V CWSR, up to 35000 kPa (5080 psi) and 200 °C (400 °F), Requirements for Qualification Testing and Control
AS4703	Fitting End, Acorn, Short Flareless, Design Standard
AS5148	Assembly, Installation and Torque for Flareless and Straight Thread Fluid Fittings and Tube Assemblies
AS7003	National Aerospace and Defense Contractors Accreditation Program (NADCAP) Program Requirements
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components
AS8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter: General Specification For

2.1.1 (Continued):

AS18280/1	Sleeve, Bite Type, 24° Cone Flareless Fitting, 3000 psi
AS18280/2	Sleeve, Internally or Externally Swaged or Welded, 24° Cone Flareless Fitting, 3000 psi
AS33514	Fitting End, Standard Dimensions for Flareless Tube Connection and Gasket Seal
AS33515	Fitting End, Standard Dimensions for Bulkhead Flareless Tube Connections

SAE DICTIONARY OF AEROSPACE ENGINEERING

2.1.2 U.S. Government Publications: Available on-line at http://assist.daps.dla.mil/quicksearch or www.assist.daps.mil or from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-HDBK-1655	Fittings, Flareless, Classification of Defects of
MIL-PRF-87257	Hydraulic Fluid, Petroleum Base, Missile Ordnance Reviewer
MIL-PRF-6083	Hydraulic Fluid, Petroleum Base, For Preservation and Operation
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-PRF-46170	Hydraulic Fluid, Rust Inhibiting, Fire Resistant, Synthetic Hydrocarbon Base
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft
FED-STD-595	Colors Used in Government Procurement

2.1.3 NAS Publications: Available from Aerospace Industries Association, 1250 Eye Street, NW, Washington, DC 20005 or www.aia.org.

NAS1760	Fitting End, Flareless Acorn, Standard Dimensions for

2.1.4 ASME Publications: Available from ASME, Three Park Ave, New York, NY 10016-5990 or www.asme.org.

ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME Y14.38	Abbreviation for Use on Drawings and in Text

2.1.5 ASQ Publications: Available from ASQ, P.O. Box 3005, 611E Wisconsin Avenue, Milwaukee WI 53201-4606 or www.asq.org.

ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes

2.1.6 ANSI Publications: Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI Z540-1	Calibration Laboratories in Measuring Test Equipment General Requirements

2.1.7 ISO Publications: Available from Internal Organization for Standardization, Case Postale 56, CH-1211 Geneve 20, Switzerland.

ISO 10012-1	Quality Assurance Requirements for Measuring Equipment

2.1.8 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM A 370	Steel Products, Mechanical Testing of
ASTM E 1417	Practice for Liquid Penetrant Examination

2.1.9 PRI Publications: Available from PRI, 161 Thornhill Road, Warrendale, PA 15086-7527 or www.sae.pri.org <http://www.sae.pri.org>

PD2001	Tasks & Procedures of the Qualified Product Management Council
PD2101	Qualified Management Product Council for Qualified Products Groups
PRI-QPL-AS18280	Fittings, Flareless, Tube, Fluid Connection

2.2 Abbreviations and Acronyms:

Standard abbreviations used in this document and frequently used in aerospace technical documents may be found in ASME Y14.38.

2.3 Definitions:

Definitions of terms used in this document and frequently used in aerospace technical documents may be found in the SAE Dictionary of Aerospace Engineering.

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

3.1.1 Product Qualification: Fittings, nuts, and sleeves furnished under this specification shall be representative of products which have been qualified to the requirements of 4.4. 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 the Performance Review Institute (PRI) Qualified Products List (QPL) PRI-QPL-AS18280.

3.1.2 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).

3.1.3 Retention of Qualification: The manufacturer shall certify in intervals not exceeding two years that the products listed in PRI-QPL-AS18280 are still available from the listed plant. The manufacturer shall forward his certification letter to PRI for approval. PRI shall confirm retention of qualification.

3.2 Material:

Fittings shall be fabricated of materials listed in Table 1 and in compliance with requirements in this specification or as specified on the applicable part standard drawing.

3.2.1 Heat Treatment:

3.2.1.1 Aluminum Alloy: Aluminum alloy fittings and nuts shall be supplied in the final temper as shown in Table 1. When fitting material is purchased in other than the final temper, the heat treatment of the raw material shall be in accordance with AMS-H-6088. Heat treating of semi-finished or finished parts shall be in accordance with AMS 2770.

3.2.1.1.1 Electrical conductivity and Hardness: Aluminum alloy fittings and nuts shall meet the electrical conductivity and hardness requirements of AMS 2658. The material may have to be heat treated before or after fabrication of parts in order to meet the requirement.

NOTE: The AMS 2658 is replacing the previously specified ARP891. Parts approved in previous inspection based on meeting the ARP891 requirements are acceptable.

3.2.1.2 Steel: When additional processing is required to comply with hardness requirements of 3.2.2.1, the heat treatment shall be in accordance with AMS-H-6875 or AMS 2759.

3.2.2 Additional Physical Properties of Steel:

3.2.2.1 Low alloy steel: Unless otherwise specified on the applicable drawings, the hardness of the finished low alloy steel fittings and nuts with plating removed shall be 92 HRB to 40 HRC. For low alloy steel fittings and nuts below a hardness of 20 HRC, hardness tests shall be made using the B scale, in which case the hardness shall be within the range of 92 to 99 HRB (see 4.6.2).

3.2.2.2 Class 300 Series Corrosion Resistant Steel: Unless otherwise specified on the applicable drawings, the hardness of the finished class 300 series corrosion resistant steel parts shall be 80 HRB minimum (see 4.6.2).

3.2.2.3 Type 15-5PH Corrosion Resistant Steel: Unless otherwise specified on the applicable drawings, type 15-5PH corrosion resistant steel material shall be heat treated to condition H-1075 per AMS-H-6875 or AMS 2759 before machining. Hardness shall be 32 to 40.5 HRC.

3.2.3 Parting Lines in Aluminum Forgings: Parting lines, which are formed by a pattern division during forging, shall be free of tears and crack-like indications. Following anodizing, the part shall not exhibit tears or crack-like indications when examined per 4.6.3. Parting lines or flash lines of 2014 aluminum alloy fittings shall be ground flush to blend with the forging body, without reduction of the forging body thickness below drawing minimum. The finish in the ground parting line or flash line area shall not exceed 125 µin Roughness Average (R_a) as defined in ASME B46.1 after grinding.

3.3 Design and Fabrication:

The design and fabrication of the fittings shall be in accordance with the applicable drawings. The fitting ends shall be in accordance with AS33514, AS33515, AS4375, AS4377, AS4458, AS4658, AS4659, AS4703, or NAS1760 as applicable. Dimensional requirements are applicable after heat treatment and protective finishing. The center body section of shape fittings machined from bar or oversized forgings shall conform to AS1376.

NOTE: Flareless fitting machined acorn ends that have a nut held in place by a retaining device shall be considered as a fitting end assembly.

TABLE 1 - Materials

Material	Type of Part	Form	Specification	Alloy & Temper	Material Code
Aluminum alloy	Straight fittings and nuts	Bars, rods	AMS-QQ-A-225/6	2024-T6 or T851	D
			AMS 4112	2024-T6	D
			AMS 4339	2024-T851	D
			AMS-QQ-A-225/9	7075-T73	W
			AMS 4124	7075-T7351	W
			Notes: /1/ /2/ /3/ all		
	Shape fittings and nuts	Forgings	AMS 4133	2014-T6	D
			AMS 4141	7075-T73	W
			Notes: /1/ /2/ /3/ all		
	Shape fittings	Bars	AMS-QQ-A-225/6 /1/	2024-T6 or T851	D
			AMS 4112	2024-T6	D
			AMS-QQ-A-225/9 /1/	7075-T73	W
			AMS 4124	7075-T7351	W
			Notes: /1/ /2/ /3/ all		
Low alloy steel	Straight and shape fittings and nuts	Bars, rods	AMS-S-6758	4130	None
			AMS 6370	4130	None
	Shape fittings	Forgings	AMS-S-6758 /6/	4130	None
			AMS 6370		
			Notes: /4/ all		
Corrosion resistant steel	Straight and shape fittings, nuts and non-bite type sleeves	Bars	AMS-QQ-S-763 /5/	Class 304, Cond A	J
			AMS 5639 /5/	Class 304, Cond A	J
			AMS-QQ-S-763 /5/	Class 316, Cond A	K
			AMS 5648 /5/	Class 316, Cond A	K
			AMS-QQ-S-763 /5/	Class 321, Cond A	R
			AMS 5645 /5/	Class 321, Cond A	R
			AMS 5659	Type 15-5PH	V
	Shape fittings	Forgings	AMS-QQ-S-763 /5/	Class 304, Cond A	J
			AMS 5639 /5/	Class 304, Cond A	J
			AMS-QQ-S-763 /5/	Class 316, Cond A	K
			AMS 5648 /5/	Class 316, Cond A	K
			AMS-QQ-S-763 /5/	Class 321, Cond A	R
			AMS 5645 /5/	Class 321, Cond A	R
			AMS 5659	Type 15-5PH	V

TABLE 1 - Materials (Continued)

Material	Type of Part	Form	Specification	Alloy & Temper	Material Code
Titanium alloy	Straight and shape fittings, nuts and non-bite type sleeves	Bars	AMS 4928	6Al-4V annealed	T
	Shape fittings	Forgings	AMS 4928	6Al-4V annealed	T

/1/ 2014 and 2024 aluminum alloy fittings, “D” Code, are discontinued and superseded by “W” Code.

/2/ The electrical conductivity and hardness of aluminum alloys shall be per 3.2.1.1.1. This requirement shall be added as a supplement to the specification when materials are procured or the material may have to be heat treated before or after fabrication in order to meet the requirement.

/3/ The parting lines in aluminum forgings shall meet the requirements of 3.2.3. This requirement and inspection per 4.6.3 may be added as a supplement to the specification when forgings are procured.

/4/ The hardness of finished low alloy steel parts shall be per 3.2.2.1. If the materials are procured with this requirement as a supplement to the specification, the purchase order shall specify that any heat treatment applied shall be per AMS-H-6875 or AMS 2759 (see 3.2.1.2).

/5/ The hardness of finished class 300 series corrosion resistant steel parts shall be per 3.2.2.2. This requirement shall be added as a supplement to the specification when materials are procured.

/6/ This specification is for bar from which forgings shall be made and only the chemical composition applies.

3.3.1 Passages:

3.3.1.1 Machining Offset: For straight fittings or in-line legs of shape fittings with the same inner diameter where the fluid passage is machined from each end, the offset between the machined holes at the meeting point of the holes shall not exceed 0.015 in. It shall be possible to pass through the fluid passage a ball whose diameter is 0.020 less than the minimum diameter specified for the passage.

3.3.1.2 Cross Section at Fluid Path Junction: For shape fittings, the cross-sectional area at the junction of fluid passages shall be such that it shall be possible to pass through the fitting from end to end, a ball whose diameter is not less than 0.7 times the minimum diameter specified for the smaller passage.

3.3.2 Threads: Threads shall be per AS8879 Category I except that the root radius is not required on incomplete threads. External threads on steel, corrosion resistant steel, and titanium alloy may be produced by a single point method, cut or rolled. External threads on aluminum alloy may be cut, single point cut, ground, or rolled. Internal threads may be produced by a single point method, cut, or ground.

NOTE: Threads shall not be grit or bead blasted unless required as preparation for application of solid film lubricant.

3.4 Finish:

3.4.1 Aluminum Alloy: Aluminum alloy fittings and nuts shall be anodized in accordance with MIL-A-8625 Type II, Class 2, or AMS 2472, dyed green similar to No. 14187 of FED-STD-595 for material code D; or brown similar to No. 10080 of FED-STD-595 for material code W as applicable (see 3.5.4) and shall be duplex sealed.

3.4.2 Low alloy steel: Low alloy steel fittings and nuts shall be cadmium plated in accordance with AMS-QQ-P-416, Type II, Class 2. The color shall be yellow to brownish (see 3.5.4). All such low alloy steel fittings and nuts shall be dipped in oil conforming to MIL-PRF-6083. Fluid passage holes, other openings, and internal threads shall not be subject to a plating thickness requirement and may exhibit bare areas provided that they are protected with a light film of oil.

Warning: The use of cadmium has been restricted and/or banned for use in many countries due to environmental and health concerns. The user should consult with local officials on applicable health and environmental regulations regarding its use.

3.4.3 Corrosion Resistant Steel:

3.4.3.1 Class 300 Series Corrosion Resistant Steel Fittings: Class 300 series corrosion resistant steel fittings, nuts, and sleeves shall be passivated per AMS 2700. The inside only of sizes 16 through 32 slip-on nuts or retained nuts shall be coated with solid film lubricant per AS5272 Type II. Minor overspray of the lubricant on the outside of the nut is permitted.

3.4.3.2 Type 15-5PH Corrosion Resistant Steel: Type 15-5PH corrosion resistant steel fittings, nuts, and sleeves shall be passivated per AMS 2700. The inside only of sizes 16 through 32 slip-on nuts or retained nuts shall be coated with solid film lubricant per AS5272 Type II. The time following passivation until the application of the solid film lubricant shall be a minimum of 24 h to allow the passivation to cure and condition the surface to improve the adhesion of the lubricant. Minor overspray of the lubricant on the outside of the nut is permitted.

When cadmium plating is specified, passivation and solid film lubricant shall be omitted and the parts shall be cadmium plated per AMS-QQ-P-416, Type II, Class 2 except that following cadmium plating in all hardnesses, post plate baking shall be performed for a minimum of 3 h at 375 °F ± 25 °F. Fluid passages, other openings, and internal threads shall not be subjected to plating thickness requirements and may exhibit bare areas.

3.4.4 Titanium Alloy Fittings: Titanium alloy fittings and nuts shall be anodized per AMS 2488 or fluoride phosphate coated per AMS 2486, except that a pretreatment, a modification of the fluoride treatment or a post treatment shall be applied so that the final color of the fittings should be approximately gray, similar to color numbers 26081 through 26293, or 36076 through 36293 per FED-STD-595 (see 3.5.4). Sealing surfaces shall not be bead or grit blasted.

NOTE: Not meeting the exact color requirement shall not be cause for rejection.

3.5 Identification of Product:

All fittings, nuts, and sleeves shall be marked in accordance with AS478 Class C or D or Method 7A3, 15A3, 15B or as specified on the applicable drawing in a location not detrimental to the performance of the fitting and not detrimental to the corrosion protection of the fitting.

NOTE: When items cannot be physically marked because of lacking space or because marking would have a deleterious effect, the package shall provide the identification per 5.4.

3.5.1 Manufacturer's Identification: Unless otherwise specified, all fittings, nuts, and sleeves shall be marked with the manufacturer's name, CAGE code or trademark and with the prefix MS, AS, or NAS as applicable. Fittings made from forgings shall be marked with the forging manufacturer's trademark or an identifying code letter or number to identify the forging source.

3.5.2 Material Identification: Fittings and nuts shall be marked with the material code letter as shown in Table 1.

3.5.3 Marking for Part Number: All fittings, nuts, and sleeves larger than 06 fitting size code shall be marked with the basic part number, exclusive of size. Fitting assemblies with assembled nuts shall be marked as above on the fitting body, but assembled nuts that have their own part number identification are acceptable.

3.5.4 Color Identification: In addition to the markings specified, the fittings, nuts, and sleeves shall be identified by the following colors:

a. Aluminum alloys 2014 and 2024: Green (see 3.4.1)

b. Aluminum alloy 7075: Brown (see 3.4.1)

c. Low alloy steel: Yellow to brownish (see 3.4.2)

d. Corrosion resistant steel 300 series: Natural silvery color (see 3.4.3.1)

e. Corrosion resistant steel, precipitation hardening (15-5PH) without cadmium: Natural silvery color (see 3.4.3.2)

f. Corrosion resistant steel precipitation hardening (15-5PH) with cadmium plate: The color will be.

g. Titanium alloy: Gray (see 3.4.4)

3.6 Performance:

Flareless fittings and nuts, when assembled to tubing specified in Table 2 and tested in accordance with applicable procedures specified in Section 4, shall meet the following performance requirements. Flareless fittings, nuts, and tube end sleeves with machined acorn ends per AS18280/2 or fitting end assemblies with nuts held in place by retaining devices, when assembled to tubing specified in Tables 3, 4, 5, or 6 and tested in accordance with applicable procedures specified in Section 4, shall meet the following performance requirements. Tube end sleeves with machined acorn ends, such as weld or swage, shall have had their tube interface connection tested per the applicable performance specification for that type of connection at the applicable operating pressure, but the tube interface connection shall not fail the performance requirements of this specification when tested at the applicable operating pressure.

3.6.1 Proof Pressure: The test assembly when assembled at either minimum or maximum torque shall withstand pressure equal to two times the operating pressure of the system. There shall be no leakage sufficient to form a drop, evidence of permanent deformation or permanent set or other malfunction that would affect assembly or disassembly using the specified range of torque values when tested per 4.4.3.

3.6.2 Burst Pressure: The test assembly when assembled at either minimum or maximum torque shall not rupture or show evidence of leakage at any pressure up to and including four times the operating pressure of the system when tested per 4.4.4. Tubing expansion is permissible.

3.6.3 Pneumatic Pressure: The fitting assembly when assembled at minimum torque shall withstand pneumatic pressure equal to the operating pressure without any visible leakage in the form of bubbles starting after 1 min at pressure when tested per 4.4.5.

3.6.4 Repeated Assembly: The test assembly shall withstand eight repeated assemblies at the specified rated minimum and maximum torque values when tested at room temperature per 4.4.6 without:

a. Leakage at any of the pressure tests.

b. Inability to reassemble the fitting to the point of interface by hand.

c. Nut deformation preventing engagement of the hex of the nut with an open end wrench.

3.6.5 Impulse: The test assembly when assembled at minimum torque shall withstand 200,000 impulse pressure cycles at a peak pressure of 150% of operating pressure without leakage from the fitting or fitting to tube junction when tested per 4.4.7.

3.6.6 Flexure, Alternate Test Methods:

3.6.6.1 Standard Flexure Test: The test specimens shall meet flexure testing to the stress levels specified in Tables 2, 3, 4 or 5, when tested per 4.4.8. Six assemblies shall withstand 10^7 flexure cycles without leakage.

1. Six assemblies of AMS-T-6845 tubing and fittings and sleeves as shown in Table 2 shall be flexure tested to the total stress level specified in Table 2, in accordance with ARP1185, at room temperature and using maximum tightening torque.

2. Modifications of 24° cone fittings, new tubing materials or other attachment methods are to be qualified by comparing their fatigue life against that of the basic 24° cone fitting by testing to 10^7 cycles, to the same fatigue life measured in deflection as the basic fitting. The performance of such other designs, materials or joining methods shall meet or exceed that of the standard 24° cone fitting and cold-worked corrosion-resistant steel tubing.

TABLE 2 - Fitting Material, Operating Pressure, and Flexure Test Stress for Flareless Fittings with Bite type Sleeves or Internally Swaged Sleeves with Machined Acorn Ends with 304 1/8 Hard Corrosion Resistant Steel Tubing (See 6.3)

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness Corrosion Resistant Steel Tubing Per AMS-T-6845	Operating Pressure psi Steel, CRES, Titanium Alloy Fittings	Bending Stress Level in Tube for Flexure Test +0/-10% psi Steel and Titanium Alloy Fittings	Operating Pressure psi Aluminum Alloy Fittings	Total Stress Level in Tube for Flexure Test +0/-10% psi Aluminum Alloy Fittings
0.125	02	0.012	3000	24,500	3000	14,000
0.188	03	0.016	3000	23,500	3000	14,000
0.250	04	0.020	3000	23,000	3000	14,000
0.312	05	0.020	3000	20,500	3000	14,000
0.375	06	0.028	3000	22,500	3000	14,000
0.500	08	0.035	3000	21,500	3000	14,000
0.625	10	0.042	3000	21,100	3000	14,000
0.750	12	0.058	3000	17,500	3000	14,000
1.000	16	0.065	3000	15,700	1500	13,000
1.250	20	0.049	1500	12,000	1500	13,000
1.500	24	0.065	1500	10,000	1000	13,000
2.000	32	0.065	1500	10,000	600	13,000

TABLE 3 - Fitting Material, Operating Pressure, and Flexure Test Stress for Aluminum Flareless Fittings with Machined Acorn Ends with Aluminum Alloy Tubing (See 6.3 and 6.4)

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness 6061-T6 Aluminum Alloy Tubing per AMS-T-7081 or AMS 4083	Operating Pressure psi	Bending Stress Level in Tube for Flexure Test +0/-10% psi
0.250	04	0.035	1500	6,000
0.312	05	0.035	1500	6,000
0.375	06	0.035	1500	6,000
0.500	08	0.035	1500	5,500
0.625	10	0.035	1000	5,500
0.750	12	0.035	900	5,000
1.000	16	0.035	900	4,000
1.250	20	0.049	600	4,000
1.500	24	0.049	600	4,000

TABLE 4 - Tubing Wall Thickness, Operating Pressure, and Flexure Test Stress for Steel or Titanium Flareless Fittings with Type 21-6-9 Corrosion Resistant Steel Tubing

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness Type 21-6-9 Corrosion Resistant Alloy Tubing per AMS 5561	Maximum Operating Pressure psi	Bending Stress Level in Tube for Flexure Test +0/-10% psi
0.188	03	0.016	3000	24,000
0.250	04	0.016	3000	24,000
0.312	05	0.020	3000	24,000
0.375	06	0.020	3000	22,000
0.500	08	0.026	3000	20,000
0.625	10	0.033	3000	18,000
0.750	12	0.039	3000	16,000
1.000	16	0.052	3000	15,000
1.250	20	0.016	600	12,000
1.250	20	0.030 min	1500	12,000
1.500	24	0.018	600	10,000
1.500	24	0.036 min	1500	12,000
2.000	32	0.047 min	1500	10,000
2.000	32	0.020	600	10,000

TABLE 5 - Tubing Wall Thickness, Operating Pressure, and Flexure Test Stress for Titanium Flareless Fittings with Type 3.0Al 2.5V Titanium Alloy Tubing

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness Type 3.0Al 2.5V Titanium Alloy Tubing per AMS 4946 /1/	Maximum Operating Pressure psi	Bending Stress Level in Tube for Flexure Test +0/-10% psi
0.125	02	0.016	3000	20,000
0.188	03	0.016	3000	20,000
0.250	04	0.016	3000	20,000
0.312	05	0.019	3000	20,000
0.375	06	0.019	3000	19,000
0.500	08	0.026	3000	18,000
0.625	10	0.032	3000	17,000
0.750	12	0.039	3000	16,000
1.000	16	0.051	3000	15,000
1.250	20	0.024	600	12,000
1.250	20	0.040 min	1500	10,000
1.250	20	0.070	3000	9,000
1.500	24	0.018	600	12,000
1.500	24	0.040 min	1500	10,000
1.500	24	0.078	3000	9,000
2.000	32	0.022	600	10,000
2.000	32	0.053 min	1500	9,000

/1/ Qualification test and procurement requirements for this tubing is specified in AS5620

3.6.6.2 S-N Flexure Test: The S-N test method per ARP1185, using eight specimens, may be used as an alternative to the method of testing six specimens to 3.6.6.1. Two specimens shall pass the minimum stress levels specifies for tube and fitting materials as specified in Table 2, Table 3, Table 4, and Table 5. The remaining six specimens shall be tested at stress levels outlined in ARP1185, to establish a S-N curve. There shall be no leakage from the fitting or fitting to tube junction during testing at any of the stress levels.

3.6.7 Joint Strength: This requirement applies to any tube end attachment fitting with a flareless design standard end in sizes 02 through 20 unless otherwise specified. The tubing to which the tube end is assembled shall have at least the minimum tensile strength of the tubing listed in Table 2. The test assembly when assembled at minimum torque shall withstand the loads as specified in Table 6 without slippage of the sleeve or tube end adapter on the tubing or cracking of the sleeve when tested at room temperature per 4.4.9.

3.7 Workmanship:

3.7.1 Machined and Unmachined Surfaces: Machined surfaces of fittings, sleeves, and nuts shall be as specified on the applicable drawings. Unmachined surfaces, such as forged surfaces and bar stock flats, shall be free from blisters, fins, folds, seams, laps, cracks, segregations, or other defects as specified in ARP4784.

3.7.2 Internal passages: Internal passages of fluid fittings shall be free from burrs, slivers, pressed-on chips or contamination as visible with macroscopic examination at 7X magnification using a light source. Surface defects may be explored by suitable etching and if they can be removed so that they do not appear on re-etching and the required section thickness can be maintained, they shall not be cause for rejection. (See 3.2.3 for parting lines or flash lines of aluminum forged fittings.)

3.7.3 Surface Texture: The surface texture of unmachined surfaces and hex surfaces, except forging parting lines, may be 250 µin R_a per ASME B46.1. The surface texture of forging parting planes except 2014 aluminum alloy may be 500 µin R_a per ASME B46.1.

3.7.4 Anodize Contact Marks: Contact areas from anodizing electrodes may show discoloration and impressions. Such discoloration and impressions, due to anodizing contact marks, shall not be cause for rejection if they occur at internal areas and in the tube stop area of the fitting end. Anodizing contact marks occurring on sealing, bearing, or threaded surfaces shall be cause for rejection.

3.7.5 Sealing Surfaces: The surface finish shall be as specified on the part standard, and shall retain pressure in testing. There shall be no measurable chatter marks. Sealing surfaces shall not be grit or bead blasted.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for performing the inspection and test requirements of the Quality Conformance Inspection of 4.5. Except as otherwise specified, the supplier may utilize his own facilities or any other laboratory for the performance of the inspection and test requirements. The purchaser reserves the right to perform any of the inspections and tests set forth in this specification, whenever such inspections and tests are deemed necessary to assure that supplies and services conform to prescribed requirements.

TABLE 6 - Minimum Joint Strength of Flareless Tube End Attachment Fittings

Nominal Tube Size	02	03	04	05	06	08	10	12	16	20
Tubing Wall Thickness	0.012	0.016	0.020	0.020	0.028	0.035	0.042	0.058	0.065	0.049
Joint Strength lb	400	800	1300	1800	2500	4200	6200	8800	10,000	9500

4.2 Inspection Lot:

A lot shall consist of finished parts that are identified by one unique part number fabricated from one mill heat of material; or, if an assembly, each component part shall be from one mill heat of material, produced by the same machining operation at approximately the same time in one continuous production run. Splits of one production run into two parallel runs that may be machined at different times constitutes splitting the lot into two distinct lots. Processes such as heat treating, plating, baking, and dry lubricant application shall be performed at essentially the same time under the same conditions; processes not meeting the condition shall require the assigning of a distinguishing lot number. Parts which consist of assemblies (i.e., fittings with retained nuts) shall be identified with a separate number which allows traceability of each part. Retaining wires need not be identified by heat lot.

4.2.1 Material Certification: Records of the chemical composition analysis and mechanical property tests showing conformance to the material requirements of this specification shall be available to the procuring activity upon request for each lot of fittings, except that for aluminum alloys a certificate of conformance to the chemical analysis requirement may be furnished in lieu of an actual chemical analysis test report.

4.2.2 Heat Treating Certification: Records of heat treating performed on the materials after purchasing showing conformance to the applicable heat treating specification shall be available to the procuring activity upon request for each lot of fittings.

4.3 Classification of Tests and Inspections:

The tests and inspections of the fittings shall be classified as follows:

a. Qualification inspection (see 4.4)

b. Quality conformance inspection (see 4.5)

c. Periodic control tests (4.5.3)

4.4 Qualification Inspection:

4.4.1 Test Samples: Samples shall consist of the parts specified in Table 7 for each size and material and for shape fittings, both bar and forging form of material. Samples for qualification testing shall have been subjected to all of the applicable requirements of quality conformance inspection (see 4.5).

4.4.2 General Testing Practice:

4.4.2.1 Thread Lubricant: Thread lubricant to be used shall be hydraulic fluid conforming to AS1241, MIL-PRF-6083, MIL-PRF-46170, MIL-PRF-83282, or MIL-PRF-87257 except no lubricating fluid shall be applied to nuts coated with solid film lubricant.

4.4.2.2 Fitting Assembly: Nuts assembled to flareless sleeves attached to tubing when lubricated with fluid per 4.4.2.1 shall be installed per AS5148 and tightened to the minimum or maximum torque values, as applicable, in accordance with Table 8.

4.4.2.3 Tube Material and Working Pressure: For qualification testing of standard body fittings with bite-type AS21922 sleeves as listed in Table 2 the fitting assemblies shall be qualification tested with AMS-T-6845 corrosion resistant steel tubing at the operating pressure as shown in Table 2. For qualification testing of fitting assemblies with machined acorn type sleeves the assemblies shall be tested with the tubing and at the applicable operating pressure as shown in Tables 3, 4, or 5.

4.4.2.4 Test Fluids: Unless otherwise specified, fluid conforming to AS1241, MIL-PRF-46170, MIL-PRF-6083, MIL-PRF-87257, or MIL-PRF-83282, or water shall be the test fluid.

4.4.2.5 Calibration of Test and Measuring Equipment: Test and measuring equipment used to verify the performance requirements shall be calibrated per specifications such as ISO 10012-1 or ANSI Z540-1.

TABLE 7 - Test Samples for Qualification Inspection and Periodic Control Tests

Test	Requirement Paragraph	Test Procedure Paragraph	Fitting Description	Material	Quantity Each
Burst Pressure	3.6.2	4.4.4	Elbow and Tee /1/	All /3/	2each
Pneumatic Pressure	3.6.3	4.4.5	Straight /2/	All /3/	3
Repeated Assembly	3.6.4	4.4.6	Straight /2/	All /3/	6 fitting ends
Impulse	3.6.5	4.4.7	Elbow and Tee /1/	All /3/	3each
Flexure	3.6.6	4.4.8	Straight /2/	All /3/	6 or 8 /4/
Joint Strength	3.6.7	4.4.9	Tube end	All except aluminum alloy	6
Periodic Control	3.6.3, 3.6.4	4.4.6	Straight or shape /5/	Titanium and 15-5PH	6 fitting ends

/1/ Qualification Tests of Shape Fittings

a. Tee or elbow configurations may be used.
b. There shall be at least one fitting end with a 24 degree cone, nut, and sleeve on each sample.
c. Qualification testing of standard-body tees satisfies qualification of standard-body elbows.

NOTE: Standard-body tees and elbows cannot be used for qualification by similarity of reduced-body tee and elbow fittings.

d. Qualification testing of reduced body tees satisfies qualification testing of reduced body elbows.
e. Qualification testing of reduced-body sections satisfies qualification of full-body sections.
f. Each set of shapes shall be qualified in full unmixed sets of either forging or bar/plate material.

/2/ Qualification Tests of Straight Fittings

Any straight fitting, union, adaptor, or plug may be used. At least one fitting end shall be tested with a tube assembly having sleeves and nuts.

/3/ Qualification of Different Material Fittings and Similar Materials

Each basic type of material shall be tested except that certain alloys and types may be tested in lieu of others as follows:

a. For qualification of 300-series corrosion resistant steel either 304, 316, or 321 may be used.
b. Change from the 4130 material approval to the replacing 15-5PH material requires successfully passing pneumatic tests and repeated assembly tests in sizes 06 and 16. New qualification approval of 15-5PH fittings requires full qualification testing per Table 7.
c. For qualification tests of 20-series and 70-series aluminum fittings 2024 or 7075 may be used for straights, and 2014 or 7075 for forgings.

/4/ Flexure Test

For standard endurance flexure test (3.6.6.1), six samples are required. For S-N flexure test (3.6.6.2), eight samples are required.

/5/ Periodic Control Tests

Periodic control tests shall be conducted on titanium and 15-5PH straight or shape fittings to verify sealing performance and thread quality.

TABLE 8 - Fitting Assembly Torque Values

Nominal Tube Size in 0.062 Increments	Minimum Torque lb-in	Maximum Torque lb-in
02	50	60
03	95	105
04	135	145
05	170	190
06	215	245
08	470	510
10	620	680
12	855	945
14	995	1100
16	1140	1260
20	1520	1680
24	1900	2100
32	2660	2940

4.4.2.6 Test Reporting: For each test required in 4.4, a test report shall be prepared giving the following information as a minimum:

1. The place of testing.
2. The date of testing.
3. The identification of the test technician or engineer responsible for the observing and recording of the measured or observed data.
4. An identification serial number of each test sample with the description of the test samples traceable to design drawings, and revisions, the material and processing records and the production inspection records for the samples.
5. The identification of the test or measuring equipment and the next date of calibration of instruments or measuring equipment used for determination of quantitative data.
6. The ambient temperature of the testing location.
7. The temperature of the test sample or the immediate area around the test sample during testing if other than ambient temperature.
8. The type of fluid used in testing if applicable.
9. Actual measured quantitative data shall be recorded. Any revisions or deletions shall be done by crossing out the original data, not erasing it, so that it is still legible. Revisions or deletions should be signed and dated by the person making the changes. Calculated data shall be presented with the formula used for calculation and with the identification of all terms.
10. Photographs of test equipment and examples of tested samples shall be included if applicable.
11. The identification of the agency responsible for the test report with the name or title and address of a point of contact person or persons who can provide technical information or answer questions concerning the testing and the report.

4.4.3 Proof Pressure Test Procedure: The test assembly shall be connected to a source of pressure with one end unrestrained. The test assembly exterior shall be clean and dry and shall show no evidence of test fluid prior to testing. Using fluid per 4.4.2.4 proof pressure test per AS2094.

4.4.4 Burst Pressure Test Procedure: The test assembly shall be burst pressure tested per AS2094. The pressure may continue to be increased above the specified minimum burst pressure until burst or leakage occurs.

4.4.5 Pneumatic Pressure Test Procedure: The test assembly shall be connected to a source of pressure with one end unrestrained and pneumatic pressure tested per AS2094.

4.4.6 Repeated Assembly Test Procedure: The test specimens shall be assembled to the fitting 24° cone seat, one half of the specimens at the minimum and one half of the specimens at the maximum torque of Table 8, as specified and tested per AS2094 except as noted below. After the first tightening the tube and fitting end shall be marked with a longitudinal stripe to indicate their in-line relationship. The test sample joint shall be assembled and disassembled eight successive times. Each disassembly operation shall include the complete removal of the tube from the seat. At reassembly the tube shall be rotated 90° from the previous tube-to-fitting phase relationship. The direction of rotation shall be the same for each reassembly. After the third tightening operation, the test assembly shall be subjected to the proof pressure test per 4.4.3. After the eighth tightening operation, the test assembly shall be subjected to the burst test per 4.4.4.

4.4.7 Impulse Test Procedure: The test assembly shall be proof tested per 4.4.3. The impulse test shall be performed per AS2094 except the temperatures shall be considered to be room and need not be measured. Hydraulic fluid per 4.4.2.4 shall be used as the testing media. After completion of the impulse testing, the test sample shall be proof tested per 4.4.3.

4.4.8 Flexure Test Procedure: The flexure test for steel, CRES and titanium fittings shall meet the minimum bending stress level shown in Table 2. For aluminum fittings the flexure test shall meet the minimum total stress as shown in Table 2. The stress level shall be measured at the specified location on the test assembly. The total stress in Table 2 is defined as the axial tensile stress due to the internal pressure plus the dynamic tensile bending stress (see Equation 1). The axial tensile stress due to the internal pressure shall be determined as specified in 4.4.8.1. The dynamic tensile bending stress shall be determined as specified in 4.4.8.2.

$$S = Sa + Sb \qquad \text{(Eq. 1)}$$

where:

S = Total stress

Sa = Axial tensile stress due to internal pressures (4.4.8.1, Equation 2)

Sb = Dynamic tensile bending stress (4.4.8.2, Equation 3)

The flexure test procedure for Tables 3, 4, and 5 shall meet the minimum dynamic tensile bending stress for 4.4.8.2.