AEROSPACE STANDARD

AS4841™	REV. D

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Revised 2021-04

Superseding AS4841C

Fittings, 37 Degree Internal Flare, Fluid Connection, Procurement Specification

RATIONALE

Note 4.5.1.2 revised to remove the statement that destructive testing is required to retain QML status. This requirement is regulated by AC7112.

1. SCOPE

1.1 Purpose

This SAE Aerospace Standard (AS) establishes the requirements for 37 degree flared tube fittings or machined internal cone fluid connection fittings for use with 37 degree external cone, spherical nose, and seal ring fittings in all types of aerospace fluid systems (see Section 6).

1.2 Classification

Tube fittings shall be furnished in types, styles and sizes designated by the applicable AS, AN, and MS standards. This specification is a similar and an improvement to MIL-F-5509 for 37 degree flared tube fittings. It is intended to serve as the procurement specification for the fittings described herein.

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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2472 Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Dyed Coatings

AMS2486 Conversion Coating of Titanium Alloys, Fluoride-Phosphate Type

AMS2488 Anodic Treatment - Titanium and Titanium Alloys, Solution pH 13 or Higher

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

For more information on this standard, visit
https://www.sae.org/standards/content/AS4841D/

AMS2658	Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts
AMS2700	Passivation of Corrosion Resistant Steels
AMS2759	Heat Treatment of Steel Parts, General Requirements
AMS2770	Heat Treatment of Wrought Aluminum Alloy Parts
AMS2771	Heat Treatment of Aluminum Alloy Castings
AMS2772	Heat Treatment of Aluminum Alloy Raw Materials
AMS4124	Aluminum Alloy, Rolled or Cold Finished Bars, Rods, and Wire, 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T73, T7351), Solution Heat Treated, Stress Relieved by Stretching, and Overaged
AMS4133	Aluminum Alloy Forgings and Rolled Rings, 4.4Cu - 0.85Si - 0.80Mn - 0.50Mg (2014-T6), Solution and Precipitation Heat Treated
AMS4141	Aluminum Alloy Die Forgings, 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T73), Solution and Precipitation Heat Treated
AMS4339	Aluminum Alloy, Rolled or Cold Finished Bars and Rods, 4.4Cu - 1.5Mg - 0.60Mn (2024-T851), Solution Heat Treated, Cold Worked, and Artificially Aged
AMS4610	Brass, Free-Cutting Bars and Rods, 61.5Cu - 35Zn - 3.1Pb, Half Hard (H02)
AMS4928	Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes, 6Al - 4V, Annealed
AMS5639	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Mechanical Tubing, and Rings, 19Cr - 10Ni, Solution Heat Treated
AMS5645	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings, 18Cr - 10Ni - 0.40Ti (321), Solution Heat Treated
AMS5646	Steel Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr - 11Ni - 0.060Cb(Nb), (347) Solution Heat Treated
AMS5648	Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings, 17Cr - 12Ni - 2.5Mo (316), Solution Heat Treated
AMS5666	Nickel Alloy, Corrosion and Heat-Resistant, Bars, Forgings, Extrusions, and Rings, 62Ni - 21.5Cr - 9.0Mo - 3.65Cb (Nb), Annealed
AMS6370	Steel, Bars, Forgings, and Rings, 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
AMS6382	Steel, Bars, Forgings, and Rings, 0.95Cr - 0.20Mo (0.38 - 0.43C) (SAE 4140), Annealed
AMS-QQ-A-225/6	Aluminum Alloy, 2024, Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished
AMS-QQ-A-225/9	Aluminum Alloy 7075, Bar, Rod, Wire, and Special Shapes; Rolled, Drawn, or Cold Finished
AMS-QQ-P-416	Plating, Cadmium (Electrodeposited)
AMS-S-6758	Steel, Chrome-Molybdenum (4130), Bars and Reforging Stock (Aircraft Quality)
AMS-H-6875	Heat Treatment of Steel Raw Materials
ARP4784	Definitions and Limits, Metal Material Defects and Surface and Edge Features, Fluid Couplings, Fittings and Hose Ends

ARP9013 Statistical Product Acceptance Requirements

AS478 Identification Marking Methods

AS1376 Alternate Dimensions, Center Body Section, Shape Fluid Fitting, Design Standard

AS1708 Fitting End, Internal Flare, Design Standard

AS4330 Tubing, Flared, Standard Dimensions for, Design Standard

AS4395 Fitting End, Flared, Tube Connection, Design Standard

AS4396 Fitting End, Bulkhead, Flared, Tube Connection, Design Standard

AS5176 Fitting, Sleeve, Flared

AS5202 Port or Fitting End, Internal Straight Thread, Design Standard

AS5203 Tube End, Double Flare, Design Standard

AS5309 Fitting End, Spherical, 37° Flared Tube Connection Design Standard

AS5310 Fitting End, Bulkhead, Spherical, 37° Flared Tube Connection Design Standard

AS8879 Screw Threads - UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter

AS33583 Tubing End Double Flare, Standard Dimensions for

AS71051 Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT - Design and Inspection Standard

2.1.2 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

A-A-59133 Cleaning Compound, High Pressure (Steam) Cleaner

FED-STD-595 Colors Used in Government Procurement

MIL-A-8625 Anodic Coatings, for Aluminum and Aluminum Alloys

MIL-DTL-83488 Coating, Aluminum, High Purity

MIL-PRF-6083 Hydraulic Fluid, Petroleum Base, for Preservation and Operation

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric

MS21344 Fitting - Installation of Flared Tube, Straight Threaded Connectors, Design Standard for

2.1.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1 Surface Texture (Surface Roughness, Waviness and Lay)

2.1.4 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 A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

ASTM A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products

ASTM B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for use in Screw Machines

ASTM B154 Standard Test Method for Mercurous Nitrate Test for Copper Alloys

ASTM B858 Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys

2.1.5 PRI Publications

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

AC7112 NADCAP Audit Criteria for Fluid Systems Component Manufacturers

AC7112/2 NADCAP Audit Criteria for Fittings and other Machined Components

2.1.6 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 6957 Copper Alloys - Ammonia Test for Stress Corrosion Resistance

3. TECHNICAL REQUIREMENTS

3.1 Accreditation

3.1.1 Manufacturer Accreditation

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of AC7112 and shall be listed in the NADCAP Qualified Manufacturers' List (QML). The QML is available at www.eAuditNet.com.

3.1.2 Accreditation of Special Processes

Manufacturers of threaded items are to be accredited to PRI NADCAP AC7112/2 (see 3.5.3).

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 (see 6.2.2).

3.3 Heat Treatment

3.3.1 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 and of semi-finished or finished parts shall be in accordance with AMS2770, AMS2771, or AMS2772, as applicable.

Table 1 - Materials

Material	Type of Part	Form /1/	Material Specification	Alloy and Temper	Material Code
Aluminum Alloy /6/	Straight fittings, nuts	Bars, rods	AMS-QQ-A-225/6	2024-T6 or T851 /4/	D /8/
			AMS-QQ-A-225/9	7075-T73	W
			AMS4124	7075-T7351	W
			AMS4339	2024-T851 /4/	D /8/
	Shape fittings, nuts	Forgings	AMS4133	2014-T6 /4/	D /8/
			AMS4141	7075-T73	W
	Shape fittings	Bars	AMS-QQ-A-225/6	2024-T6 or T851 /4/	D /8/
			AMS-QQ-A-225/9	7075-T73	W
			AMS4124	7075-T7351	W
			AMS4339	2024-T851 /4/	D /8/
Copper-Base Alloy, Brass	Sleeves	Bars, rods	ASTM B16/B16M	Alloy 360, half hard	B
			AMS4610	Alloy 360, half hard	B
Corrosion Resistant Steel	Straight and shape fittings, nuts, sleeves	Bars	AMS5639	Class 304, Cond A	J
			AMS5648	Class 316, Cond A	K
			AMS5645	Class 321, Cond A	R
			AMS5646	Class 347, Cond A, /5/	S
	Shape fittings	Forgings	AMS5639	Class 304, Cond A	J
			AMS5648	Class 316, Cond A	K
			AMS5645	Class 321, Cond A	R
			AMS5646	Class 347, Cond A, /5/	S
Carbon and Low Alloy Steel /2/	Straight and shape fittings, nuts, sleeves	Bars, rods	AMS-S-6758 /3/	4130	F or none
			AMS6370	4130	F or none
			AMS6382	4140	F or none
	Shape fittings	Forgings	ASTM A108 /3/	1137, /7/	None
			AMS-S-6758 /3/	4130	F or none
			AMS6370	4130 Cold Finished	F or none
			AMS6382	4140 Cold Finished	F or none
Nickel Alloy	Straight and shape fittings, nuts, sleeves	Bars	AMS5666	Type 625	N
	Shape fittings	Forgings	AMS5666	Type 625	N
Titanium Alloy	Straight and shape fittings, nuts	Bars	AMS4928	6Al-4V annealed	T
	Shape fittings	Forgings	AMS4928	6Al-4V annealed	T

/1/ The center body section of shape fittings machined from bar or oversized forgings shall conform to AS1376 (see 3.5).
/2/ The hardness of carbon and low alloy steel parts shall be per 3.3.4. 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 AMS2759 (see 3.3.3).
/3/ This document is for bar from which forgings shall be made and only the chemical composition applies.
/4/ For U.S. Department of Defense Contracts, Type 2014 and 2024 aluminum shall not be used.
/5/ For U.S. Department of Defense Contracts, Class 347 material condition shall not be used.
/6/ The electrical conductivity and hardness of aluminum alloy shall be per 3.3.2. This requirement shall be added to the applicable document when materials are procured, or the material is heat treated before or after fabrication in order to meet the requirement.
/7/ For U.S. Department of Defense contracts, Type 1137 shall not be used.
/8/ Material Code letter W, 7075 aluminum, is a preferred replacement for material code letter D, 2014 and 2024 aluminum, because of superior corrosion and stress corrosion resistance.

3.3.2 Electrical Conductivity and Hardness

Aluminum alloy fittings and nuts shall meet the electrical conductivity and hardness requirements of AMS2658. The material may have to be heat treated before or after fabrication of parts in order to meet the requirement (see 4.7.2).

3.3.3 Steel

When required additional processing is required to comply with the hardness requirements of 3.3.4, heat treatment shall be per AMS-H-6875 or AMS2759.

3.3.4 Hardness Properties for Finished Carbon and Low Alloy Steel

Unless otherwise specified on the applicable drawings, the hardness of the finished carbon and low alloy steel parts with plating removed as applicable shall be 92 HRB to 40 HRC. For carbon and low alloy steel parts below a hardness of 20 HRC, hardness tests shall be made using the Rockwell B scale, in which case the hardness shall be within the range of 92 to 99 HRB (see 4.7.3).

3.4 Finish

3.4.1 Aluminum Alloy

3.4.1.1 Anodic Coating

Aluminum alloy fittings and nuts shall be anodized in accordance with MIL-A-8625 Type II, Class 2, or AMS2472, dyed blue for material code D; or brown for material code W, as applicable (see 3.7.4) and shall be duplex sealed. Contact area from anodizing electrode may show discoloration and impressions. Such discoloration and impression due to anodizing electrode shall not be cause for rejection if they occur in internal passages. Burn marks are not permissible. Bare areas occurring on 37 degree cone or spherical sealing surfaces, bearing or threaded surfaces shall be cause for rejection. Bare areas shall not exceed 30% of the remaining surface area.

3.4.1.2 High Purity Aluminum Coating

When specified, high purity aluminum coating shall be per MIL-DTL-83488, Class 3, Type II, with 0.0005 inch maximum thickness. Chromate treatment shall be applied after glass bead peening at a pressure of 25 psig maximum. Barrel processing is not permitted. Surface texture after glass bead peening and chromate treatment shall not exceed drawing tolerances. Coating thickness requirements for holes, recesses, and internal threads do not apply. Visual evidence of coating in holes and openings shall be to a minimum depth of two diameters or two times opening.

3.4.2 Low Alloy Steel Fittings

Low alloy steel fittings, sleeves, and nuts shall be cadmium plated in accordance with AMS-QQ-P-416, Type II, Class 2, dyed black (see 3.7.4). All such low alloy steel fittings, sleeves, and nuts shall be dipped in oil conforming to MIL-PRF-6083 or MIL-PRF-83282. 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.

3.4.3 Corrosion-Resistant Steel Fittings

Corrosion-resistant steel fittings, nuts, and sleeves shall be passivated per AMS2700, Type 6 or 7.

3.4.4 Copper-Base Alloy Fittings

Plating of copper-base alloy fittings in accordance with AMS-QQ-P-416, Type II, Class 3 when specified.

3.4.5 Titanium Alloy Fittings

Titanium alloy fittings and nuts shall be anodized per AMS2488 Type 2 or shall be fluoride phosphate coated per AMS2486, 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 shall be similar to colors 36076 through 36293 per FED-STD-595. Bare areas occurring on sealing, bearing, or threaded surfaces shall be cause for rejection. Bare areas shall not exceed 30% of the remaining surface area (see 3.8).

3.5 Design and Fabrication

The design and fabrication of the fittings ends shall be in accordance with the applicable standard part drawings. The fitting and tube ends shall be in accordance with AS1708, AS4330, AS4395, AS4396, AS5202, AS5203, AS5309, AS5310, AS33583, or other design standards 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. The following tube ends are called out as reference: AS4330, AS5203, and AS33583.

3.5.1 Shape and Form Restrictions

Abrupt reductions of section shall be avoided. Small external sections adjoining relatively heavy body sections shall be transitioned into the heavier sections by means of ample fillet radii.

3.5.2 Passages

3.5.2.1 Machining Offset

On straight fittings where the fluid passage is drilled from each end, the offset between the drilled holes at the meeting point of the drills shall not exceed 0.015 inch. It shall be possible to pass through the fluid passage a ball whose diameter is 0.020 inch less than the minimum diameter specified for the passage. Passages must meet the minimum diameter requirement by the detail part standard drawings.

3.5.2.2 Cross Section at Fluid Path Junction

On 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.

3.5.3 Threads

Pipe threads shall conform to AS71051. Straight threads shall be of unified form and shall conform to AS8879, except as specified herein. Threads may be cut, or ground, or rolled.

3.5.4 Rolled External Threads

Laps and seams, whose depths are within the limits of Table 2, are acceptable on the crest and the non-pressure thread flank above the pitch diameter. Laps and seams are not acceptable on any part of the pressure thread flank, in the thread root, or on the non-pressure thread flank in the area between the thread root and the pitch diameter (see Figure 1). Stress cracks are unacceptable.

Table 2 - Depth of laps, seams, surface irregularities, and discontinuities in rolled threads

Size Code	Depth, Inches, Max
02	0.006
03	0.006
04	0.007
05	0.007
06	0.008
08	0.009
10 through 48	0.010

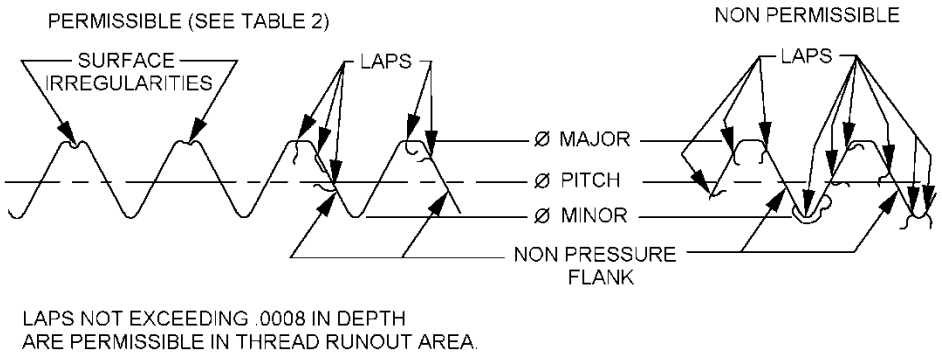

Figure 1 - Laps and surface irregularities in threads

3.5.5 Assembly

Unless otherwise specified, assemble using methods and torque values in accordance with MS21344.

3.6 Performance

3.6.1 Internal Strain of Copper-Base Alloys

Fittings fabricated from copper-base alloys shall have no internal strain as revealed by the test specified in 4.7.4. After testing, the parts shall be examined. Any evidence of cracks indicates internal strain and is not acceptable.

3.6.2 Expansion Test of Low Alloy Steel Sleeves

Sleeves per AS5176 or equivalent fabricated from low alloy steel shall meet the load values shown in Table 3 when subjected to the expansion test of 4.7.5.

Table 3 - Expansion test load values for standard AS5176 or equivalent low alloy steel sleeves

Size Code	Load, Pounds ±10 Pounds	Size Code	Load, Pounds ±10 Pounds
02	1700	16	8400
03	2200	20	11700
04	1950	24	15350
05	1950	28	16950
06	2050	32	18700
08	4200	40	20450
10	4100	48	22200
12	7400		

3.6.3 Operating Pressures

Fittings covered by this document when assembled per MS21344 are intended for use with all types of fluids, such as hydraulic fluids, oils, fuels, and oxygen. Except titanium for air and low density gases. Also except titanium and cadmium finished steel for oxygen and water. Recommended operating pressures are as shown in Tables 4A and 4B.

Historically, the pressures specified in Table 4 (prior to revision C) were intended to be used on steel tubing as specified in legacy standard MIL-F-5509. Tables 4A and 4B are being introduced to show recommended pressures based on fitting and tubing material combinations.

User shall verify pressures based on tubing wall thickness considered. When used on pressure lines higher than shown in Table 4A or 4B, the user shall perform tests defined herein.

Table 4 - Operating pressures /3.6.3/

Table 4A - Fitting material and operating pressures for use on 304 1/8 hard CRES tubing

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness Corrosion Resistant Steel Tubing per AMS-T-6845	Maximum Operating Pressure (psi) Steel, CRES, Ti Alloy Fittings	Maximum Operating Pressure (psi) Al Alloy /6.2.3/ Cu Alloy Fittings
0.125	02	0.012	3000	3000
0.188	03	0.016	3000	3000
0.250	04	0.020	3000	3000
0.312	05	0.020	3000	3000
0.375	06	0.028	3000	3000
0.500	08	0.035	3000	3000
0.625	10	0.042	3000	3000
0.750	12	0.058	3000	3000
1.000	16	0.065	3000	1500
1.250	20	0.049	1500	1500
1.500	24	0.065	1500	1000
2.000	32	0.065	1500	600
2.500	40	/1/	/1/	600
3.000	48	/1/	/1/	600

/1/ End user shall perform tests to determine acceptable pressure ratings, no test data is available at the time of this publication.

Table 4B - Operating pressures for Al alloy, Cu alloy or Ni alloy fittings for use on aluminum alloy tubing

Nominal Tubing OD	Tube Size in 0.062 Increments	Nominal Wall Thickness 6061-T6 Aluminum Alloy Tubing per AMS4083	Maximum Operating Pressure (psi) Al Alloy Cu Alloy Ni Alloy Fittings
0.125	02	/1/	1500
0.188	03	/1/	1500
0.250	04	0.035	1500
0.312	05	0.035	1500
0.375	06	0.035	1500
0.500	08	0.035	1500
0.625	10	0.035	1000
0.750	12	0.035	900
1.000	16	0.035, 0.049 /2/	900 /3/
1.250	20	0.049	600
1.500	24	0.049	600
2.000	32	0.065	600
2.500	40	/1/	600
3.000	48	/1/	600

/1/ End user shall perform tests to determine acceptable pressure ratings, no test data is available at the time of this publication.

/2/ If testing is completed with the 0.035 inch wall tubing at 900 psi operating pressure, then fittings tested with 0.049 inch tube wall are considered qualified by similarity.

/3/ When tested, the minimum burst pressure of 3600 psi cannot be consistently achieved with 0.035 inch tube wall for size 16 fittings. Therefore, 0.049 inch tube wall is recommended when 900 maximum operating pressure is required.

3.7 Identification of Product

All fittings, nuts, and sleeves shall be marked in accordance with the following instructions. The marking shall be applied per AS478 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. When items cannot be physically marked because of lack of space or because marking would have a deleterious effect, the package shall provide the identification per 5.4.

3.7.1 Manufacturer’s and Basic Part Number Prefix Identification

Unless otherwise specified, all fittings and nuts shall be marked with the manufacturer’s name, CAGE code, or trademark, and the letters AN, MS, AS, or NAS, as applicable. Sleeves may be trademarked only.

3.7.2 Material Identification

Fittings, nuts, and sleeves shall be marked with the material code letter as shown in Table 1.

3.7.3 Marking for Part Number and Size

A numerical size code, equivalent to the nominal tube size in 0.062 inch increments is optional. All fittings and nuts larger than 06 size code except cap assemblies, shall be marked with the basic part number, exclusive of size. Marking of part numbers on sleeves is optional. 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.

3.7.4 Color Identification

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

a. Aluminum alloy 2014 and 2024: Blue (see 3.4.1.1).

b. Aluminum alloy 7075: Brown (see 3.4.1.1).

c. Steel: Black (see 3.4.2).

d. Corrosion-resistant steel: None.

e. Copper-base alloys: Natural or cadmium plate, if applicable (see 3.4.4).

f. Titanium alloy: Gray (see 3.4.5).

g. Nickel base alloys: None.

3.8 Workmanship

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, seams, laps, cracks, segregations, spongy areas, burrs, or other defects as specified in ARP4784. 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. The surface texture of unmachined surfaces, except forging parting lines, shall be 250 µin Ra per ASME B46.1. The surface texture of forging parting lines shall be 500 µin Ra per ASME B46.1. ARP4784 also gives inspection methods.

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. Except as otherwise specified, the supplier may utilize their own facilities or any other laboratory acceptable to the procuring activity for the performance of the inspection and test requirements. The procuring activity reserves the right to perform any of the inspections and tests set forth in this document, whenever such inspections and tests are deemed necessary to assure that supplies and services conform to prescribed requirements.

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.

4.3 Material Certification

Records of the chemical composition analysis and mechanical property tests showing conformance to the material requirements of this document shall be available to the procuring activity upon request for each lot of fitting 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.

4.4 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.

4.5 Quality Conformance Sampling

4.5.1 Sampling

4.5.1.1 Sampling for Non-Destructive Inspection

Samples for non-destructive inspection shall be in accordance with ARP9013 and the IRR specified in Appendix A, and inspected per Table 5. The acceptance number is equal to zero rejections. A statistical method for product acceptance which provides equivalent or greater quality assurance than this sampling procedure may be used if approved by the procuring activity.

4.5.1.2 Sampling for Destructive Tests

Samples for destructive inspection shall be six samples taken at random from the lot being procured, or per Appendix A, and inspected per Table 6. The acceptance number is equal to zero rejections. A statistical method for product acceptance which provides equivalent or greater quality assurance than this sampling procedure may be used if approved by the procuring activity.

Table 5 - Quality conformance inspection for nondestructive inspection

Examination and Inspection Methods Requirement	Requirement Paragraph	Examination or Inspection Paragraph
Material requirements	3.2	4.3, 4.6
Design and fabrication	3.5	4.6
Identification of product	3.7	5.4
Workmanship	3.8	4.6

Table 6 - Quality conformance inspection for destructive tests

Tests and Inspection Methods Requirement	Requirement Paragraph	Examination or Inspection Paragraph
Durability of aluminum finish	3.4.1	4.7.1
Electrical conductivity and hardness	3.3.2	4.4, 4.7.2
Hardness for finished carbon and low alloy steel fittings	3.3.3, 3.3.4	4.4, 4.7.3
Internal strain of copper alloy	3.6.1	4.7.4
Expansion test of low alloy steel sleeves	3.6.2	4.7.5

4.6 Examination of Product

Using the sampling of 4.5.1.1, for nondestructive inspection, each lot of fittings shall be examined per Table 5. Design and dimensions shall be examined in accordance with ARP9013 as shown in Appendix A.

4.7 Tests

Using the sampling of 4.5.1.2 for destructive testing, each lot of fittings shall be examined per Table 6.

4.7.1 Durability of Finish

Dyed aluminum anodized fittings shall withstand immersion in a cleaning solution containing 5 to 6 ounces of a cleaner conforming to A-A-59133 per gallon of solution at a temperature of 160 to 170 °F for 5 minutes. The color shall not rub off when wiped lightly with a clean cloth.

4.7.2 Electrical Conductivity and Hardness

Aluminum alloy fittings and nuts shall be tested per AMS2658.

4.7.3 Hardness of Low Alloy Steel Fittings

The hardness of low alloy steel fittings shall be determined by hardness tests of the fittings. Rockwell hardness readings shall be taken on a smooth flat surface of any unthreaded portion of the fitting from which the plating has been removed as applicable. Hardness tensile strength relationships are specified in ASTM A370.

4.7.4 Internal Strain of Copper-Base Alloys

Fittings fabricated from copper-base alloys, shall be tested for residual internal stresses from manufacturing per ASTM B154 or ASTM B858 or ISO 6957. The risk level PH for ASTM B858 or ISO 6957, for the ammonia vapor test, shall be ten. Any visual evidence of cracks indicates internal strain and is not acceptable.

4.7.5 Expansion Test of Low Alloy Steel Sleeves

Sleeves shall be selected as required by 4.5.1.2 and submitted to an expansion test. The test shall be performed with a tapered arbor and a holding device as shown in Figure 2. The arbor shall be loaded as required by the values given in Table 7. The head of the sleeve shall be expanded by the load applied through the tapered arbor. The maximum expansion of the outside diameter shall be measured with the load applied. This measurement shall be taken in at least two places 90 degrees apart on the diameter. The average measurement shall be recorded and compared with the minor diameter of the threads of the mating nut. The average expanded diameter shall not exceed the minimum minor diameter of the threads. This test is in addition to and does not supplant the required dimensional inspection of low alloy steel sleeves, which shall be conducted prior to the expansion test.

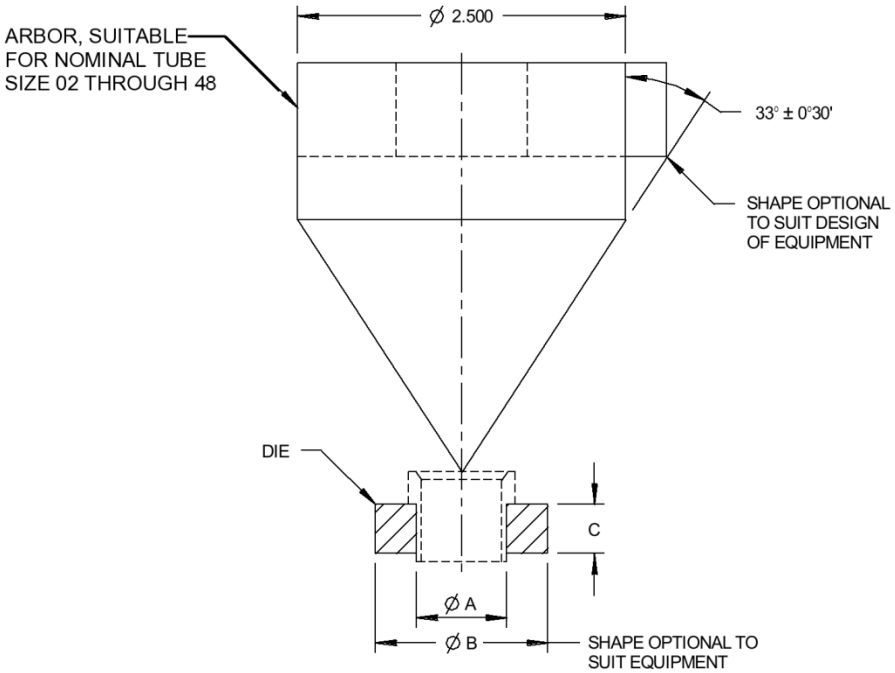

Figure 2 - Fixture for testing sleeves, dimensions in inches; see Table 7

Table 7 - Dimensions, sleeves test fixture

Size	A +0.003/−0.000	B Min	C Min
02	0.180	0.750	0.460
03	0.242	0.750	0.500
04	0.305	0.750	0.560
05	0.374	0.750	0.560
06	0.440	1.250	0.590
08	0.570	1.250	0.590
10	0.698	1.250	0.340
12	0.834	1.750	0.680
16	1.089	1.750	0.750
20	1.347	2.000	0.840
24	1.617	2.250	1.010
28	1.890	3.000	1.000
32	2.167	3.000	1.010
40	2.667	3.250	1.040
48	3.180	3.250	1.040

4.7.6 Rejection and Retest

Rejected lots shall be resubmitted for retest one time with one or more failure to reject the entire lot. Those fittings subjected to destructive testing shall be discarded, whether they pass the test or not.

5. PREPARATION FOR DELIVERY

5.1 Cleaning

Surfaces of fittings shall be free of oil, grease, dirt, and other foreign material, except as noted in 5.2.

5.2 Preservation Application

No preservative compound shall be applied except that cadmium plated steel parts shall be dipped in oil as specified in 3.4.2.

5.3 Packaging

All fittings shall be packaged as necessary to prevent damage, corrosion, or deterioration during storage or shipment.

5.4 Package Identification

Each package shall be identified with the following minimum information:

a. Manufacturer’s identification (name, CAGE code).

b. Manufacturer’s part number.

c. Customer’s part number, if different from b.

d. Item description (noun).

e. Quantity and unit of issue (each, piece, etc.).

f. Contract number (for government contracts only).

5.5 Packing for Shipment

Containers of parts shall be prepared for shipment in accordance with commercial practice to ensure carrier acceptance and safe transportation to the point of delivery.

6. NOTES

NOTICE

This document references a part which contains cadmium as a plating material. Consult local officials if you have questions concerning cadmium's use.

6.1 This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

6.2 Intended Use

Hydraulic and fluid Tube fittings covered within this standard are intended for use in all types of fluids and are considered a replacement for MIL-F-5509. These parts are used in various applications through the aerospace industry and the DoD.

6.2.1 Supplemental Information

The previous listed capabilities for flared fittings are for reliable fitting joints based upon operational experience using AS, AN, MS, and fittings, nuts, sleeves, and flares. By using nonstandard design joints (thicker walled nuts or fittings, special seals, etc.), burst pressures of 20000 to 25000 psi have been obtained with correspondingly higher operating pressures and proof pressures and qualified with impulse test. These nonstandard fittings may be used at more severe conditions (load, vibration, corrosion, etc.) than specified in this document, but the design and supporting test data are the designer's responsibility and are subject to approval by the procuring activity. In addition, the Barlow formulae as defined in ASTM A370 may be used to determine the wall thickness using the yield strength of the metal with some safety factor and then tested with higher proof pressures, burst pressures, and impulse test.

6.2.2 Superseding Information

This document is intended to be an improved suitable designation as a procurement specification for flared tube fittings incorporating internal nominal 37 degree conical sealing surfaces. This document is also an improvement as a primary procurement specification for the following known fittings and other associated part standard fittings that use MIL-F-5509, as follows:

Table 8 - Supersession table

Cancelled	Name	Replacement	Name
AN783	TEE, FLARED TUBE, INTERNAL THREAD ON SIDE	AS1031	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, INTERNAL PORT ON SIDE, FLARED
AN784	TEE, FLARED TUBE, INTERNAL THREAD ON RUN	AS1032	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, INTERNAL PORT ON RUN, FLARED
AN804	TEE, FLARED TUBE WITH BULKHEAD ON RUN	AS1033	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, FLARED
AN821	ELBOW-FLARED TUBE, 90°	AS1034	FITTING, ELBOW 90°, STANDARD AND REDUCER, FLARED
AN824	ELBOW-FLARED TUBE, 90°	AS1035	FITTING, TEE, STANDARD AND REDUCER, FLARED
AN827	CROSS-FLARED TUBE	AS1036	FITTING, CROSS, STANDARD AND REDUCER, FLARED
AN833	ELBOW-FLARED TUBE AND BULKHEAD UNIVERSAL, 90°	AS1038	FITTING, ELBOW, 90°, STANDARD AND REDUCER, BULKHEAD, FLARED
AN834	TEE, BULKHEAD AND UNIVERSAL FLARED TUBE	AS1039	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON SIDE, FLARED

AN837	ELBOW, FLARED TUBE AND UNIVERSAL, 45°	AS1040	FITTING, ELBOW, 45°, STANDARD AND REDUCER, BULKHEAD
AN910	COUPLING, PIPE	AS4859	FITTING, COUPLING, PIPE, INTERNAL THREAD
AN911	NIPPLE, PIPE	AS4860	FITTING, NIPPLE, PIPE, EXTERNAL THREAD
AN912	BUSHING, PIPE	AS4861	FITTING, BUSHING, PIPE, INTERNAL AND EXTERNAL THREAD
AN914	ELBOW, PIPE, INTERNAL AND EXTERNAL THREAD, 90°	AS4854	FITTING, ELBOW, 90°, PIPE, INTERNAL AND EXTERNAL THREAD
AN915	ELBOW, PIPE, 45°	AS4855	FITTING, ELBOW, 45°, PIPE, INTERNAL AND EXTERNAL THREAD
AN916	ELBOW, PIPE, INTERNAL THREAD, 90°	AS4856	FITTING, ELBOW, 90°, PIPE, INTERNAL THREAD
AN917	TEE, PIPE	AS4857	FITTING, TEE, PIPE, INTERNAL THREAD
AN918	CROSS, PIPE	AS4858	FITTING, CROSS, PIPE, INTERNAL THREAD
AN933	PLUG, PIPE, HEX HEAD	AS4862	FITTING, PLUG, PIPE, EXTERNAL THREAD, HEX HEAD
MS24385	FITTING END, FLARED TUBE CONNECTION, PRECISION TYPE, STANDARD DIMENSIONS	AS4395	FITTING END, FLARED, TUBE CONNECTION, DESIGN STANDARD
MS24386	FITTING END, BULKHEAD FLARED TUBE CONNECTION, PRECISION TYPE, STANDARD DIMENSIONS	AS4396	FITTING END, BULKHEAD, FLARED TUBE CONNECTION, DESIGN STANDARD
MS24388	TEE, FLARED TUBE, INTERNAL THREAD ON SIDE, PRECISION TYPE	AS1031	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, INTERNAL PORT ON SIDE, FLARED
MS24389	TEE, TUBE, INTERNAL THREAD ON RUN, PRECISION TYPE	AS1032	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, INTERNAL PORT ON RUN, FLARED
MS24390	TEE, FLARED TUBE WITH BULKHEAD ON RUN-PRECISION TYPE	AS1033	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON RUN, FLARED
MS24394	ELBOW, TUBE, BULKHEAD, 90°, PRECISION TYPE	AS1038	FITTING, ELBOW, 90°. STANDARD AND REDUCER, BULKHEAD, FLARED
MS24395	TEE, TUBE, BULKHEAD, PRECISION TYPE	AS1039	FITTING, TEE, STANDARD AND REDUCER, BULKHEAD ON SIDE, FLARED
MS24396	TEE, BULKHEAD AND UNIVERSAL FLARED TUBE	AS1040	FITTING, ELBOW, 45°, STANDARD AND REDUCER, BULKHEAD
MS24401	ELBOW, TUBE, 90°, PRECISION TYPE	AS1034	FITTING, ELBOW, 90°, STANDARD AND REDUCER, FLARED
MS24402	TEE, TUBE, PRECISION TYPE	AS1035	FITTING, TEE, STANDARD AND REDUCER, FLARED
MS24403	CROSS, TUBE, PRECISION TYPE	AS1036	FITTING, CROSS, STANDARD AND REDUCER, FLARED
MS33656	FITTING END, STANDARD DIMENSIONS FOR FLARED TUBE CONNECTION AND GASKET SEAL	AS4395	FITTING END, FLARED, TUBE CONNECTION, DESIGN STANDARD
MS33657	FITTING END, STANDARD DIMENSIONS FOR BULKHEAD FLARED TUBE CONNECTION	AS4396	FITTING END, BULKHEAD, FLARED TUBE CONNECTION, DESIGN STANDARD
MS33583	TUBING END, DOUBLE FLARE, STANDARD DIMENSIONS FOR	AS33583	TUBING END DOUBLE FLARE, STANDARD DIMENSIONS
MS33584	TUBING END, STANDARD DIMENSIONS FOR FLARED	AS4330	TUBING, FLARED, STANDARD DIMENSIONS FOR, DESIGN STANDARD

Fittings that have a 37 degree cone seat and also have pipe threaded connections, beaded hose connections, or flanged or straight threaded port connections will have different primary procurement specification, but will designate this as a supplement specification to cover the 37 degree cone seat connections.

6.2.3 Lessons Learned, Aluminum Fittings and Their Use on Commercial Jet Aircraft

The use of aluminum sleeves in conjunction with aluminum fittings for sizes -10 and -12 on 3000 psi systems resulted in unacceptable performance levels on commercial aircrafts. Replacing aluminum sleeves with CRES sleeves improved performance levels. As a result, manufacturers of commercial aircrafts discontinued the use of the aluminum sleeve/fitting combinations as well as aluminum fittings having the flared feature as part of the fitting, for 3000 psi systems entirely.

The use of any aluminum fittings on 3000 psi systems is not recommended for new design but remain supported for legacy systems, at user's discretion.

6.3 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

6.4 Dimensions

All dimensions are in inches unless noted.

PREPARED BY SAE SUBCOMMITTEE G-3B, AEROSPACE FITTINGS OF
COMMITTEE G-3, AEROSPACE COUPLINGS, FITTINGS, HOSE AND TUBING ASSEMBLIES

APPENDIX A

A.1 SCOPE

This appendix establishes a classification of commonly occurring defects applicable to flared fluid fittings. The information contained herein is intended for use as notes and advices to be used on contracts.

A.1.1 Impact of Characteristics

Impact on classes of characteristics are herein considered using minimum Initial Reliability Requirement (IRR), according to the effect they have on safety and usability. The classes of impact on characteristics, and associated IRR are shown in the following tables.

Table A1 - Classes of characteristics, impact, and IRR

Class	Characteristic	IRR
Major	Likely to result in failure or to reduce materially the usability of the unit of product for its intended purpose	98%
Minor A	May have a slight effect on usability	95%
Minor B	Has essentially no effect on usability	92%

Table A2 - Fitting end design, 37 degree external flared cone

Class	Characteristics	IRR
Major	Incomplete or missing holes Surface finish of cone or spherical sealing surface	98%
Minor A	Dimensions of thread Width of O-ring seal undercut Circular runout of cone or spherical sealing surface to thread Surface finish of O-ring seal undercut Squareness of O-ring seal undercut face to thread Angle of 37 degree seal cone Diameter of O-ring undercut Circular runout of O-ring undercut diameter to thread	95%
Minor B	Remainder	92%

Table A3 - Fitting end design, 37 degree external flared cone, bulkhead

Class	Characteristics	IRR
Major	Incomplete or missing holes Surface finish of cone or spherical sealing surface	98%
Minor A	Dimensions of thread Width of O-ring seal undercut Surface finish of O-ring seal undercut Circular runout of cone or spherical sealing surface to thread Angle of 37 degree seal cone Diameter of O-ring undercut Circular runout of O-ring undercut diameter to thread Continuation of same thread lead on interrupted thread	95%
Minor B	Remainder	92%

Table A4 - Nut, coupling tube, 37 degree internal flared fitting

Class	Characteristics	IRR
Major	Circular runout of ID hole to thread Minimum length of full thread, burr inspection	98%
Minor A	Dimensions of threads ID of nut Overall length Distance from inside shoulder to front of nut	95%
Minor B	Remainder	92%

Table A5 - Straight fitting (adapter, reducer, union), 37 degree cone flared

Class	Characteristics	IRR
Major	Incomplete or missing holes, burr inspection	98%
Minor A	Design and fabrication	95%
Minor B	Remainder	92%

Table A6 - Cap assemblies, 37 degree, internal flared

Class	Characteristics	IRR
Major	Surface finish of sealing surface (verify before assembly), burr inspection	98%
Minor A	Thread dimensions (verify before assembly) Nut free to swivel Retainer wire within hex limits	95%
Minor B	Remainder	92%

Table A7 - Shape fitting (tee, elbow, cross, etc.), 37 degree cone flared

Class	Characteristics	IRR
Major	Incomplete or missing holes, burr inspection	98%
Minor A	Minimum wall thickness Angle between legs Wire installation, retained nut fitting ends	95%
Minor B	Remainder	92%

Table A8 - Nut, lock, flat bulkhead

Class	Characteristics	IRR
Major	Burr inspection	98%
Minor A	Dimensions of thread Squareness of thread to face of hex	95%
Minor B	Remainder	92%

Table A9 - Sleeves tube, 37 degree internal flared fitting

Class	Characteristics	IRR
Major	Expansion test, circular, concentricity, squareness, Minimum ID, interface, and angle of seal surface burr inspection	98%
Minor A	Overall length	95%
Minor B	Elliptical, but fits next higher assembly, remainder	92%

Table A10 - Sampling inspection, tables for isolated lot applications

Initial Reliability Requirement (IRR) (98%)	
Lot Size	Sample Size
Up to 25	All
26-52	25
53-57	26
58-63	27
64-74	28
75-104	29
105-126	30
127-181	31
182-303	32
304-693	33
694 or larger	34

Initial Reliability Requirement (IRR) (95%)	
Lot Size	Sample Size
Up to 10	All
11-22	10
23-33	11
34-80	12
81-4371	13
4372 or larger	14

Initial Reliability Requirement (IRR) (92%)	
Lot Size	Sample Size
Up to 6	All
7-12	6
13-32	7
33 or larger	8