SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS18280 | REV. D

Issued 1999-03
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Superseding AS18280C

Fittings, 24° Cone Flareless, Fluid Connection, 3000 psi

RATIONALE

To correct material specification numbers in Table 1, to clarify fluorescent inspection for aluminum forgings, and to add a thread requirement for ISO 3161.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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TABLE OF CONTENTS

1. SCOPE

1.1 Scope

This SAE Aerospace Standard (AS) establishes the requirements for 24 degree 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 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 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.

AMS2472	Anodic Treatment of Aluminum Alloys Sulfuric Acid Process, Dyed Coating
AMS2486	Conversion Coating of Titanium Alloys Fluoride Phosphate Type
AMS2488	Anodic Treatment - Titanium and Titanium Alloys Solution pH 13 or Higher
AMS2658	Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts
AMS2700	Passivation Treatment for Corrosion Resistant Steel
AMS2759/3	Heat Treatment Precipitation-Hardening Corrosion-Resistant and Maraging Steel Parts
AMS2770	Heat Treatment of Wrought Aluminum Alloy Parts
AMS2772	Heat Treatment of Aluminum Alloy Raw Material
AMS4083	Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round 1.0Mg – 0.60Si – 0.28Cu – 0.20Cr (6061-T6) Solution and Precipitation Heat Treated
AMS4124	Aluminum Ally, Rolled or Cold Finished Bars, Rods, and Wire 5.6Zn – 2.5Mg – 1.6Cu – 0.23Cr (7075-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 - 2.6Mg - 1.6Cu - 0.23Cr (7075-T73), Solution and Precipitation Heat Treated
AMS4339	Aluminum Alloy Rolled and Cold Finished Bars and Rods 4.4 Cu - 1.5Mg - 0.60Mn (2024-T851) Solution Heat Treated, Cold Worked and Artificially Aged
AMS4928	Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes 6Al-4V, Annealed
AMS4946	Titanium Alloy Tubing, Seamless, Hydraulic 3Al-2.5V, Texture Controlled, Cold Worked, Stress Relieved
AMS5561	Steel, Corrosion and Heat Resistant, Welded and Drawn or Seamless and Drawn Tubing 9.0Mn - 20Cr - 6.5Ni - 0.28N High-Pressure Hydraulic
AMS5564	Steel, Corrosion Resistant, Tubing 19Cr - 10Ni (SAE 30304) High-Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless Cold Drawn, One Eighth – Hard Temper
AMS5566	Steel, Corrosion Resistant, Seamless or Welded Hydraulic Tubing 19Cr - 10Ni, (SAE 30304) High Pressure, Cold Drawn
AMS5639	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing and Rings, 19Cr - 10Ni Solution Heat Treated
AMS5645	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings, 18Cr - 10Ni - 0.40Ti (SAE 30321) Solution Heat Treated
AMS5648	Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing and Rings, 17Cr - 12Ni - 2.5Mo Solution Heat Treated
AMS5659	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Rings and Extrusions, 15Cr - 4.5Ni - 0.30 (Cb (Nb) - 3.5Cu Consumable Remelted Precipitation Hardenable
AMS6370	Steel, Bars, Forgings and Rings, 0.95Cr - 0.20Mo (0.28-0.33C) (SAE 4130)
AMS-H-6875	Heat Treatment of Steel Raw Materials
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-T-6845	Tubing, Steel, Corrosion-Resistant (S30400), Aerospace Vehicle Hydraulic System 1/8 Hard Condition
AMS-T-7081	Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061, Aircraft Hydraulic Quality
AS478	Identification Marking Methods
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS1376	Alternate Dimensions, Center Body Section, Shape Fluid Fittings, Design Standard
AS1581	Fitting, Sleeve, Flareless Acorn to Integral Weld Ring, 3000 psi
AS2094	Test Methods for Tube-Fitting Assemblies

AS4375	Fitting End, 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
AS4703	Fitting End, Acorn, Short Flareless, Design Standard
AS5148	Assembly, Installation and Torque for Flareless and Straight Thread Fluid Fittings and Tube Assemblies
AS5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting, Procurement Specification
AS5620	Titanium Hydraulic Tubing, Ti-3Al-2.5V Cold Worked and Stress Relieved, Up to 35,000 kPa (5080 psi) Requirements for Qualification Testing and Control
AS5863	Fitting End, 24° Cone, Flareless, Fluid Connection, Design Standard
AS5864	Fitting End, 24° Cone, Bulkhead, Flareless, Fluid Connection, Design Standard
AS7003	Nadcap Program Requirements
AS8879	Screw Threads - UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter
ARP9013	Statistical Product Acceptance Requirements
AS18280/1	Sleeve, Bite Type, 24° Cone Flareless Fitting, 3000 psi
AS18280/2	Sleeves, Internally or Externally Swaged or Welded, 24° Cone Flareless Fitting, 3000 psi
AS21914	Cap, Pressure Seal, Flareless Tube Fitting
AS21922	Sleeve, Coupling, Flareless
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 from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch or www.assist.daps.mil.

MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-HDBK-1655	Fittings, Flareless, Classification of Defects of
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
MIL-PRF-6083	Hydraulic Fluid, Petroleum Base, For Preservation and Operation

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

MIL-PRF-87257 Hydraulic Fluid, Petroleum Base, Missile Ordnance Reviewer Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

FED-STD-595 Colors Used in Government Procurement

2.1.3 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS1760 Fitting End, Flareless Acorn, Standard Dimensions for

2.1.4 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)

ASME Y14.38 Abbreviation for Use on Drawings and in Text

2.1.5 ASQ Publications

Available from American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203, Tel: 800-248-1946 (North America) or +1-414-272-8575 (International), www.asq.org.

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

2.1.6 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

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

2.1.7 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

AC7102 Nadcap Audit Criteria for Heat treating

AC7102/2 Nadcap Audit Criteria for Aluminum Heat Treating

AC7114 Nadcap Audit Criteria for Nondestructive Testing (NDT) Suppliers Accreditation Program

AC7114/1 Nadcap Audit Criteria for Nondestructive Testing (NDT) Facility Penetrant Survey

PD2001 Tasks & Procedures of the Qualified Product Management Council

PD2101 Aerospace Quality Assurance, Product Standards, Qualification Procedure, Fluid Distribution Systems

PRI-QPL-AS18280 Fittings, Flareless, Tube, Fluid Connection

2.1.8 ISO Publications

Available from Internal Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment

ISO 17025 General Requirements for the Competence of Calibration and Testing Laboratories

ISO 3161 Aerospace - UNJ Threads - General Requirements and Limit Dimensions

2.1.9 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 A 370 Steel Products, Mechanical Testing of

ASTM E 1417 Practice for Liquid Penetrant Examination

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 AC7112 and shall be listed in a Performance Review Institute (PRI) Qualified Manufacturers List (QML).

3.1.2.1 Accreditation of Special Processes

Special processes as listed in AC7112 require Nadcap Accreditation of the following processes by the manufacturer and/or his subtier:

a. Heat treatment of aluminum forged fittings to AC7102 and AC7102/2 (see 3.2.1)

b. Fluorescent penetrant inspection of aluminum forged fittings to AC7114 and AC7114/1 (see 4.6.3)

c. Fabrication of fittings seal areas to AC7112/2 (see 3.4.5)

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

3.2.1.1.1 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.

NOTE: In the event of conflict of hardness or electrical conductivity between AMS2658 and the fitting forging specifications AMS4141 (7075-T73) and AMS4133 (2014-T6) the hardness requirement of AMS2658 may be considered a reference if in conflict with AMS4141, and the electrical conductivity requirement may be considered reference if it is in conflict with AMS4133.

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 AMS2759/3.

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).

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 /7/
			AMS4339	2024-T6	D /7/
			AMS4339	2024-T851	D /7/
			AMS-QQ-A-225/9	7075-T73	W
			AMS4124	7075-T7351	W
			Notes: /1/ /2/ /3/ all		
	Shape fittings and nuts	Forgings	AMS4133	2014-T6	D /7/
			AMS4141	7075-T73	W
			Notes: /1/ /2/ /3/ all		
	Shape fittings	Bars	AMS-QQ-A-225/6 /1/	2024-T6 or T851	D /7/
			AMS4339	2024-T6	D /7/
			AMS-QQ-A-225/9 /1/	7075-T73	W
			AMS4124	7075-T7351	W
			Notes: /1/ /2/ /3/ all		
Low alloy steel	Straight and shape fittings and nuts	Bars, rods	AMS6370	4130	None /8/
	Shape fittings	Forgings	AMS6370	4130	None /8/
			Notes: /4/ all		
Corrosion resistant steel	Straight and shape fittings, nuts and non-bite type sleeves	Bars	AMS5639 /5/	Class 304, Cond A	J
			AMS5648 /5/	Class 316, Cond A	K
			AMS5645 /5/	Class 321, Cond A	R
			AMS5659	Type 15-5PH	V
	Shape fittings	Forgings	AMS5639 /5/	Class 304, Cond A	J
			AMS5648 /5/	Class 316, Cond A	K
			AMS5645 /5/	Class 321, Cond A	R
			AMS5659	Type 15-5PH	V
Titanium alloy	Straight and shape fittings, nuts and non-bite type sleeves	Bars	AMS4928	6Al-4V annealed	T
	Shape fittings	Forgings	AMS4928	6Al-4V annealed	T

/1/ 2014, 2024, and 7075 aluminum alloy fittings, D Code and W Code, are qualified with 304 1/8 hard tubing to pressures as listed under Table 2, and with 6061 T6 tubing to pressures as listed under Table 3, depending on application.

/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 AMS2759/3 (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.

/7/ AS21900-series part standards controlled by AS18280 have been revised to make Code Letter D fittings of 2014 and 2024 aluminum inactive for design and procurement.

/8/ Code “F” has been used in AS1001-series standards.

3.2.2.2 Class 300 Series Corrosion Resistant Steel

Unless otherwise specified on the applicable drawings, the finished Class 300 series condition A corrosion resistant steel yield strength shall be 30 000 psi minimum (80 HRB minimum reference) (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 AMS2759/3 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 and 7075 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, AS5863, AS5864, 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.

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 or ISO 3161 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.

NOTES:
1. Threads shall not be grit or bead blasted unless required as preparation for application of solid film lubricant.
2. Gaging and conformance requirements for ISO 3161 threads shall follow practices outlined under AS8879 Category I.

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 AMS2472, 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.

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 AMS2700 Method 1 or Method 2. 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 AMS2700. 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 twenty-four hours 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 three hours at 375 °F ± 25 °F. Color shall be yellow to brownish (see 3.5.4). 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 AMS2488 or 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 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.

NOTES: 1. Not meeting the exact color requirement shall not be cause for rejection.

2. When solid film lubricant is specified it shall be in accordance with AS5272 Type II. Minor overspray of the lubricant on outside of internal threads is permitted.

3.4.5 Fabrication of Seal Areas for 15-5PH and Titanium Fittings by Sub-tier

Initial approval of a subtier without Nadcap Accreditation, requires passing requirements of the periodic control test of titanium and 15-5PH sample fittings per 4.5.3 prior to supplying parts for procurement. For final approval of the subtier, this test has to be repeated three times following fabrication of 2500, 5000, and 10 000 fittings. Following fabrication of 10 000 fittings the subtier shall maintain the same test-period criteria as the manufacturer.

NOTES: 1. This requirement shall be specified for each different subtier that a manufacturer utilizes under their fabrication system. Records shall be maintained showing compliance with these requirements for each sub-tier utilized by the manufacturer.

2. Seal Area of fittings is defined as the contact area between 24 degree union cone and the rounded sleeve or acorn which establishes a seal when the assembly is tightened. This also pertains to O-ring seal areas in boss installations, in AS33649 and AS5202 bosses and on mating unions, having AS33514, AS4375, AS4377, AS5863 or AS5684 fitting ends,

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, lot number, 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 or inclusion in the lot number to identify the forging source.

NOTES: 1. A permanent mark associated with the lot number is required on each part. The mark shall be comprised of alpha-numeric characters whose size is at least as large as specified in AS478. Lot number marking shall be traceable to identify intended parts and may represent multiple finished part lots produced from a single production run. It is not necessary to mark the actual lot number on the part as long as the suppliers can decode the mark, as read by the customer, to determine the lot number. The lot number and lot code (if used) are required on the package and on the shipping label.

2. Letter combinations that are associated with the standard part number such as MS, AN, AS, etc. should be avoided if there is any possibility of confusion with a part number. The lot number mark shall not obscure other marks required by this document.

3. Lot number marks on parts sized -6 and below may use marking media (paint, ink, etc.) which might not meet the criteria necessary for a permanent mark. The mark should survive incidental contact (incidental contact - the mark shall be legible after immersion in hydraulic fluid and wiped dry) with the hydraulic fluids referenced by this document, but it might not survive a prolonged immersion test. The lot number or code on size -6 and below may also be applied across other marks as long as the lot mark and the other marks remain legible. See 3.5 above.

4. The lot number is required on the packages and shipping label.

5. Introduction of lot numbering shall be implemented by January 1, 2010. Parts fabricated prior to that date may be used until depleted. Lot numbering is required for four-digit AS part standards listed in AS18280SUP. Lot numbering is not required for AS1790 Retained Nuts and five-digit part standards listed in AS18280SUP. It is noted that introduction of this requirement may constitute a Class 1 or Class 2 change per PD2101 and shall be processed in accordance with the requirements of PD2101 prior to implementation.

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: Yellowish brown (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 yellowish-brown (see 3.4.2).

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.

NOTE: As specified in PD2101, qualification testing of sizes 06 and 16 is sufficient for qualification of sizes 06, 08, 10, 12, and 16. Qualification testing of remaining sizes 05 and under, and sizes 20 and over shall be performed in the individual sizes.

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.

a. 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.

b. Modifications of 24 degree cone fittings, new tubing materials or other attachment methods are to be qualified by comparing their fatigue life against that of the basic 24 degree 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 degree cone fitting and cold-worked corrosion-resistant steel tubing.

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 per 3.6.6.1. Two specimens shall pass the minimum stress levels specified 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.

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	Maximum 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 AMS4083	Maximum Operating Pressure psi	Bending Stress Level in Tube for Flexure Test +0/-10% psi
0.250	04	0.035	1500	6000
0.312	05	0.035	1500	6000
0.375	06	0.035	1500	6000
0.500	08	0.035	1500	5500
0.625	10	0.035	1000	5500
0.750	12	0.035	900	5000
1.000	16	0.035	900	4000
1.250	20	0.049	600	4000
1.500	24	0.049	600	4000

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 Tubing per AMS5561	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 AMS4946 /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	9000
1.500	24	0.018	600	12 000
1.500	24	0.040 min	1500	10 000
1.500	24	0.078	3000	9000
2.000	32	0.022	600	10 000
2.000	32	0.053 min	1500	9000

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

TABLE 6 - MINIMUM JOINT STRENGTH OF FLARELESS TUBE END ATTACHMENT FITTINGS, 304 1/8 HARD CORROSION RESTISTANT STEEL TUBING

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

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.

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 and 7075 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 externally 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, unless required as preparation for application of solid film lubricant.

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. 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.

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 (see 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-5606, MIL-PRF-6083, 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.

TABLE 7 - TEST SAMPLES FOR QUALIFICATION INSPECTION AND PERIODIC CONTROL TESTS

Test	Requirement Paragraph	Test Procedure Paragraph	Fitting Assembly Description	Material	Quantity Each
Burst Pressure	3.6.2	4.4.4	Straights with Tube and Tee /1/	All /3/	2 each Union 3 each Tee
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	Straights with Tube and Tee /1/	All /3/	3 each Union 3 each Tee
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, 4.5.3	Straight or shape /5/	Titanium and 15-5PH	8 fitting ends

/1/ Qualification Tests of Shape Fittings

a. For description of test specimens see AS2094.
b. There shall be at least one fitting end with a 24 degree cone, nut, sleeve, and tube 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 of 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

4.4.2.3 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-5606, MIL-PRF-6083, MIL-PRF-87257, or MIL-PRF-83282, or water shall be the test fluid.

4.4.2.5 Calibration and Certification 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. Except as otherwise specified, the supplier shall utilize a test laboratory that is accredited to ISO 17025.

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:

a. The place of testing.

b. The date of testing.

c. The identification of the test technician or engineer responsible for the observing and recording of the measured or observed data.

d. 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.

e. 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.

f. The ambient temperature of the testing location.

g. The temperature of the test sample or the immediate area around the test sample during testing if other than ambient temperature.

h. The type of fluid used in testing if applicable.

i. 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.

j. Photographs of test equipment and examples of tested samples shall be included if applicable.

k. 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.

NOTE: The pneumatic pressure test may be combined with the repeated assembly test to economize on test assemblies by following procedure in 4.4.6.

4.4.6 Repeated Assembly Test Procedure

The test specimens shall be assembled to the fitting 24 degree 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 degrees 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.

NOTE: To economize on test assemblies, the pneumatic pressure test may be combined with the repeated assembly test. This is accomplished by conducting the pneumatic pressure test in place of the hydraulic pressure test during the first assembly cycle, conducting a pneumatic pressure test before the proof pressure test of the third assembly cycle, and conducting another pneumatic pressure test before the burst test of the eighth assembly cycle. Sealing surfaces should be clean and dry before conducting pneumatic pressure tests.

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.

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

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.

4.4.8.1 Axial Tensile Stress Due to Internal Pressure

The axial tensile stress due to internal pressure may be calculated per Equation 2.

$$Sa = \frac{Pd^2}{D^2 - d^2} \quad \text{(Eq. 2)}$$

where:

Sa = Axial tensile stress due to internal pressure

D = Tube outside diameter

d = Tube inside diameter

P = Internal pressure

4.4.8.2 Dynamic Tensile Bending Stress

The dynamic bending strain shall be measured by one or more strain gages placed on the tube 0.188 ± 0.031 from the end of the sleeve. The dynamic strain reading shall be taken while the test specimen is being flexed at the rate given below. The dynamic tensile bending stress shall be determined as shown for the test method in 4.4.8.2.2.

During testing, a constant pressure equal to the operating pressure, noted in Tables 2, 3, 4, or 5 shall be imposed. The frequency of flexing shall be at any rate from 30 to 500 cps, depending on the method selected. The specimens shall be assembled with maximum torque values per Table 8. The duration of the testing shall be 10 million cycles or until prior failure or leakage occurs.

4.4.8.2.1 Modulus of Elasticity

For purposes of stress calculations, the modulus of elasticity for 304 CRES tubing shall be considered to be 28 000 000 psi, for 21-6-9 CRES tubing to be 28 500 000 psi, for 3.0Al 2.5V titanium tubing to be 15 000 000 psi and for 6061-T6 aluminum alloy tubing to be 10 000 000 psi.