



AEROSPACE STANDARD

AS5958™**REV. G**Issued 2006-01
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Superseding AS5958F

Fittings, Axially Swaged Tube with Flareless Separable, Fluid System
for Operating Pressures up to and Including 5080 psi (35000 kPa), Specification for

RATIONALE

Clarify corrosion conditioning time requirements and size -08 vibration testing test specimen length.

1. SCOPE

This SAE Aerospace Standard (AS) establishes the requirements for axially swaged titanium fittings on titanium, CRES, and aluminum tubing with flareless separable fitting ends for use in hydraulic supply and return aerospace fluid systems up to operating pressure of 5080 psig (35000 kPa) maximum. The operating temperature range for titanium tubing and CRES tubing is -65 to +275 °F (-54 to +135 °C) and the operating temperature range for aluminum return system tubing is -65 to +225 °F (-54 to +107 °C).

This specification covers a common 5080 psi pressure titanium fitting that may be used for a range of operating pressures up to 5080 psi with different tubing materials and tubing wall thicknesses and is assembled with the same tooling in accordance with AS5959. The flareless fitting operating pressure is based on the fitting thread pitch. Extra fine pitch is used for 5080 psi operating pressure and fine pitch for operating pressures 3000 psi and less. Table 14 shows applicable aerospace fitting part number standard and tubing materials and operating pressures.

1.1 Classification

The fittings shall be of the following types and classes as specified:

1.1.1 System Types

Type I - Temperature range -65 to +275 °F (-54 to +135 °C) for CRES and titanium tubing as specified in Tables 2A, 2B, 2C, and 2D.

Type II - Temperature range -65 to +225 °F (-54 to +107 °C) for use with aluminum tubing specified in Table 2E.

1.1.2 Classes

Fitting qualified under this document shall be of the following classes.

- a. Class 1: Fittings qualified with titanium and CRES tubing only (Tables 2A, 2B, 2C, and 2D) as a Type I system. Class 1 parts do not need to have a designator added to the part standard number (e.g., AS5969T0606B is a Class 1 part).

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- b. Class 2: Fittings qualified with all tubing materials (titanium, CRES, and aluminum per Tables 2A, 2B, 2C, 2D, and 2E), using both Type I and Type II system requirements. Class 2 parts shall be designated by adding a “D” to the end basic part standard number (e.g., AS5969T0606BD).

NOTE: See Table 14 for intended usage of each part number.

1.1.3 Recommended Usage

- a. Class 1 parts can only be used on titanium or CRES tubing systems.

NOTE: For contamination sensitive systems where the presence of coating/paint debris is detrimental, bare or anodized ring fittings (Ring Code “A” or “B”) are recommended.

- b. Class 2 parts with anodized ring (Ring Finish Code: “B”) are recommended for use on all systems.

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.

AMS1428	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV
AMS2488	Anodic Treatment - Titanium and Titanium Alloys Solution pH 13 or Higher
AMS2700	Passivation of Corrosion Resistant Steels
AMS4083	Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T6) Solution and Precipitation Heat Treated
AMS4928	Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes, 6Al - 4V Annealed
AMS4945	Titanium Alloy Tubing, Seamless, Hydraulic, 3Al - 2.5V, Controlled Contractile Strain Ratio, Cold Worked, Stress Relieved
AMS4946	Titanium Alloy Tubing, Seamless, Hydraulic, 3Al - 2.5V, Texture Controlled Cold Worked, Stress Relieved
AMS4965	Titanium Alloy, Bars, Wire, Forgings, and Rings, 6.0Al - 4.0V, Solution Heat Treated and Aged
AMS5561	Steel, Corrosion and Heat-Resistant, Welded and Drawn or Seamless and Drawn Tubing, 9.0Mn - 20Cr - 6.5Ni - 0.28N, High-Pressure Hydraulic
AMS5637	Steel, Corrosion Resistant, Bars and Wire, 18Cr - 9.0Ni (302), Solution Heat Treated, Cold Drawn and Stress Relieved, 125 ksi (862 MPa) Tensile Strength

AMS-STD-595 Colors Used in Government Procurement

ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
ARP4784	Definitions and Limits, Metal Material Defects and Surface and Edge Features, Fluid Couplings, Fittings and Hose Ends
ARP5412	Aircraft Lightning Environment and Related Test Waveforms
AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies
AS1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS1376	Alternate Dimensions, Center Body Section, Shape Fluid Fitting, Design Standard
AS5620	Titanium Hydraulic Tubing, Ti-3Al-2.5V Cold Worked and Stress Relieved, Up to 35000 kPa (5080 psi), Requirements for Qualification Testing and Control
AS5685	Steel, Corrosion Resistant, Safety Wire, 18Cr - 11.5Ni (UNS S30500), Solution Heat Treated, Cold Finished
AS5827	Fitting End, Flareless, Extra Fine Thread, Design Standard
AS5863	Fitting End, 24° Cone, Flareless, Fluid Connection, Design Standard
AS5959	Axially Swaged Fittings, Installation and Inspection Procedure
AS85449/2	Clamp Assembly, Saddle Type, Cushioned, Phosphate Ester Fluid Resistant
AS85449/3	Clamp Assembly, Saddle Type, Cushioned, High Temperature

2.1.2 ASD-STAN Publications

Available from ASD-STAN Secretariat, Rue Montoyer, 10/5, B-1000 Brussels, Belgium, Tel: +32 2 775 81 26, www.asd-stan.org.

EN 2808	Aerospace Series Anodizing of Titanium and Titanium Alloys
EN 6123	Aerospace Series Fitting End, 24° Internal Cone, External Thread, Flareless Type, Extra Fine Thread Pitch, Dimension Inch Series

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)
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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 A580/A580M	Standard Specification for Stainless Steel Wire
ASTM D740	Standard Specification for Methyl Ethyl Ketone

ASTM D1193/D1193M Standard Specification for Regent Water

ASTM D1655 Aviation Turbine Fuels

ASTM E8/E8M Tension Testing for Metallic Materials

2.1.5 ISO Publications

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

ISO 7137 Environmental Conditions and Test Procedures for Airborne Equipment

2.1.6 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

PD1100 NADCAP Program Requirements

PD2001 Qualified Product Management Council Procedures for Qualified Products Group

PD2101 Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

2.1.7 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

2.1.8 U.S. Military Specifications and Standards

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

MIL-DTL-5541 Chemical Conversion Coatings on Aluminum and Aluminum Alloys

MIL-DTL-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5

MIL-DTL-83133 Turbine Fuels, Aviation, Kerosene Types, NATO F-34 (JP-8), NATO F-35, and JP-8 + 100

MIL-HDBK-831 Preparation of Test Reports

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance (Inactive for New Design as of 29 March 1996)

MIL-PRF-23699 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156

MIL-PRF-23377 Primer Coatings: Epoxy, High-Solids

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

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

TT-I-735 Isopropyl Alcohol

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 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.

AS5545	Nut Coupling, Flareless, Extra Fine Thread, 5080 psi
AS5546	Nut, Fitting, Flareless, Retained, Lightweight, Extra Fine Thread, up to 5080 psi
AS5767	Fitting Assembly, Tee, Female Flareless on Run, Axially Swaged, Hydraulic, 5080 psi
AS5791	Fitting Assembly, Straight, Bulkhead Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5792	Fitting Assembly, Straight, Female Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5793	Fitting Assembly, Straight, Male Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5801	Fitting Assembly, 90°, Female Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5802	Fitting Assembly, 90°, Male Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5803	Fitting Assembly, Elbow, 45°, Female Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5804	Fitting Assembly, Tee, Female Flareless and Axially Swaged on the Run, Axially Swaged on the Branch, Hydraulic, 3000 psi
AS5805	Fitting Assembly, Elbow, 90°, Bulkhead Flareless, Axially Swaged, Hydraulic, 3000 psi
AS5806	Fitting Assembly, Tee, Axially Swaged on the Run, Female Flareless on the Branch, Hydraulic, 3000 psi
AS5807	Fitting Assembly, Tee, Axially Swaged on the Run, Male Flareless on the Branch, Hydraulic, 3000 psi
AS5808	Fitting Assembly, Tee, Female Flareless and Axially Swaged on the Run, Female Flareless on the Branch, Hydraulic, 3000 psi
AS5809	Fitting Assembly, Tee, Female Flareless and Axially Swaged on the Run, Male Flareless on Branch, Hydraulic, 3000 psi
AS5810	Fitting Assembly, Tee, Male Flareless on the Run, Axially Swaged on the Run and the Branch, Hydraulic, 3000 psi
AS5828	Fitting End, Bulkhead, Flareless, Extra Fine Thread, Design Standard
AS5863	Fitting End, 24° Cone, Flareless, Fluid Connection, Design Standard
AS5864	Fitting End, Bulkhead, 24° Cone, Flareless, Fluid Connection, Design Standard
AS5868	Fitting Assembly, Straight, Bulkhead Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5869	Fitting Assembly, Union, 3 Hole Flange, Axially Swaged, Hydraulic, 5080 psi
AS5969	Fitting Assembly, Union, Axially Swaged, Hydraulic, 5080 psi

AS5970	Fitting Assembly, Elbow, 90°, Axially Swaged, 5080 psi
AS5971	Fitting Assembly, Elbow, 45°, Axially Swaged, 5080 psi
AS5972	Fitting Assembly, Tee, Axially Swaged, Hydraulic, 5080 psi
AS5973	Fitting Assembly, Cross, Axially Swaged, Hydraulic, 5080 psi
AS5974	Fitting Assembly, Straight, Female Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5975	Fitting Assembly, Straight, Male Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5976	Fitting Assembly, Elbow, 90°, Female Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5977	Fitting Assembly, 90°, Male Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5978	Fitting Assembly, Elbow, 45°, Female Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5979	Fitting Assembly, Elbow, 45°, Male Flareless, Axially Swaged, Hydraulic, 5080 psi
AS6106	Fitting Assembly, Straight, Extended Bulkhead Shank, Flareless, Axially Swaged, Hydraulic, 5080 psi
AS6107	Fitting Assembly, Straight, Extended Bulkhead Shank, Flareless, Axially Swaged, Hydraulic, 3000 psi
AS6322	Fitting Assembly, Extended Union, Axially Swaged, Hydraulic, 5080 psi

3. TECHNICAL REQUIREMENTS

3.1 Qualification

Fittings supplied in accordance with this document shall be representative of products which have been subjected to and which have successfully passed the qualification tests specified in this standard.

3.1.1 Manufacturer Qualification

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of PD2101, PD1100, and AC7112, and shall be listed in a Performance Review Institute (PRI) qualified manufacturers list (QML).

3.1.2 Product Qualification

All products shall conform to the requirements of this procurement specification and shall be approved in accordance with the requirements of PD2001 and PD2101 for listing in a Performance Review Institute (PRI) qualified parts list (QPL) PRI-QPL-AS5958. Refer to www.eAuditNet.com.

3.2 Materials

The fitting materials shall be uniform in quality, free from defects, consistent with good manufacturing practices, and shall conform to the applicable specifications and the requirements specified herein.

3.2.1 Bars and Forgings

AMS4928	Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes, 6Al - 4V, Annealed
AMS4965	Titanium Alloy, Bars, Wire, Forgings, and Rings, 6.0Al - 4.0V, Solution Heat Treated and Aged

3.2.2 Wire

AMS5637	Steel, Corrosion Resistant, Bars and Wire, 18Cr - 9.0Ni (302), Solution Heat Treated, Cold Drawn, and Stress Relieved, 125 ksi (862 MPa) Tensile Strength
AS5685	Steel, Corrosion Resistant, Safety Wire, 18Cr - 11.5Ni (UNS S30500), Solution Heat Treated, Cold Finished
ASTM A580/A580M	Standard Specification for Stainless Steel Wire

3.2.3 Reinforcement

Composite; a high strength carbon fiber/epoxy resin composite may be used as a reinforcement over the ring.

3.2.4 Tube Requirements

Titanium tubing shall be in accordance with AS5620 and shall meet at least the requirements of AMS4945 or AMS4946. Stainless steel tubing shall be in accordance with AMS5561 and passivated per AMS2700. Aluminum tubing shall be in accordance with AMS4083 and finished with MIL-DTL-5541 and MIL-PRF-23377 as required per Table 6E and 3.4.2.4.

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

3.4 Fabrication

3.4.1 Fluid Passages

3.4.1.1 Drill Offset

In the run, tees where the fluid passage is bored from each end, the offset between the bores at the meeting point shall not exceed 0.010 inch. A sphere with a 0.015 smaller diameter shall be capable of traversing the bore intersection. The cross-sectional area of the bore junction of angle fittings shall not be less than the cross-sectional area of the smaller passage. The mismatch in straight couplings shall be controlled such that a maximum OD tube (nominal +0.003) will pass through the entire fitting.

3.4.2 Finish

3.4.2.1 Titanium

No requirement.

3.4.2.2 Coating Color

When color is specified on the part standard, the outer ring surface shall be partially or completely colored blue with a pigmented polytetrafluoroethylene (PTFE), fluid resistant paint, or anodize in accordance with EN2808. Final blue color is to be similar to either of the following colors 15095, 15123, 15180, 15182, 15187, 15488, 15200, 15450, 25095, 25488, 35180, 35183, 35250, 35450, 35466, and 35488 of AMS-STD-595.

Anodized rings shall be subjected to fluid resistance test in accordance with 4.5.3.1. Anodize coating shall show no evidence of peeling, blistering, bleeding, fading, or any other evidence of deterioration as compared to similar parts not exposed to the test media. Separate specimens shall be tested in each medium.

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

3.4.2.3 Dry Lube

The axially swaged fitting may be dry lubed to facilitate the fitting assembly process.

3.4.2.4 Aluminum Tubing Test Samples

Aluminum tubing used for impulse, corrosion conditioning (including electrical conductivity) tests as defined in Table 6E do require the application of one coat (0.0005 to 0.0009 inch thick) of fluid resistant epoxy structural primer per MIL-PRF-23377, Type II, Class C1 or C2 on the entire outside of the tubing excluding the tubing area to be swaged with the fitting (up to the maximum insertion depth). Primer and touch-up of tubing after swage in the tube-fitting interface is allowed. For maximum corrosion protection, the tubing shall be entirely chemical conversion coated (OD and ID) per MIL-DTL-5541 Type I Class 3 prior to any other primer coat application or as defined in Table 6E.

3.5 Identification of Product

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

3.5.1 AS Standard Symbol and Manufacturer's Trademark

Unless otherwise specified, all fittings shall be marked with the letters "AS" or AS part number. If space permits, the manufacturer's identification or trademark, manufacturer's part number, and lot number.

3.5.2 Size, Method, and Location of Marking

Marking shall be accomplished per those permanent methods listed in AS478 which do not cause surface oxidation greater than 0.0005 inch (0.0127 mm) or other detrimental effects. Heat cured marking (ink, paint) may be used for PTFE coated parts only provided the marking is complete and legible after exposure to hydraulic fluids in accordance with 4.5.2 and 4.5.3.

3.6 Performance

Fittings and tubing when attached per AS5959 or fitting manufacturer's authorized procedures shall meet the following performance requirements:

3.6.1 Environmental Conditions

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

3.6.1.1 Pressures

- a. Titanium 5080 psi supply tubing in accordance with Table 1A.
- b. Titanium and CRES 3000 psi supply tubing in accordance with Table 1B.
- c. Thin wall titanium return tubing in accordance with Table 1C.
- d. Aluminum tubing in accordance with Table 1D.

3.6.1.2 Temperature

- a. Ambient air: -65 to 275 °F (-54 to 135 °C), except as noted.
- b. Fluid: -65 to 275 °F (-54 to 135 °C), except as noted.

NOTE: The temperature range shall be -65 to +225 °F (-54 to 107 °C) for aluminum tube return systems.

Table 1A - 5080 psi titanium supply pressures

Operating Pressure Min	Proof Pressure Min	Burst Pressure Min
5080 psi (35000 kPa)	10160 psi (70000 kPa)	20320 psi (140000 kPa)

Table 1B - 3000 psi CRES and titanium supply pressures

Operating Pressure Min	Proof Pressure Min	Burst Pressure Min
3000 psi (20600 kPa)	6000 psi (41300 kPa)	12000 psi (82700 kPa)

Table 1C - Thin wall titanium return pressures

Tube Size Inch	Operating Pressure Minimum		Proof Pressure Minimum		Burst Pressure Minimum	
	psi	kPa	psi	kPa	psi	kPa
0.500	2000	13700	4000	27500	8000	55100
0.625	2000	13700	4000	27500	8000	55100
0.750	2000	13700	4000	27500	8000	55100
1.000	1500	10300	3000	20600	6000	55100
1.250	1500	10300	3000	20600	6000	55100

Table 1D - Aluminum return pressures

Tube Size Inch	Operating Pressure Minimum		Proof Pressure Minimum		Burst Pressure Minimum	
	psi	(kPa)	psi	(kPa)	psi	(kPa)
0.250	1500	10340	3000	20680	6000	41370
0.375	1500	10340	3000	20680	6000	41370
0.500	1500	10340	3000	20680	6000	41370
0.625	1000	6900	2000	13790	4000	27580
0.750	900	6200	1800	12410	3600	24820
1.000	750	5170	1500	10340	3000	20680
1.250	600	4140	1200	8270	2400	16550

3.6.2 Proof Pressure

Test assemblies shall withstand pressure equal to two times the design operating pressure for 5 minutes without visually detectable escape of fluid from the fitting assembly or the tube fitting interface or evidence of permanent deformation when tested in accordance with 4.6.2.

3.6.3 Gaseous Leakage

Test assemblies shall be capable of containment of nitrogen gas without evidence of gas bubbles appearing at the tube/fitting interface, when tested in accordance with 4.6.3. No bubbles shall appear after 1 minute at pressure.

3.6.4 Impulse

Fittings shall pass 300000 impulse cycles without leakage or other failure, when tested in accordance with 4.6.4.

Fittings used on aluminum tubing shall pass 200000 impulse cycles without leakage or other failure, when tested in accordance with 4.6.4.

3.6.5 Burst Pressure

Burst pressure shall be as specified in Tables 1A, 1B, 1C, and 1D. The fittings shall withstand burst pressure without leakage, slippage, or other failure when tested in accordance with 4.6.5.

3.6.6 Flexural Strength

Fittings shall withstand 10000000 cycles of flexure at the stress levels specified in Tables 2A, 2B, 2C, 2D, and 2E, when tested in accordance with 4.6.6 without leakage or other failure.

3.6.7 Re-Use (Separable Only)

The separable fitting shall be capable of eight reuses, when tested in accordance with 4.6.7.

3.6.8 Joint Strength

Test assemblies shall withstand, without separation, a tensile load as specified in Tables 3A, 3B, and 3C, when tested in accordance with 4.6.8.

3.6.9 Thermal Shock

The fitting assembly shall withstand the temperature and pressure, when tested in accordance with 4.6.9 without leakage, evidence of permanent deformation, or other malfunction that shall affect assembly or disassembly of the fitting.

3.6.10 Overtightening Torque (Separable Only)

The fittings shall pass a proof and gaseous leakage test after being subjected to two times the maximum torque for sizes -04 through -08, and 1.5 times the maximum torques for sizes -10 through -20 to the values specified in Table 4A, when tested in accordance with 4.6.10.

3.6.11 Fitting Conductivity

The fitting shall be conductive. The maximum resistance shall be 10 mΩ between the two tubes connected to the fitting, when tested in accordance with 4.6.11.

3.6.12 Vibration

The tube assembly shall withstand vibration testing without leakage or other malfunction, when tested in accordance with 4.6.12.

3.6.13 System Pressure

Test assemblies shall withstand 24-hour exposure at low pressure and 24 hours at operating pressure with no visually detectable escape of fluid from the fitting assembly or the tube fitting interface, when tested in accordance with 4.6.13.

3.6.14 Fitting Twisting (Separable Only)

The separable fitting shall not twist more than 2 degrees, when torqued in accordance with 4.6.14.

3.6.15 Fitting/Tube Rotation Torque

The nut shall not loosen or the tube rotate, when subjected to 1.5 times assembly torque in accordance with 4.6.15.

3.6.16 Stress Corrosion

The tube/fitting joint shall not exhibit intergranular or stress corrosion cracking after salt spray exposure, in accordance with 4.6.16.

3.6.17 Lightning Strike

The fitting assemblies, sizes 04 and 12, shall not leak after being subjected to 12 lightning strikes, when tested in accordance with 4.6.17.

3.6.18 Fire Proof

Titanium and CRES tube assemblies shall withstand a 2000 °F (1093 °C) flame for 15 minutes, when tested in accordance with 4.6.18. There shall be no leakage detected by visual observation or failure of the test assembly prior to the specified time. This test is not applicable for aluminum tubing assemblies.

Table 2A - 5080 psi supply tubing bending stresses

Tube Size Inches	Tube Wall Thickness Inch	Minimum Endurance Limit /1/ Tube Bending Stress psi /2/	Minimum Endurance Limit /1/ Tube Bending Stress kPa /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	0.022-0.025	20000	137900	2.4
0.375	0.030-0.032	19000	131000	2.6
0.500	0.040-0.043	18000	124000	2.8
0.625	0.050-0.054	17000	117200	3.0
0.750	0.059-0.065	16000	110300	3.2
1.000	0.079-0.088	15000	103400	3.4
1.250	0.098-0.105	13700	94500	3.7

Table 2B - 3000 psi titanium supply tubing bending stresses

Tube Size Inches	Tube Wall Thickness Inch	Minimum Endurance Limit /1/ Tube Bending Stress psi /2/	Minimum Endurance Limit /1/ Tube Bending Stress kPa /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	0.016	20000	137900	2.4
0.375	0.019	19000	131000	2.6
0.500	0.026	18000	124000	2.8
0.625	0.032	17000	117200	3.0
0.750	0.039	16000	110300	3.2
1.000	0.051	15000	103400	3.4
1.250	0.070	13700	94500	3.7

NOTES:

/1/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1×10^7).

/2/ See Figure 2 for characteristic curves.

Table 2C - 3000 psi CRES supply tubing bending stresses

Tube Size Inch	Tube Wall Thickness Inch	Minimum Endurance Limit /1/ Tube Bending Stress psi /2/	Minimum Endurance Limit /1/ Tube Bending Stress kPa /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	0.016-0.019	24000	165500	2.0
0.375	0.019-0.022	22000	151700	2.2
0.500	0.026-0.030	20000	137900	2.4
0.625	0.032-0.036	18000	124000	2.8
0.750	0.038-0.043	16000	110300	3.2
1.000	0.049-0.055	15000	103400	3.4

Table 2D - Thin wall titanium return tubing bending stresses

Tube Size Inches	Tube Wall Thickness Inch	Minimum Endurance Limit /1/ Tube Bending Stress psi /2/	Minimum Endurance Limit /1/ Tube Bending Stress kPa /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.500	0.022	18000	124000	2.8
0.625	0.023	17000	117200	3.0
0.750	0.027	16000	110300	3.2
1.000	0.028	15000	103400	3.4
1.250	0.035	13700	94500	3.7

NOTES:

/1/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1×10^7).

/2/ See Figure 2 for characteristic curves.

Table 2E - Aluminum return tubing bending stresses

Tube Size Inches	Tube Wall Thickness Inch	Minimum Endurance Limit /1/ Tube Bending Stress psi /2/	Minimum Endurance Limit /1/ Tube Bending Stress kPa /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	0.028	6000	41360	6.6
0.375	0.035	6000	41360	6.6
0.500	0.035	5500	37920	6.9
0.625	0.035	5500	37920	6.9
0.750	0.035	5000	34470	7.2
1.000	0.035	4000	27570	8.0
1.250	0.035	4000	27570	8.0
1.250	0.049	4000	27570	8.0

NOTES:

/1/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1×10^7).

/2/ See Figure 2 for characteristic curves.

Table 3A - 5080 psi and 3000 psi supply minimum joint strength

Tube Size Inches	5080 psi Supply Ti Tubing Joint Strength Pounds	5080 psi Supply Ti Tubing Joint Strength N	3000 psi Supply Ti Tubing Joint Strength Pounds	3000 psi Supply Ti Tubing Joint Strength N	3000 psi Supply CRES Tubing Joint Strength /1/ Pounds	3000 psi Supply CRES Tubing Joint Strength /1/ N
0.250	1100	4895	589	2620	442	1966
0.375	2800	12460	1325	5894	994	4422
0.500	4700	20915	2356	10480	1767	7860
0.625	7900	35155	3681	16374	2761	12282
0.750	11900	52955	5301	23580	3976	17686
1.000	16750	74537	9424	41920	7069	31444
1.250	25000	112000	14726	65505	11045	49131

/1/ Joint strength for CRES tubing based on 9000 psi burst pressure.

Table 3B - Thin wall titanium return minimum joint strength

Tube Size Inches	Titanium Return Joint Strength Pounds	Titanium Return Joint Strength N
0.500	1570	6984
0.625	2453	10911
0.750	3652	16245
1.000	4710	20951
1.250	7359	32734

Table 3C - Aluminum return minimum joint strength

Tube Size Inches	Al. Return Joint Strength Pounds	Al. Return Joint Strength N
0.250	295	1312
0.375	663	2950
0.500	1178	5240
0.625	1227	5458
0.750	1590	7073
1.000	2356	10480
1.250	2945	13100