SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS4459

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Submitted for recognition as an American National Standard

FITTINGS, TUBE, FLUID SYSTEM, 3000 psig MAXIMUM, PERMANENTLY ATTACHED, SPECIFICATION FOR

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) establishes the requirements for MIL-H-5440 Class II permanently attached tube fittings for use in hydraulic and other aerospace fluid systems.

1.2 Classification:

Fittings will be of two categories

a. Type 1: Externally swaged
b. Type 2: Other permanent mechanical attachment methods

Fittings shall be furnished per the applicable standards as specified herein or other approved engineering standard drawings.

1.3 Field of Application:

The field of application is primarily that of 3000 psig maximum, aeronautical hydraulic systems. Under some circumstances, the fittings defined may be used successfully at temperature and pressure ranges beyond those listed. Prior to such use, supporting test data should be approved by the procuring activity. Qualification approval of the product specified herein approves the product only for use in such manner as defined in the qualification tests.

2. REFERENCES:

The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS), Aerospace Standards (AS), and Aerospace Recommended Practices (ARP) shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 4921	Titanium Bars, Forgings, and Rings, Annealed, 70 000 psi Yield Strength
AMS 4928	Titanium Alloy Bars, Forgings, and Rings 6Al-4V Annealed, 120 000 psi (825 MPa) Yield Strength
AMS 4944	Titanium Alloy Tubing, Seamless Hydraulic 3.0Al-2.5V Cold Worked Stress Relieved
AMS 4945	Titanium Alloy Tubing, Seamless Hydraulic, 3Al-2.5V, Texture Controlled, 105 000 psi (724 MPa) Yield Strength
AMS 4965	Titanium Alloy Bars, Forgings, and Rings 6.0Al-4.0V Solution and Precipitation Heat Treated
AMS 5561	Steel Tubing, Welded and Drawn Corrosion Resistant, 9Mn-20Cr-6.5Ni-0.27N High Pressure Hydraulic
AMS 5656	Steel Bars, Forgings, and Rings, Corrosion Resistant, 9.0Mn-20Cr-6.5Ni-0.27N
AMS 5659	Steel Bars, Forgings, and Rings, Corrosion Resistant 15Cr-4.5Ni-0.30 (Cb+Ta) -3.5 Cu Solution Heat Treated
AS478	Identification Marking Methods
ARP603	Impulse Testing of Hydraulic Hose Assemblies, Tubing, and Fittings
ARP899	Tube Fitting, Fluid Systems, Permanent Type, General Requirements for
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
ARP1258	Qualification of Hydraulic Tube Joints to Specified Flexure Fatigue Requirements
AS1376	Wrench Pads for Fluid Fittings Machined from Alternate Shapes of Material

2.2 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

QQ-A-225/8	Aluminum Alloy 6061, Bar, Rod, Wire, and Special Shapes; Rolled, Drawn, or Cold Finished
QQ-A-367	Aluminum Alloy, Forgings, Heat Treated
QQ-P-35	Passivation Treatment for Corrosion - Resisting Steel
QQ-S-763	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
FED-STD-595	Colors
MIL-H-5440	Hydraulic Systems, Aircraft, Types I and II, Design and Installation Requirements for
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-H-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Testing
MIL-T-6845	Tubing, Steel, Corrosion Resisting (304) Aerospace Vehicle Hydraulic System, 1/8 Hard Condition
MIL-T-7081	Tube, Aluminum Alloy, Seamless, Round, Drawn 6061 Aircraft Hydraulic Quality

2.2 (Continued):

MIL-T-8973 Tubing, Steel, Corrosion and Heat Resistant for Aerospace Vehicle Hydraulic Systems Assembled by Brazing
MIL-H-81200 Heat Treatment of Titanium and Titanium Alloys

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 Marking for Shipment and Storage

2.3 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036.

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

2.4 ASTM Publications:

Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E 8 Tension Testing for Metallic Materials

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

The fittings furnished under this specification shall be products which have been qualified under the requirements of Sections 3 and 4 of this document at the time set for opening of bids. For shape fittings, both forged shapes and machined shapes shall be qualified separately. In addition, the retention of qualification fittings shall be dependent on periodic verification of continued compliance with the requirements of this specification. When there is no qualified source for a given size and material, a source of qualified fittings may be considered for approval in smaller sizes. Written approval must be obtained from the qualifying agency before this special qualification may be used for procurement. This special qualification may be used only where there is no qualified source for the size and material in the fitting being procured. The qualifying activity shall reserve the right to conduct whatever tests it deems necessary for this approval.

3.2 Materials:

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

TABLE 1 - Materials

Fitting Type	Material	Form	Specification
Straight (Couplings) Type 1	Aluminum Alloy	Bars	QQ-A-225/8 (6061) (See 3.2.1)
Straight (Couplings) Type 1	Com. Pure Titanium	Bars	AMS 4921 (See 3.2.2)
Straight (Couplings) Type 2	6Al-4V Titanium	Bars	AMS 4965 (See 3.2.5)
Straight (Couplings) Type 1	Cres (21-6-9)	Bars	AMS 5656 (See 3.2.3)
Straight (Couplings) Type 1	Cres (316L)	Bars	QQ-S-763 (See 3.2.4)
Straight (Couplings) Type 2	Cres (15-5 PH)	Bars	AMS 5659 (See 3.2.6)
Shapes Type 1	Aluminum Alloy	Forgings	QQ-A-367 (6061) (See 3.2.1)
Shapes Type 1	Com. Pure Titanium	Forgings	AMS 4921 (See 3.2.2)
Shapes Type 1	Cres (21-6-9)	Forgings	AMS 5656 (See 3.2.3)
Shapes Type 1	Cres (316L)	Forgings	QQ-S-763 (See 3.2.4)
Shapes Type 2	6Al-4V Titanium	Forgings	AMS 4965 (See 3.2.5) or AMS 4928
Shapes Type 2	Cres (15-5 PH)	Forgings	AMS 5659 (See 3.2.6)

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

3.2.2 Commercially Pure Titanium: Titanium fittings shall be manufactured from material per Table 1 except that tensile yield strength shall be within the range of 70 000 to 95 000 psi. In addition, material of fittings shall be vacuum annealed to remove excess hydrogen. Hydrogen content in finished parts shall not exceed 10 ppm in either forged or bar stock fittings. Oxygen equivalency shall not exceed .47 as defined in Equation 1. Fitting surfaces shall be clean and free from contaminants. Vacuum annealing shall meet all applicable requirements of MIL-H-81200. Material code letter is "E".

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

3.2.3 Corrosion Resistant Steel 21-6-9: Fittings shall be manufactured from material per Table 1 except that it shall be fully annealed and the tensile yield strength shall not exceed 85 000 psi. The material code letter is "-".

3.2.4 Corrosion Resistant Steel 316L: Fittings shall be manufactured from the material per Table 1 except tensile yield strength shall not exceed 45 000 psi. The material code letter is "K".

3.2.5 Titanium Alloy 6Al-4V: Fittings shall be manufactured from the material per Table 1. The material code letter is "T".

3.2.6 Corrosion Resistant Steel 15-5 PH: Fittings shall be manufactured from the material per Table 1. The material code letter is "V".

3.2.7 Proprietary Materials: Fittings shall be manufactured from the material manufacturer's specification. Material code letter shall not conflict with established standard material code letters.

3.2.8 Tubing Requirements: Tubing utilized in the qualification program shall conform to the specifications listed and must be certified by the tubing manufacturer to have completed a minimum of 1000 flight hours in commercial or military aircraft.

a. AMS 5561
b. AMS 4944
c. MIL-T-6845
d. AMS 4945
e. MIL-T-8973
f. MIL-T-7081

3.3 Design and Dimensions:

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

3.4 Fabrication:

3.4.1 Fluid Passages:

3.4.1.1 Drill Offset: In the run of tees where the fluid passage is bored from each end, the offset between bores at the meeting point shall not exceed .015 in. A sphere with a .020 smaller diameter than the minimum specified passage 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 + .003) will pass through the entire fitting.

3.4.1.2 Fitting Wall Thickness: Except as otherwise specified on the applicable drawing, the wall thickness at any point on the fitting shall not be less than the thickness established by the dimension and tolerances for the eccentricities specified in the applicable design standard.

3.4.1.3 Elastomer Filling of Groove in Fitting Bore (Type 1 Fittings): Each swaged end contains two internally machined grooves. The outermost groove only is filled with silicone elastomer for titanium and 21-6-9 corrosion resistant steel fittings. Both grooves shall be filled for aluminum alloy and 316L corrosion resistant steel fittings. The silicone elastomer (GE RTV 630 or equivalent) shall be cured in place and completely bonded to the grooves. Groove fill shall be such that the elastomer is flush with the fitting bore diameter or .004 below the fitting bore diameter as the minimum groove fill. Flash outside of the grooves is not permitted.

3.4.2 Finish:

3.4.2.1 Aluminum Alloy and C.P. Titanium Fittings (Type 1 Fittings): Aluminum alloy fittings shall be chemical film coated per MIL-C-5541 on all surfaces prior to application of elastomeric seals or PTFE coating. Aluminum and titanium fittings shall be coated with PTFE to a baked film thickness of .0005 to .0015 in. All external surfaces shall be coated, and the fitting bore of swaged ends shall be coated to the depth specified in the applicable aerospace standard.

3.4.2.2 Corrosion Resistant Steel 21-6-9 (Type 1 Fittings): 21-6-9 corrosion resistant steel fittings shall be PTFE coated to a baked film thickness of .0005 to .0015 in. The fitting bore of the swaged end only shall be coated to the depth specified in the applicable aerospace standard.

3.4.2.3 Corrosion Resistant Steel 316L (Type 1 Fittings): 316L corrosion resistant steel fittings shall be PTFE coated to a baked film thickness of .0005 to .0015 in. The fitting outside diameter and the fitting bore of the swaged end shall be coated to the depth specified in the applicable aerospace standard.

3.4.2.4 Corrosion Resistant Steel 15-5 PH (Type 2 Fittings): 15-5 PH corrosion resistant steel fittings shall be PTFE coated to a baked film thickness of .0005 to .0015 in. The fitting bore shall be coated to the depth specified in the applicable aerospace standard.

3.4.2.5 Coating Color: PTFE coatings shall be pigmented as follows:

a. Aluminum alloy: light green (to approximate color number 14272 of FED-STD-595)

b. Titanium: black

c. Cres 21-6-9: green as for aluminum alloy

d. Cres 316L: gray (to approximate color number 16440 of FED-STD-595)

e. Cres 15-5 PH: green as for 21-6-9 Cres

3.5 Marking:

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

3.5.1 AS Standard Symbol and Manufacturer's Trademark: Unless otherwise specified, all fittings shall be marked with the letters "AS" and the manufacturer's identification or trademark. Fitting forgings shall be marked with the forging's manufacturer's trademark, code number, or letter to identify forging source. Forgings shall also be marked with raw material lot control number and job number.

3.5.2 Material Identification: Corrosion resistant steel fittings shall be marked with the letter "-" (no code letter) if manufactured from 21-6-9, the letter "K" if manufactured from class 316L, or the letter "V" if manufactured from 15-5 PH. The letter "D" shall be used if manufactured from 6061 aluminum alloy. The letter "E" shall be used if produced from commercially pure titanium. The letter "T" shall be used if produced from 6Al-4V titanium alloy. Proprietary materials shall use a material code letter which does not conflict with existing material codes.

3.5.3 Marking for Part Number and Size: A numerical equivalent to the dash number indicating size is optional. All fittings larger than .375 in tube size shall be marked with the part number.

3.5.4 Size, Method, and Location of Marking: Marking shall be accomplished per permanent methods listed in AS478 which does not cause surface oxidation or other detrimental effects.

3.6 Performance:

Fittings when swaged to tubing using equipment and procedures authorized by the procuring activity shall conform to the requirements specified in 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5, 3.6.6, and 3.6.7 when tested in accordance with the procedures specified in 4.2.

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

3.6.1.1 Temperature:

a. Ambient air: -65 to 275 °F
b. Fluid: -65 to 275 °F

3.6.1.2 Leakage: Leakage is defined as any visually detectable escape of fluid or wetting from any point of the fitting assembly or the tube fitting interface. The fitting and joint assembly shall not exhibit the escape of any fluid. Any escape of fluid shall constitute a failure of the test.

3.6.2 Burst Pressure: Burst pressure shall be as specified in Table 2. The fittings shall withstand burst pressure without leakage, slippage, or other failure when tested in accordance with 4.2.1.3.2.

TABLE 2 - Pressures

Tube Size	Fitting Material Aluminum Alloy Rated	Fitting Material Aluminum Alloy Proof	Fitting Material Aluminum Alloy Burst	Fitting Material Cres, Titanium, and Proprietary Rated	Fitting Material Cres, Titanium, and Proprietary Proof	Fitting Material Cres, Titanium, and Proprietary Burst
.188	1500	3000	6000	3000	6000	12 000
.250	1500	3000	6000	3000	6000	12 000
.312	1500	3000	6000	3000	6000	12 000
.375	1500	3000	6000	3000	6000	12 000
.500	1500	3000	6000	3000	6000	12 000
.625	1000	2000	4000	3000	6000	12 000
.750	1000	2000	4000	3000	6000	12 000
1.000	1000	2000	4000	3000	6000	12 000
1.250	600	1200	2400	3000	6000	12 000
1.500	600	1200	2400	2000	4000	8 000

3.6.3 Impulse: Fittings of all materials shall be capable of 200 000 impulse cycles without leakage or other failure when tested in accordance with 4.2.1.3.3.

3.6.4 Flexure Strength: Fittings shall withstand 10 000 000 cycles of flexure at the stress levels specified in Table 3 when tested in accordance with 4.2.1.3.4 without leakage or other failure.

TABLE 3 - Bending Stresses

Tube Size	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) Aluminum Alloy /3/	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) S/N	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) Cres and Proprietary /3/	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) S/N	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) Titanium /3/	Minimum Endurance Limit /1/ /2/ Tube Bending Stress (psi) S/N
.188	6000	6.6	24 000	1.8	24 000	1.8
.250	6000	6.6	24 000	1.8	20 000	2.4
.312	6000	6.6	24 000	1.8	20 000	2.4
.375	5500	6.9	22 000	2.1	19 000	2.6
.500	5500	6.9	20 000	2.4	18 000	2.8
.625	5500	6.9	18 000	2.8	17 000	3.0
.750	5000	7.2	16 000	3.1	16 000	3.1
1.000	4000	8.0	15 000	3.4	14 500	3.6
1.250	4000	8.0	15 000	3.4	14 000	3.7
1.500	4000	8.0	14 000	3.7	13 000	3.9

/1/ See Table 7 for tube materials and wall thicknesses.
/2/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1×10^7).
/3/ Refer to Figure 1 for characteristic curves. For example, an S/N characteristic of 2.4 falls between the number 2 and number 3 curve.

3.6.5 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 4.2.1.3.5. No bubbles may appear after 1 min at pressure.

3.6.6 System Pressure: All test assemblies, with the exception of joint strength test assemblies, shall undergo a system pressure test consisting of gaseous leakage test as described in 4.2.1.3.5 and hydraulic tested as described in 4.2.1.3.6.

3.6.7 Joint Strength: Test assemblies shall withstand without disassembly, a tensile load as specified in Table 4 when tested in accordance with 4.2.1.3.7.

TABLE 4 - Minimum Joint Strength

Tube Size	Material/Joint Strength (lb) Aluminum Alloy	Material/Joint Strength (lb) Cres, Titanium, and Proprietary
.188	167	333
.250	295	589
.312	459	917
.375	663	1325
.500	1178	2356
.625	1227	3682
.750	1767	5301
1.000	3140	9420
1.250	___ /1/	___ /1/
1.500	___ /1/	___ /1/

/1/ Not required for sizes 20 and 24.

3.7 Workmanship:

Machined surfaces of fittings shall be free from burrs, longitudinal or spiral tool marks. A burr is defined as any localized sharp deviation from the true contour of the part, as implied by the production drawing, the extreme excursion of which falls outside the tolerance envelope defined on the drawing, and/or any thin deviation of lesser magnitude which can be dislodged during normal assembly or operation. Unless a finer finish is specified on applicable drawings, all machined surfaces shall not exceed 125 μin Ra as defined in ANSI B46.1. Unmachined surfaces, such as forging surfaces and bar stock flats, shall be free from blisters, fins, folds, seams, laps, cracks, segregations, spongy areas, and except for forging parting lines, shall not exceed 250 Ra. Surface defects may be explored by suitable etching and if they can be removed so that they do not appear on re-etching, they shall not be cause for rejection.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements specified herein. Except as otherwise specified in the contract order, the contractor may use his/her own or any other facilities suitable for the performance of the inspection requirements specified herein unless disapproved by the procuring activity. The procuring activity reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Lot: A lot shall consist of all parts of a given part number made from the same batch of material and processed at the same time.

4.1.2 Record Maintenance: The supplier shall maintain a record of inspections applied to each lot.

4.1.3 Material Certification: Records of chemical composition analysis, magnetic particle inspection, and mechanical property tests showing conformance to the applicable material specifications shall be made available to the procuring activity for each lot of fittings.

4.2 Classification of Tests:

4.2.1 Qualification Tests: Qualification inspection shall consist of the following requirements and tests, as applicable, and as specified in Sections 3 and 4. Sampling quantities and sequence of tests shall be in accordance with Tables 5 and 6, respectively.

TABLE 5 - Qualification Test Samples

Specimen Size	Number of Specimens per Size Per Test Paragraph							
	Exam. of Product 4.2.1.1	Pneumatic Test 4.2.1.3.5	System Press. Test 4.2.1.3.6	Proof Test 4.2.1.3.1	Impulse Test 4.2.1.3.3	Flexure Test 4.2.1.3.4	Tensile Test 4.2.1.3.7	Burst Test 4.2.1.3.2
03	14	11	11	11	3	8	3	2
04	14	11	11	11	3	8	3	2
05	14	11	11	11	3	8	3	2
06	14	11	11	11	3	8	3	2
08	14	11	11	11	3	8	3	2
10	14	11	11	11	3	8	3	2
12	14	11	11	11	3	8	3	2
16	14	11	11	11	3	8	3	2
20	14	11	11	11	3	8	3	2
24	14	11	11	11	3	8	3	2
Total	140	110	110	110	30	80	30	20

TABLE 6 - Qualification Test Sequence

Test Type/Test Paragraph 4.2.1.X.X							
E/P 1	G/T 3.6	S/T 3.5	Proof 3.1	F/S 3.4	IMP 3.3	Burst 3.2	Tensile 3.7
1	2	3	4	5	-	6	-
1	2	3	4	-	5	6	-
1	-	-	-	-	-	-	2

Abbreviations:

E/P Examination of Product
G/T Gaseous Leakage Test
S/T System Pressure Test
F/S Flexural Strength
IMP Impulse Test

4.2.1.1 Examination of Product: Fittings shall be examined to determine conformance with this specification and the applicable standard with respect to material, dimensions, wall thickness, surface defects, finish, marking, and workmanship.

4.2.1.2 General Testing Practices:

4.2.1.2.1 Tube Preparation: Tubes shall be cut square within 0.5° and all burrs removed from inside and outside of the tube ends. The break or chamfer on either the outside diameter or inside diameter shall not exceed 25% of the tube wall thickness.

4.2.1.2.2 Tube Material, Compatibility, and Rated Pressure: Fittings shall be tested with tubing as specified in Table 7 for the appropriate rated pressure. Compatibility of fitting materials and tubing combinations are listed in Table 8.

TABLE 7 - Tube Material and Wall Thickness

Tube O.D. Material	System Press (PSIG)	.188	.250	.312	.375	.500	.625	.750	1.000	1.250	1.500
21-6-9	3000	.016	.016	.020	.020	.026	.032	.039	.052	.063	-
21-6-9	2000	-	-	-	-	-	-	-	-	-	.054
304 1/8 HD	3000	.016	.020	.020	.028	.035	.042	.058	.065	-	-
304 1/8 HD	1500	-	-	-	-	-	-	-	-	.049	.065
321 1/8 HD	3000	-	.028	.028	.035	.042	.058	.065	.083	-	-
3Al-2.5V	3000	.016	.016	.016	.019	.026	.032	.039	.051	.063	-
3Al-2.5V	2000	-	-	-	-	-	-	-	-	-	.054
6061-T6	1500	-	.035	.035	.035	.035	-	-	-	-	-
6061-T6	1000	.020	.020	.028	.028	.035	.035	.035	.049	-	-
6061-T6	600	-	-	-	-	-	-	-	-	.035	.035

Applicable Material Specifications

21-6-9 CRES	AMS 5561
304 1/8 HD	MIL-T-6845
321 1/8 HD	MIL-T-8973
3.0Al-2.5V CWSR	AMS 4944
6061-T6	MIL-T-7081

TABLE 8 - Fitting Material and Tubing Material Compatibility

Fitting Material	Tubing Material
21-6-9 Cres per AMS 5656	21-6-9 Cres per AMS 5561 304 1/8 HD Cres per MIL-T-6845 3Al-2.5V Titanium per AMS 4944/4945 6061-T6 Aluminum per MIL-T-7081
316L Cres per QQ-S-763	304 1/8 HD Cres per MIL-T-6845 321 1/8 HD Cres per MIL-T-8973
15-5 PH Cres per AMS 5659	21-6-9 Cres per AMS 5561 304 1/8 HD Cres per MIL-T-6845 3Al-2.5V Titanium per AMS 4944/4945 6061-T6 Aluminum per MIL-T-7081
Commercially Pure Titanium per AMS 4921	3Al-2.5V Titanium per AMS 4944/4945
6Al-4V Titanium per AMS 4965	21-6-9 Cres per AMS 5561 304 1/8 HD Cres per MIL-T-6845 3Al-2.5V Titanium per AMS 4944/4945 6061-T6 Aluminum per MIL-T-7081
6061-T6 Aluminum per QQ-A-225/8	6061-T6 Aluminum per MIL-T-7081
Proprietary	21-6-9 Cres per AMS 5561 304 1/8 HD Cres per MIL-T-6845 3Al-2.5V Titanium per AMS 4944/4945 6061-T6 Aluminum per MIL-T-7081

4.2.1.2.3 Proof Pressure: Proof pressure shall be twice the rated pressure.

4.2.1.2.4 Burst Pressure: Burst pressure shall be four times the rated pressure.

4.2.1.2.5 Test Fluids: Unless otherwise specified, fluid conforming to MIL-H-5606 or MIL-H-6083 shall be the test fluid.

4.2.1.3 Performance Tests:

4.2.1.3.1 Hydraulic Proof Test: Test assemblies shall be mounted to a pressure source and pressurized to two times the rated pressure and held for 5 min. Rate of pressure rise shall be 20 000 psi/min ± 5000 psi/min.

4.2.1.3.2 Burst Pressure Test: Test assemblies shall be pressurized to the proof pressure and held at that pressure for 5 min. The pressure shall then be increased at a rate of 20 000 psi/min ± 5000 psi/min until destruction occurs. No burst, slippage, leakage, or other failure shall occur at a pressure below the burst pressure as specified in Table 2.