SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS1576 REV. C

Issued 1980-02
Revised 1996-07
Reaffirmed 2007-08

Fittings, Welded, Hydraulic, Titanium and Corrosion Resistant Steel, 3000 psi Hydraulic

RATIONALE

This document has been reaffirmed to comply with the SAE 5-Year Review policy.

1. SCOPE:

This document defines the requirements for weld fittings and machine weldments using an orbiting welding head suitable for use on cold worked 3Al-2.5V titanium and 21Cr-6Ni-9Mn CRES tubing.

2. REFERENCES:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications:

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

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 5561	Steel Tubing, Welded and Drawn, Corrosion and Heat Resistant, 9.0Mn-20Cr-6.5Ni-0.28N, High-Pressure Hydraulic
AMS 5656	Steel Bars, Forgings, and Rings, Corrosion Resistant, 9.0Mn-20Cr-6.5Ni-0.27N
AMS 5659	Steel Bars, Forgings, Rings, and Extrusions, Corrosion Resistant, 15Cr-4.5Ni-0.03 (Cb + Ta) 3.5Cu, Consumable Electrode Melted, Solution Heat Treated
AS478	Identification Marking Methods
ARP603	Impulse Testing of Hydraulic Hose Assemblies, Tubing and Fittings

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1 (Continued):

ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
ARP1258	Qualification of Hydraulic Tube Joints to Specified Flexure Fatigue Requirements
AS1577	Tube End, Welding, Hydraulic
AS1578	Bellmouth Tube End, Welding
AS1579	Fitting End, Welded Girth Joint, Dimensions, 3000 psi Hydraulic
AS1580	Ring, Tube Weld, 3000 psi Hydraulic, Titanium
AS1581	Sleeve, Flareless Tube End, Welded, Hydraulic, 3000 psi
AS1582	Union, Flareless Tube End, Welded, 3000 psi Hydraulic
AS1583	Tee, Tube Weld, 3000 psi Hydraulic
AS1584	Elbow, 90° Tube Weld, 3000 psi Hydraulic
AS1585	Reducer, Tube Weld, Hydraulic
AS1893	Ring, Tube Weld, 3000 psi Hydraulic, CRES.

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

O-H-795	Hydrofluoric Acid, Technical
O-N-350	Nitric Acid, Technical
MIL-STD-129	Marking for Shipment and Storage
MIL-F-18280	Fittings, Flareless Tube, Fluid Connections
MIL-H-5440	Hydraulic Systems, Aircraft, Type I and II Design, Installation and Data Requirements for
MIL-H-6875	Heat Treatment of Steels, Process for
MIL-STD-6866	Inspection, Liquid Penetrant
MS21921	Nut, Sleeve Coupling, Flareless
MS33514	Fitting End Standard Dimensions for Flareless Tube Connection

2.3 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness, and Lay
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes

2.4 NAS Standards:

Available from National Standards Association, 1200 Quince Orchard Blvd, Gaithersburg, MD 20878.

NAS 1760	Fitting End, Fluid, Acom, Standard Dimensions for

2.5 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 1447 Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

2.6 Other Publications:

AWS A3.0 Welding Terms and Definitions (American Welding Society)

3. REQUIREMENTS:

3.1 Qualification:

Fittings furnished under this document shall be products which have been subjected to and successfully passed the test requirements of this specification.

3.2 Materials:

3.2.1 Fitting Materials: Fittings and other parts shall be made of materials listed in Table 1.

3.2.2 Fitting Forgings:

3.2.2.1 Surface Defects: Forged fittings shall be free from cracks, laps, seams and other defects.

NOTE: Surface defects may be removed as long as wall thickness requirements are met and as long as defects do not reappear after etching and in penetrant inspection.

3.2.2.2 Titanium Forgings: Titanium forgings shall exhibit an equiaxed microstructure. Oxide or other gas contaminated surface scale shall be removed by pickling.

TABLE 1 - Materials

Type of Part	Material	Material Code	Specification
Straight and Shape Fittings	Corrosion Resistant Steel	V	AMS 5659[1] (15-5 PH, H-1075)
Weld Ring	Corrosion Resistant Steel	-	AMS 5656 (21Cr-6Ni-9Mn)
Straight and Shape Fittings and Weld Ring	Titanium	T	AMS 4928 (Ti-6Al-4V)

[1] Solution heat treated, aged to H-1075 per MIL-H-1075 per MIL-H-6875 after machining.

3.3 Design and Construction:

Fittings and other parts shall be per the following standards, as applicable:

a. AS1577
b. AS1578
c. AS1579
d. AS1580
e. AS1581
f. AS1582
g. AS1583
h. AS1584
i. AS1585
j. AS1893

Tubing shall be to the requirements per AMS 4944 and AMS 5561, as applicable. Shape fittings such as elbows, tees, or crosses shall be machined from forgings or bar stock. Straight fittings shall be machined from bar stock.

3.3.1 Passages:

3.3.1.1 Drill Offset: On straight fittings where the fluid passage is drilled from each end, the offset between the drilled holes at the meeting point of the drills shall not exceed 0.015 in.

3.3.1.2 Cross Section: On shape fittings, the cross sectional area at the junction of the fluid passages shall not be smaller than the cross sectional area of the smaller passage.

3.4 Cleaning:

Parts that are to be cleaned to standard industry practice for fittings shall have no suffix code letter in the part number and shall be cleaned per 5.1.1. These parts may then have special cleaning as specified by the user prior to welding. Parts that are to be alkaline cleaned as suitable for welding shall have the suffix letter “C” in the part number and shall be cleaned per 5.1.2. Titanium alloy parts that are to be cleaned and nitric-hydrofluoric acid etched as suitable for welding shall have the suffix letter “E” in the part number and shall be cleaned and etched per 5.1.3.

3.5 Identification of Product:

All fittings, nuts, and sleeves shall be marked in accordance with the following instructions. The marking shall be applied per AS478 as specified on the applicable drawing in a location not detrimental to the performance of the fitting and not detrimental to the corrosion protection of the fitting. When items cannot be physically marked because of lack of space or because marking would have a deleterious effect, the package shall provide the identification per 5.2.

3.5.1 Manufacturer’s Identification: Unless otherwise specified, all fittings and sleeves shall be marked with the manufacturer’s name, CAGE code or trademark and with the letters AS.

3.5.2 Material Identification: Fittings and sleeves shall be marked with the material code letter as shown in Table 1. Forged shapes such as elbows or tees, shall also be marked with the forging manufacturer's trademark or a code identification letter or number.

3.5.3 Marking for Part Number and Size: A numerical size code equivalent to the nominal tube size in .062 inch increments is optional. All fittings and sleeves larger than 06 fitting size code shall be marked with the basic part number, exclusive of size. Fitting or sleeve 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. T-rings shall not be marked but the package shall be identified per 5.2.

3.6 Performance:

Fitting samples per Table 2 welded to tubing shall be capable of meeting the requirements of 3.6.1, 3.6.2, 3.6.3, and 3.6.5 when tested per the test procedures specified in Section 4.

3.6.1 Leakage: The welded fitting shall show no evidence of bubbles when immersed in water and pressurized to proof pressure of Table I of MIL-H-5540 for 5 min.

3.6.2 Proof Pressure Test: The test assemble shall withstand proof pressure per MIL-H-5440 without leakage, evidence of permanent deformation at separable connectors, or other malfunction that would affect assembly or disassembly.

3.6.3 Impulse Test: The test assemblies shall withstand 200 000 impulse pressure cycles without leakage as specified in 3.6.1 or other failure.

3.6.4 Burst: The test assemblies shall not rupture or leak in excess of that specified in 3.6.1 at pressures up to and including the values specified in MIL-H-5440.

3.6.5 Flexure: The test assemblies shall not rupture or leak in excess of that specified in 3.6.1 when flexure-fatigue tested to the requirements of ARP1258 or MIL-F-18280.

3.7 Workmanship: All machined surfaces shall be smooth to 125 µin Ra per ANSI/ASME B46.1. Unmachined areas, such as forged surfaces, shall be free of laps, seams, or other defects. Parting lines in forging shall blend smoothly with the forged body and shall have a finish of 250 µin Ra as defined in ANSI/ASTM B 46.1.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection and Test:

Unless otherwise specified, the supplier is responsible for the performance of all inspection and test requirements specified herein. The suppliers may utilize their own facilities or other facilities which have been approved by the user. The user has the right to perform any of the inspections or tests set forth in this document, as deemed necessary to assure that the parts conform with the specified requirements.

4.2 Material Certification:

Tests for chemical composition and heat treat condition shall be performed to show conformance with the applicable requirements. Tensile and hardness test shall be performed to verify compliance with the mechanical properties of 3.2. Gas content of titanium shall be controlled per AMS 4928, except that forgings shall comply with requirements under 3.2.2. Records of these tests shall be made available to the user upon request.

4.3 Inspection 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. The supplier shall maintain a record of inspections applied to each lot.

4.4 Inspection Records:

The supplier shall keep a complete record of all material certifications, examinations, inspections, and tests performed to verify conformance to the requirements of this document. Such records shall be available upon request.

4.5 Classification of Inspections:

The testing and inspection shall be classified as follows:

a. Qualification inspection
b. Quality conformance inspection

4.6 Qualification Inspection:

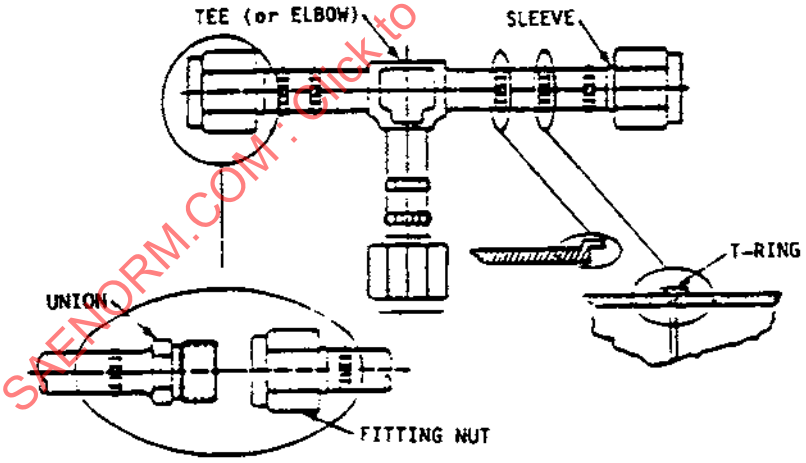
4.6.1 Sampling Instructions: Qualification inspection shall be conducted for each fitting or part standard as listed in Table 2 and for the sizes and materials used.

4.6.1.1 Test Specimen Preparation: Specimens for proof, burst, and impulse tests shall be assembled as illustrated in Figure 1. Flexure test specimens shall be in accordance with ARP1185.

TABLE 2 - Qualification Test Samples

Part	Standard	Quantity	Test	Paragraph
Tube End	AS1577	3	Impulse	3.5.3, 4.6.3.3
	AS1578	3	Burst	3.5.4, 4.6.3.4
		6	Flexure	3.5.5, 4.6.3.5
T-Ring (Tube-Tube)	AS1580	3	Impulse	3.5.2, 4.6.3.3
	AS1893	3	Burst	3.5.3, 4.6.3.4
		6	Flexure	3.5.4, 4.6.3.5
Tee	AS1583	3	Impulse	3.5.2, 4.6.3.3
		3	Burst	3.5.3, 4.6.3.4
		2	Flexure	3.5.4, 4.6.3.5
Union, Sleeve, Nut	AS1582 AS1581 MS21921 (T)	3 3 6	Impulse Burst Flexure	3.5.2, 4.6.3.3 3.5.3, 4.6.3.4 3.5.4, 4.6.3.5

NOTE: All specimens shall be proof tested per 3.5.2 prior to impulse, burst, and flexure testing.



NOTE: The minimum distance between welds is 3 in.

FIGURE 1 - Examples for Proof, Burst, and Impulse Test Specimen (Optional, Combined or Single)

4.6.1.2 Tube Preparation: Tube ends to be welded shall be in accordance with AS1577 or AS1578, as applicable. Corrosion resistant steel specimens shall be alkaline cleaned or vapor degreased and then thoroughly drained and blown out to remove any remaining cleaning fluid. Titanium tubing shall be alkaline cleaned and then drained and blown out like the CRES tubing. No chlorinated solvents shall be used with titanium. Immediately prior to welding, the tube area that will be exposed to heat shall be solvent cleaned with MEK or acetone, unless specified otherwise.

4.6.2 Weldments:

4.6.2.1 Weld Beads: Welds for test specimens shall be smooth and uniform in appearance, with 100% penetration and fusion of the mating tube and fitting end. Undercut, thinning, concavity, or overlap at the edge of the weld bead shall be unacceptable. Underfill shall be unacceptable, except that for titanium a local blended underfill of 10% of the thinner wall thickness is allowed as long as it does not exceed 50% of the weld circumference. Cracks, weld craters, or open holes in the weld are unacceptable, except that a local blended depression in the weld tail-out area in the middle of weld reinforcement width with a maximum of 0.005 in depth x 0.015 in diameter is not regarded as detrimental.

NOTE: Definitions of welding terms, such as undercut, and overlap, are given in American Welding Society Standard AWS A3.0.

4.6.2.2 Weld Porosity: Subsurface porosity and inclusions shall not exceed the following items:

a. Porosity and inclusions with sharp terminations are unacceptable.

b. Porosity and inclusions shall not be closer together than three times the size of the smallest adjacent pore or inclusion in its largest dimension.

c. Interconnected porosity, or two or more pores or inclusions which are closer together than the largest dimension of the smaller adjacent pore or inclusion, shall be considered as a single pore or inclusion.

d. Porosity and inclusions shall not exceed one-half of the wall thickness in their largest dimension or 0.020 in, whichever is less.

e. Porosity and inclusions shall not exceed an accumulated length of 1-1/3 of the wall thickness in any lineal 1/2 in of weld.

4.6.2.3 Weld Discoloration: For titanium weldments, the following applies regarding discoloration:

a. Bright silver to straw to pale violet is acceptable. Light blue is acceptable only on the base metal, provided it does not contact the weld metal. All discoloration shall be removed when additional welding is to be performed.

b. Discoloration removal, when required, shall be done with a suitable abrasive fabric such as Scotch-Brite Type A or S, fine to ultrafine.

4.6.3 Qualification Tests:

4.6.3.1 Examination of Product: Prior to testing, the fitting parts and tubing shall be submitted to quality conformance inspection. All welded assemblies shall be visually and penetrant inspected and X-rayed in two planes, at a 90° angle, for compliance with the requirements under 4.6.2.

4.6.3.2 Proof Pressure: Test assemblies shall be connected to a pneumatic source of pressure immersed in water and pressure tested to the proof test value per MIL-H-5440 for a period of 5 min. The test shall be conducted at room temperature. The test assembly shall meet the requirement of 3.5.1.

CAUTION: A suitable tank or screen shall be provided to protect the operator in case of failure of the assembly.

4.6.3.3 Impulse Test: Test assemblies as illustrated in Figure 1 and Table 2 shall be tested to the requirements specified in ARP603 for:

a. Operating Pressure: 3000 psi
b. Peak Pressure: 4500 psi
c. Temperature: Room temperature
d. Specimen: Figure 1 or equivalent
e. Speed: 70 cpm
f. Rate of Rise: 175 000 to 300 000 psi/s

4.6.3.4 Burst Test: Test assemblies as described in Figure 1 and Table 2 shall be connected to a liquid source of pressure. The pressure shall be increased at a rate of 20 000 psi ± 5000 psi/min until leakage occurs or the burst pressure is reached. This test shall be conducted at room temperature.

CAUTION: A suitable tank or screen shall be provided to protect the operator in case of failure of the assembly.

4.6.3.5 Flexure Test: Samples shall be fabricated and the test shall be conducted per ARP1185 or MIL-F-18280 as applicable.

4.7 Quality Conformance Inspection:

Each lot of fittings shall be subjected to the inspections as listed.

4.7.1 Sampling: Sampling for material, dimensions, finish, and workmanship shall be random in accordance with ANSI/ASME Z1.4. Unless otherwise specified under 4.8, the accepted quality level (AQL) shall be 4%.

4.7.2 Penetrant Inspection: Fitting forgings shall be 100% penetrant inspected per MIL-I-6866 until 30 consecutive pieces of each part number have been found defect free. Thereafter, a sampling plan in accordance with ANSI/ASME Z1.4, General Inspection Level II shall be applied. Indications of any surface defect within the sample size shall cause rejection of the entire lot. Inspection shall be done after machining, with the option that it may be done before threads and sealing surfaces are machined. Defects may be removed if drawing tolerances are not exceeded and the part passes penetrant inspection after in-process correction.

4.7.3 Microexamination - Titanium Forgings: Sample fittings or forgings from each forging lot shall be microscopically examined for compliance with 3.2.2.2, in particular for microstructure and oxide scale.

4.8 Classification of Defects:

4.8.1 Classes of Defects, Defect Characteristics, and AQL's: The classes of defects, defect characteristics, and AQL's associated with the classes are shown in Table 3.

TABLE 3 - Classes of Defects, Defect Characteristics, and AQL's

Class	Characteristic	AQL
Major	Likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.	1.5%
Minor A	May have a slight effect on usability.	4.0%
Minor B	Has essentially no effect on usability.	6.5%

4.8.2 Classes and Characteristics by Fitting Description: The classes and characteristics of defects are shown for various types of weld fittings in Tables 4 through 10. Classification of defects for separable fitting ends will be as specified in the applicable specification for those ends.

TABLE 4 - AS1579 Fitting End, Welded Girth Joint, Dimensions, 3000 psi Hydraulic

Class	Characteristic
Major	A - Outside Diameter B - Weld End Diameter E - Weld End Depth D - Fitting End Diameter Machine Finish - "B" Diameter, "D" Diameter, Bore Diameter and Tube Butting Surface
Minor A	C - Overlap Diameter F - Overlap Length Machining Finish

TABLE 5 - AS1580 Ring, Tube Weld, 3000 psi Hydraulic, Titanium; AS1893 Ring, Tube Weld, 3000 psi Hydraulic, CRES

Class	Characteristic
Major	B - Weld End Diameter E - Weld End Depth R - Shoulder Radius Cleanliness/Finish - "B" Diameter, "C" Diameter and Tube Butting Surface
Minor A	A - Outside Diameter C - Inside Diameter .015/.020 Shoulder Thickness (AS1580) .005/.010 Shoulder Thickness (AS1593)

TABLE 6 - AS1581 Sleeve, Flareless Tube End, Welded, 3000 psi Hydraulic (Ends per AS1579 and NAS 1760)

Class	Characteristic
Major	A - Weld Positioning Length
	B - Gage Diameter
	F - Gage Depth
	H - Acorn Length
	M - Wire Recess Diameter
	Cleanliness/Finish - Globe Seal, ID, Weld End
Minor A	A - Center, Acorn Radius
	C - Acorn Diameter
	D - Sleeve End Diameter
	E - Sleeve ID Bore
	L - Shoulder Diameter
	N - Nut Shoulder
	P - Sleeve Skirt Diameter
	T - Radius
	Cleanliness, Finish
Minor B	Remainder

TABLE 7 - AS1582 Union, Flareless Tube End, Welded, 3000 psi Hydraulic (Ends per AS1579 and MS 33514)

Class	Characteristic
Major	B - Weld Positioning Length
	Cleanliness/Finish - Conical Sealing Surface, ID, Weld End
Minor A	Remainder
	Finish

TABLE 8 - AS1583 Tee - Tube Weld, 3000 psi Hydraulic (Ends per AS1579)

Class	Characteristic
Major	A - Bore Diameter E - Leg Length, Weld Tool Dimension .030/.125R Rounding of Bore Intersection Cleanliness/Finish - "A" Bore Diameter, Weld End
Minor A	Finish Squareness
Minor B	Remainder

TABLE 9 - AS1584 Elbow, 90°, Tube Weld, 3000 psi Hydraulic (Ends per AS1579)

Class	Characteristic
Major	A - Bore Diameter E - Leg Length, Weld Tool Dimension .030/.125R Rounding of Bore Intersection Cleanliness/Finish - "A" Bore Diameter, Weld End
Minor A	Finish
Minor B	Remainder

TABLE 10 - AS1585 Reducer Tube Weld, Hydraulic (Ends per AS1579)

Class	Characteristic
Major	A - Weld Tool Length 1.300 Weld Tool Length
Minor A	T_1 and T_2 Thickness Finish Squareness
Minor B	Remainder

5. PREPARATION FOR DELIVERY:

5.1 Cleaning:

5.1.1 Parts Without Code Letter “C” or “E”: Parts shall be uniform in appearance and free from staining and fingerprints.

NOTE: For cleaning of titanium alloy fittings, only solvents that are not chlorinated shall be used.

5.1.2 Parts With Code Letter “C”: Parts with a suffix code letter “C” in the part number (see 3.4) shall be hot alkaline cleaned per 5.1.5.

5.1.3 Titanium Alloy Parts With Code Letter “E”: Titanium alloy parts with a suffix code letter “E” in the part number (see 3.4) shall be nitric-hydrofluoric acid etched per 5.1.6.

5.1.4 Definitions:

5.1.4.1 Water-Break-Free Surface: A surface which maintains a continuous water film for a period of at least 30 s after having been spray or immersion rinsed in clean water at a temperature below 100 °F.

5.1.5 Hot Alkaline Cleaning Procedure:

5.1.5.1 Precleaning: The parts shall have been cleaned to meet the requirement of 5.1.1 before start of alkaline cleaning to minimize the contamination of cleaning tanks and to ensure maximum alkaline cleaning effectiveness.

5.1.5.2 Soak Cleaning: Rack or position parts to permit circulation of solution over all of the surfaces. The cleaning solution shall be 6 to 12 oz of alkaline cleaner per gallon of water at a temperature of 180 to 190 °F. Completely immerse parts in the cleaning solution for 10 min minimum or until soil is removed and the surface is water-break-free after rinsing. When possible, agitate part during processing. Use of ultrasonic agitation is permitted.

5.1.5.3 Rinsing: Whenever possible after processing, rinsing should include the use of a water-fog curtain above the processing tank to prevent the alkaline solution from drying on the part. After cleaning, immersion rinse or spray rinse without allowing the cleaner to dry on the parts. The spray must impinge on and drain from all surfaces. Parts shall be free of water breaks after rinsing. A spray rinse is preferred prior to the immersion rinse to remove excess cleaner and to avoid “dry on” of alkaline cleaner. When immersion rinsing, soak for at least 5 min using part or water agitation to facilitate rinsing. Sufficient water shall be flowing into the rinse tanks to maintain contaminant levels at 350 ppm maximum.

A final rinse prior to drying of the parts shall be accomplished by the use of heated de-ionized or distilled water. The intent of the hot rinse is to minimize drying time. It is recommended that the water deionizing unit be equipped with a conductivity meter.

5.1.5.4 Post-Rinse: Dry the parts except where a wet process follows immediately. Dry by blasting parts with filtered, dry, oil free air or gaseous nitrogen. Use of a drying gas heater is optional. Keep parts dry and free of oil, grease, fingerprints or other contamination.

5.1.5.5 Appearance: When visually examined without magnification after alkaline cleaning and rinsing, parts shall be free of residue, pitting, etching, dry-on, smut and soil including wax pencil marks, marking inks, printing ink or other contaminants and shall show a water-break-free surface.

5.1.6 Nitric-hydrofluoric Acid Etch Procedure:

5.1.6.1 Pre-cleaning: The parts shall have been cleaned to meet the requirement of 5.1.1 before start of alkaline cleaning to minimize the contamination of cleaning tanks and to ensure maximum alkaline cleaning effectiveness.

5.1.6.2 Cleaning and Etching: The parts shall be cleaned and nitric-hydrofluoric acid etched per Appendix A.

5.2 Packaging:

Subsequent to cleaning, fitting shall be packaged as follows:

a. Individual Fittings: Each fitting except weld end sleeves or weld rings shall be individually packaged in a clean, durable, clear polyethylene bag or container. Weld end sleeves or T-rings may be bulk packaged with the maximum quantity per package of 100 pieces for sizes 02 through 05, 50 pieces for sizes 06 through 08, 25 pieces for sizes 10 through 16, and 10 pieces for size 20 and larger. Packaging shall be sufficiently thick to prevent accidental rupture or tearing and shall prevent damage to the parts during shipment and handling. Thread or fitting end protectors, identification labels or any item except the fittings shall not be placed in the bags.

b. Package Identification: Each unit package shall be marked as specified in MIL-STD-129 with the following identification on or in the package:

(1) Part name
(2) AS standard part number
(3) Manufacturer's name, trademark, or CAGE code
(4) Lot number and date of manufacture. Bulk packaged parts shall also have the quantity of parts per package marked on the package.

6. NOTES:

6.1 The change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

6.2 Key Words:

Fittings, weld, performance

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

APPENDIX A
NITRIC-HYDROFLUORIC ACID ETCH OF TITANIUM ALLOYS

A.1 DEFINITIONS:

WATER-BREAK-FREE SURFACE:

A surface which maintains a continuous water film for a period of at least 30 s after having been spray or immersion rinsed in clean water at a temperature below 100 °F.

A.2 FACILITIES CONTROL:

A.2.1 Temperature:

The etch shall be equipped with temperature indicating and regulating devices capable of controlling the solution within ±5 °F. A temperature indicator should be readily visible to the shop operator. Automatic regulators are recommended but are not mandatory.

A.2.2 Agitation:

The etch shall be agitated slowly as required to minimize temperature and concentration gradients. The maximum temperature gradient shall be measured from the hottest to the coldest point in the tank and shall be within the specified range of that solution. When constant agitation is not used, agitation immediately prior to processing of parts is required to minimize etch variations and temperature and concentration gradients.

A.2.3 Air:

Compressed air used for abrasive cleaning, blowing off dust, drying, and other process operations shall be free of water, oil, and solid particles.

A.2.4 Fixtures:

Fixtures such as racks, clamps, and baskets used during etching require special construction to assure against damage to parts (see A.3.1.1a).

A.3 PROCESS CONTROL:

A.3.1 General Notes:

A.3.1.1 Racking: During etching, the following precautions shall be taken:

a. Position the parts to minimize contact with other material.
b. Rack parts to meet the requirements of A.6b.
c. When necessary use fixtures such as racks, clamps, and baskets made from the materials such as those listed in Table A1.

TABLE A1 - Materials for Fixtures

Fixtures	Materials
Metallic	Nickel chromium alloy UNS N06002, 300 Series CRES, Cobalt Alloy UNS R30605
Nonmetallic	Polyethylene, Polypropylene, PVDC, PVC, PTFE
With continuous impermeable coatings	Polyethylene, Polypropylene, PVDC, PVC, PTFE

A.3.1.2 Final Surfaces: Bare metal surfaces shall be water-break-free following immersion in any final rinse. Re-clean parts which develop water-breaks.

A.3.2 Process Method:

A.3.2.1 Alkaline Cleaning: Alkaline clean and rinse per 5.1.5 of AS1576.

A.3.2.2 Etching: Etch in a solution in accordance with A.4.2.2 at 45 to 90 s to remove surface contamination.

A.3.2.3 Rinsing: Cold water rinse for 3 to 5 min, followed by a hot water rinse if desired to facilitate drying. See A.4.1.3 for chloride and other restrictions. The final rinse shall be with deionized water meeting the requirements of A.4.1. To remove any nitric-fluoride stains visible after rinsing, parts may be immersed 15 to 60 s in nitric acid followed by a thorough cold water rinsing.

A.3.2.4 Drying: Dry the parts. Dry by blasting parts with filtered, dry, oil free air or gaseous nitrogen. Use of a drying gas heater is optional. Keep parts dry and free of oil, grease, fingerprints or other contamination.