AN AMERICAN NATIONAL STANDARD

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

METRIC AEROSPACE STANDARD

MA 2005
(ISO 7169)

Issued 9-1-81
Revised 9-1-83

Rev. A

TUBE FITTINGS, METRIC, AEROSPACE FLUID SYSTEMS, SEPARABLE — GENERAL SPECIFICATION FOR

REAFFIRMED: 9-88

1. SCOPE AND FIELD OF APPLICATION

1.1 SCOPE

This standard establishes the basic performance and quality criteria for screw-together tube fitting assemblies and port connectors. It was prepared to standardize on the qualification test and procurement requirements for ISO standard tube fittings. The test requirements are intended to satisfy the most strenuous demands encountered in a high performance aircraft hydraulic system. The procurement requirements are intended to assure that fittings which are bought to this specification are of the same quality as the fittings used during the original qualification testing. Compliance with these test and procurement requirements is necessary for fittings which are used in control systems where a malfunction could affect the safety of flight.

1.2 FIELD OF APPLICATION

1.2.1 Standard 24 Degree Fitting, Hydraulic

Performance and quality requirements are stated to which standard 24 degree cone fittings must be qualified and fabricated to assure reliable performance in aircraft hydraulic systems.

This standard is a word-for-word equivalent of ISO 7169 with the exception that United States material, test and process specifications are introduced where ISO equivalents are not available. Areas in this document that differ from ISO 7169 are indicated by a line on the margin. The ISO 7169 is based on MIL-F-18280.

Printed in U.S.A.

1.2.2 Other Designs, Hydraulic Fittings

The performance and quality requirements in this document shall be regarded as a baseline to which other fitting designs and materials are to be qualified for hydraulic use. Some of the requirements of this document are special for the 24 degree cone fitting and do not apply to other designs.

1.2.3 Power Plant and Other Systems

System fittings not requiring hydraulic qualification testing shall be designed and fabricated to the general criteria in this standard as far as these criteria are applicable and practical for the intended use and for general standardization.

1.3 CLASSIFICATION

Fittings covered by this specification shall be of the temperature types and pressure classes specified in MA 2001-ISO 6771.

2. APPLICABLE DOCUMENTS

The following documents of the issue in effect on the date of invitation for bids form a part of this specification to the extent specified herein.

2.1 SPECIFICATIONS

2.1.1 Federal

QQ-A-225/6 Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn or Cold Finished, 2024

QQ-A-225/9 Aluminum Alloy Bar, Rod, Wire, and Special Shapes, rolled, Drawn, or Cold Finished, 7075

QQ-A-367 Aluminum-Alloy, Forgings, Heat Treated

QQ-P-416 Plating, Cadmium (Electrodeposited)

QQ-S-637 Steel Bar, Carbon, Cold Finished (Standard Quality, Free Machining)

QQ-S-763 Steel Bars, Shapes, and Forgings, Corrosion Resisting

2.1.2 Military

MIL-S-5002 Surface Treatments and Metallic Coatings for Metal Surfaces of Weapons Systems

MIL-H-6088 Heat Treatment of Aluminum Alloys

MIL-S-6758 Steel, Chrome-Molybdenum (4130) Bars and Reforging Stock (Aircraft Quality)

MIL-T-6845 Tubing; Steel, Corrosion-Resisting (304) Aerospace Vehicle Hydraulic System, 1/8 Hard Condition

MIL-I-6868 Inspection Process, Magnetic particle

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

MIL-F-18280 Fittings, Flareless Tube, Fluid Connection

2.2 STANDARDS

2.2.1 Military

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes (ISO 2859)

MIL-STD-810 Environmental Test Methods

MIL-STD-1655 Fittings, Flareless, Classification of Defects of

Copies may be obtained from the procuring activity or as directed by the contracting officer.

2.3 INDUSTRY PUBLICATIONS

2.3.1 SAE, Aerospace Material Specifications

AMS 2241 Tolerances - Corrosion and Heat Resistant Steel, Iron Alloy, Titanium and Titanium Alloy Bars and Wire

AMS 2486 Conversion Coating of Titanium Alloys, Fluoride Phosphate Type

AMS 4928 Titanium Alloy Bars and Forgings, 6Al-4V, Annealed, 120,000 PSI (827MPa) Yield

AMS 4944 Tubing, Seamless, Hydraulic — 3.0 Al 2.5 V Cold Worked, Stress Relieved

AMS 5561 Tubing, Welded and Drawn — 9.0Mn 20Cr 0.28N High-Pressure, Hydraulic
AMS 5658 Bars, Forgings and Rings 15Cr 5Ni 4Cu

Aerospace Recommended Practices

ARP 891 Determination of Aluminum Alloy Tempers Through Electrical Conductivity Measurement (Eddy Current)

Aerospace Standards

AS 1055 (ISO/DIS 2685) Fire Resistance, Fire Test and Performance Requirements for Flexible Hose and Rigid Tube Assemblies

Metric Aerospace Standards

MA 2001 - ISO 6771 Aerospace Fluid Systems, Pressure and Temperature Classifications

MA 2002 - ISO 6772 Impulse Testing of Hydraulic Hose, Tubing and Fitting Assemblies

MA 2003 - ISO 7252 Rotary Flexure Testing

MA 2004 - ISO 6773 Thermal Shock Test

Copies may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.3.2 American National Standards Institute, Inc.

B46.1 (ISO 468) Surface Texture (Surface Roughness, Waviness and Lay)

Copies may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

3. DEFINITIONS

3.1 PRESSURE TERMS

3.1.1 Nominal Pressure, Operating Pressure: The maximum steady working pressure to which a fitting assembly or component may be subjected. The basic operating pressure without regard to operating pressure variations.

3.1.2 Proof Pressure: The static pressure for testing an assembly, a prescribed multiple of the nominal or operating pressure.

3.1.3 Impulse Pressure: A rapidly occurring pressure rise, peaking at a prescribed multiple of the nominal or operating pressure. After the impulse peak the pressure trace follows a prescribed curve, with a hold at nominal and zero pressure during one impulse pressure cycle.

3.2 FITTING TERMS

3.2.1 (Fitting) Assembly: Assembled and torque tightened fittings, nuts, sleeves and tubing.

3.2.2 Port (also Boss): Threaded connection with a seal, component to pipe line, machined into the component.

3.2.3 Straight Fittings: Parts such as unions, machined out of bar stock, connecting to a port or tube-to-tube.

3.2.4 Forged Parts, also "Shapes": Fitting parts such as elbows and tees machined out of individual forging blanks. The term "shape" is used also for cross, tee and elbow fittings machined out of bar or plate stock.

3.3 WORKMANSHIP, SURFACE DEFECTS

3.3.1 Surface Irregularity: Nonconformity with general surface appearance, possible defect.

3.3.2 Crack: A crack is a clean (crystalline) fracture passing through or across the grain boundaries and may possibly follow inclusions of foreign elements. Cracks are normally caused by overstressing the metal during forging or other forming operations, or during heat treatment. Where parts are subjected to significant reheating, cracks usually are discolored by scale.

3.3.3 Fold: A fold is a doubling over of metal which may occur during the forging operation. Folds may occur at or near the intersection of diameter changes, and are especially prevalent with non-circular necks, shoulders and heads.

3.3.4 Lap: Fold like machining defect.

3.3.5 Seam: Usually a surface crack resulting from a defect obtained in casting or forging, also extraneous material, stringer in the material, not homogeneous with base metal.

3.3.6 Pit: Void, hole in the surface as caused for example by corrosion.

3.4 QUALITY ASSURANCE

3.4.1 Lot: A fabrication run of a given part number from the same batch of material, processed at the same time and in the same manner.

3.4.2 Accepted Quality Level (AQL), Defect Classification, etc: Quality control definitions used in Section 5 are further explained in MIL-STD-105 (ISO 2859).

3.4.3 Qualification, Qualify: The performance testing required to demonstrate successful performance of the fitting in simulated service—overload, destructive and accelerated tests.

4. REQUIREMENTS

4.1 QUALIFICATION

Fitting parts furnished under this standard shall be representative of products which have been subjected to and successfully passed the tests specified in clauses of this standard.

4.2 MATERIALS

4.2.1 Fittings

4.2.1.1 Fitting Material Requirements

The fitting parts shall be fabricated from materials as listed in Table 1 or equivalent passing the specified qualification tests.

a) Bar stock for fitting nuts from C1137/C1141 shall not have laps, surface cracks or other gross defects detectable by magnetic particle inspection per MIL-I-6868.

Table 1 - Materials, Fittings and Tubing

Fittings					Tubing			
Part	Material	Type Per MA 2001	Material Code	Starting Stock	Material	F_{tu}* MPa	F_{ty}** MPa	El % min.
Straight fittings and nuts	Aluminum alloy 2024 T6, T62, T851 QQ-A-225/6	I	D	Bar, rod	Coldworked corrosion resistant steel 304 1/8 h MIL-T-6845	725	515	20
	7075 T73 QQ-A-225/9		W		High strength corrosion resistant steel 21Cr-6Ni-9Mn AMS 5561	980	825	20
Shaped fittings	Aluminum alloy 2014 T6 QQ-A-367	I	D	Forgings, bar	Titanium unalloyed commercially pure	350	250	28
	2024 T6, T851 QQ-A-225/6 7075 T73 QQ-A-225/9 QQ-A-367		W		Titanium coldworked and stress relieved Ti-3Al-2.5V AMS 4944	860	720	10
Straight and shaped parts	Carbon steel 4130, C1137, QQ-S-637 MIL-S-6758	II	F	Bar, rod forgings				
Straight and shaped parts	Corrosion resistant steel 304, 316, 347 QQ-S-763	I II III IV	J,S K	Bar and forgings				
Straight and shaped parts	Titanium alloy Ti-6Al-4V AMS 4928	IV	T	Bar and forgings				
Sleeves (bite type)	Carbon steel C-1213, C-12L14, C-1215 QQ-S-637	II	F	Bar				
Sleeves (swaged and brazed)	Corrosion resistant steel 15-5 PH AMS 5658	IV	P	Bar				

* F_{tu} = Ultimate tensile strength, MPa minimum

** F_{ty} = Yield strength (0,2% proof stress), MPa minimum

Table 2 - Tubing Wall Thickness Requirement for Qualification of Fittings

dimensions in millimeters

Temperature (MA 2001)	Type II (-55 to 135°C)						Type III (-55 to 200°C)	
Pressure (MA 2001)	Class D 20 000 kPa (200 bar)			Class E 28 000 kPa (280 bar)			Class D 20 000 kPa (200 bar)	Class E 28 000 kPa (280 bar)
Tube Material	Cold worked corrosion resistant steel 304 1/8h	High strength corrosion resistant steel 21-6-9	Cold worked titanium 3Al-2.5V	Unalloyed titanium Ti-C.P.	High strength corrosion resistant steel 21-6-9	Cold worked titanium 3Al-2.5V	Cold worked titanium 3Al-2.5V	Cold worked titanium 3Al-2.5V
$F_{tu}/F_{ty}/El$	725/515/20	980/825/20	860/720/10	350/250/28	980/825/20	860/720/10	860/720/10	860/720/10
DN05*	0.40	0.40	0.40	-	0.60	0.60	-	-
DN06	0.40	0.40	0.40	0.80	0.60	0.60	0.40	0.65
DN08	0.50	0.50	0.50	0.90	0.75	0.75	-	-
DN10	0.70	0.50	0.50	1.20	0.80	0.80	0.60	0.90
DN12	0.80	0.60	0.60	1.40	0.90	0.90	0.70	1.0
DN14	-	-	-	1.6	-	-	-	-
DN16	1.0	0.80	0.80	1.80	1.2	1.2	0.90	1.3
DN20	1.5	1.0	1.0	-	1.5	1.5	1.1	1.8
DN25	1.6	1.3	1.3	-	1.9	1.9	1.4	2.2
DN32	2.2	1.4	1.4	-	2.2	2.2	1.6	2.5
DN40	(**) -	-	-	-	-	-	-	-
Code	F, J, S, T			T, F			T	
	Code letters, fitting material							

*DN = Nominal tube outside diameter. Example: DN05 = 5mm tube diameter
(**) Tubing walls for DN 40 to be added

Table 3 - Maximum Depth of Laps and Surface Irregularities in Rolled Threads

dimensions in millimeters

Size DN	Depth	Size DN	Depth
05	0.15	10	0.20
06	0.18	12	0.23
08	0.18	14 to 40	0.25

b) Carbon steel fittings and nuts shall have a hardness of Rockwell B92 to C31. Corrosion resistant steel fittings and nuts shall have a hardness of Rockwell B80 minimum.

c) Aluminum alloy fittings shall meet the electrical conductivity and hardness requirements of ARP 891.

4.2.1.2 Temperatures and Pressures

The various fitting materials are to be used according to the pressure and temperature requirements of the system (see Tables 1 and 2). Temperature types and system pressure classes are defined in MA 2001-ISO 6771.

4.2.2 Tubing

The tubing used with the assembled fittings shall be as described in Table 2, or equivalents passing the specified qualification tests.

4.3 DESIGN AND FABRICATION

4.3.1 Threads

Threads may be cut, rolled, or except for titanium, ground. The external threads of fittings should be rolled, and if machined, shall have a surface finish of 3,2 µm R_a or smoother. The grain flow in rolled threads should be continuous and follow the general thread contour with the maximum density at the thread root.

Laps, cracks, surface irregularities and seams (see clause 3) are not acceptable on any part of the pressure thread flank, in the threadroot or on the non-pressure thread flank. Laps and seams, whose depths are within the limits of Table 3 are acceptable on the crest and the non-pressure thread flank above the pitch diameter.

4.3.2 Fluid Passages

On fittings where the fluid passage is drilled from each end, the offset between the drilled holes at the meeting point shall not exceed 0.4 mm. It shall be possible to pass through the fitting passage a ball whose diameter is 0.5 mm less than the minimum diameter specified for the passage.

4.3.3 Surface Texture

Surface roughness values shall be interpreted in accordance with ANSI B46.1 (ISO R 468).

4.4 SURFACE PROTECTION AND COLOR IDENTIFICATION

4.4.1 Surface Protection

The surfaces of fitting parts shall be protected in the following manner:

a) Aluminum alloy fittings by sulphuric or chromic acid anodizing per MIL-A-8625, then dyed and hot water sealed, except for chromic acid anodized parts.

b) Carbon steel fittings and sleeves by cadmium plating 0.007 to 0.012 mm thick per QQ-P-416 type II, class 2, followed by a chromate post-plate treatment.

c) Corrosion resistant steel fittings by passivation treatment per MIL-S-5002. Sleeves may be cadmium plated per QQ-P-416 type II, class 2.

d) Titanium fittings by a fluoride conversion coating per AMS 2486 or anodizing process.

4.4.2 Color Identification

As a reference the material of the finished fitting may be distinguished by the color codes shown in Table 4.

4.5 MARKING

Unless specified otherwise, parts shall be permanently identified with the complete part number and the manufacturer's trademark. The method of marking shall be impression stamping or electro-etching, in that order of preference. When the complete part number cannot be used in 8 mm size and under because of the size of the part, the marking may be limited to the basic part number, without size designation. The marking shall be in a location not detrimental to the part or its surface protection and preferably visible when the part is assembled. When material code letters are used, the code letter shall also be impression stamped on the part. Standard material code letters for use on fittings shall be as shown in Table 4. The complete part number shall always appear on the part container.

Table 4 - Material Codes and Colors

Code letter	Material	Color (see 4.4)
D	= Aluminum (2024, 2014)	Yellow (except for chromic acid anodized)
W	= Aluminum (7075)	
F	= Carbon steel (C1137, C1141, 4130)	Gold brown
J	= Corrosion resistant steel (304)	Bright metallic
K	= Corrosion and acid resistant steel (316)	
S	= Heat stabilized corrosion resistant steel (347)	
T	= Titanium (6Al-4V)	Dull grey Metallic
P	= Heat treatable corrosion resistant steel (15-5)	

4.6 PERFORMANCE

The tubing-fitting assembly shall be capable of the performance specified in 4.6.1 through 4.6.10 below.

4.6.1 Proof Pressure

The test assembly shall withstand pressure equal to twice the nominal pressure (3.1.1) of the system for five minutes without leakage, evidence of permanent deformation or other malfunction that would affect the ability to disconnect or connect using the specified range of torque values. The test shall be performed in accordance with 5.6.1.

4.6.2 Gaseous Pressure Tightness

Assemblies shall pass the gaseous pressure test to the specified nominal pressure (see definitions, 3.1) without leakage or other failure when tested in accordance with 5.6.2.

4.6.3 Hydraulic Impulse Resistance

The test assembly shall withstand 200,000 impulse pressure cycles without leakage when tested in accordance with 5.6.3.

4.6.4 Minimum Burst Pressure Capability

Pressure of four times the specified nominal pressure shall be applied in accordance with 5.6.4. There shall be no leakage or burst at less than this pressure. Tubing expansion is permissible.

4.6.5 Flexure resistance

4.6.5.1 Standard Flexure Test, Temperature Type II, Pressure Class D

When tested with 304 1/8 hard cold worked corrosion resistant steel tubing per MIL-T-6845, assemblies of type II, class D, fittings shall withstand ten million flexure cycles at a bending stress level of 107 MPa in sizes DN05 through DN16 and 72 MPa in sizes DN20 through DN40. This bending stress is to be determined prior to the application of internal pressure. In order to obtain the true bending stress, it is necessary to always measure the microstrain dynamically at the flexure test frequency. The tolerance for the specified bending stress is to be +10%, -0%.

Six specimens as shown in Figure 1 shall pass this test without failure when tested in accordance with 5.6.5. Bulkhead tee fitting connections shall match the flexure fatigue life of straight unions.

NOTES

1. Basic qualification test to ten million cycles. Steel 24 degree cone fittings shall be used with type II, class D, cold worked corrosion resistant steel tubing and tested to the stress levels defined above.

2. Modifications of the 24 degree cone flareless fitting, other fitting designs, 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 million cycles, to the same 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 flareless type II, class D fitting and cold worked corrosion resistant steel tubing, i.e., all six speciments shall withstand ten million flexure cycles without failure.

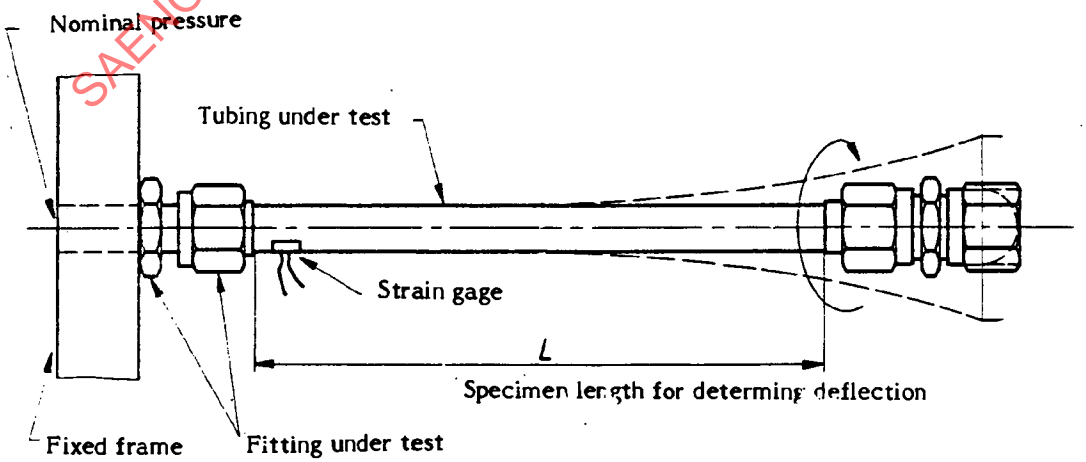


Figure 1 - Schematic for Flexure Test Specimen

4.6.5.2 Flexure Test for Other Types and Pressure Classes

Fitting assemblies of other temperature types and pressure classes as listed in MA 2001-ISO 6771 are to be qualified by testing to the same deflection levels as obtained for testing per 4.6.5.1 (see Figure 1). The performance shall meet or exceed that of the type II, class D fitting.

4.6.6 Stress Corrosion Resistance

The test assembly shall withstand salt spray exposure without occurrence of any of the following defects:

a) Indications of cracking or pitting of the exposed surfaces of the tube joint area when fittings and tubing are visually examined with 10 power magnification and the joint area is compared to the remainder of the tubing.

b) Indications of inter- or transgranular corrosive attack during metallurgical examination of longitudinal and transverse sections of the fitting and fitting-tube junction.

The test shall be conducted in accordance with 5.6.6.

4.6.7 Re-Use Capability

The test assembly shall withstand eight repeated assemblies when tested in accordance with 5.6.7 without occurrence of any of the following defects:

a) Leakage at any of the proof pressure tests.

b) Inability to assemble the fitting to the interface point by hand.

c) Nut deformation preventing engagement of the nut hexagon with an open-end wrench.

d) Gaseous leakage following final assembly when tested per 5.6.2.

Note: The same test assembly may be used subsequently for the burst test. In such circumstances it shall also pass requirements per 4.6.4.

4.6.8 Tensile Load Capability

Fitting assemblies of steel shall withstand axial loads specified in Table 5 without rupture when tested in accordance with 5.6.8. Other designs must hold, as a minimum, axial loads equivalent to those as generated in the fitting by four times the nominal pressure.

Table 5 - Joint Strength, Steel 24 Degree Cone Fitting on 304 1/8 Hard Corrosion Resistant Steel Tubing per MIL-T-6845 (kN)

Size DN	05	06	08	10	12	14	16	20	25	21	40
Joint strength, min.	*	6.60	8.80	11.0	19.0	*	31.0	40.0	44.0	*	*

Note: *) Values to be added when available

4.6.9 Thermal Shock Resistance

The test assembly shall not leak during temperature and pressure cycling from the minimum to the maximum system temperature when tested in accordance with 5.6.9.

4.6.10 Fire Resistance

Tubing and fittings manufactured from steel or titanium shall withstand the fire test with a 1100°C flame for fifteen minutes without leakage. The test procedure shall be per 5.6.10.

4.7 WORKMANSHIP

Fitting parts shall conform with the requirements on the drawing and in this document, and must be free of burrs and slivers. Sealing surfaces must be machined smooth to a finish of 1.6 µm R_a as defined in ANSI B46.1 or smoother. All other machined surfaces shall have a roughness of 3.2 µm R_a or smoother. Unmachined surfaces of forgings or bar stock flats must be of uniform quality and condition, and free of cracks, folds, fissures, pits or defects which could adversely affect the serviceability of the part (see clause 3). Defects in the shear area along forging parting planes of aluminum alloy fittings may be explored by grinding (6.5 µm R_a max) and etching. If the defects can be removed so that they do not reappear on re-etching, and the required section thickness can be maintained, they shall not be cause for rejection.

5. QUALITY ASSURANCE PROVISIONS

5.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified in this standard. Except as otherwise specified, the manufacturer may utilize his own facility or any commercial laboratory acceptable to the purchaser. The purchaser has the right to perform any inspection set forth in this standard whenever such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

5.1.1 Record Maintenance

The supplier shall maintain a record of inspections applied to each lot (as defined under 3.4.1).

5.1.2 Material Certification

Records of chemical composition analysis, mechanical property tests showing conformance with the applicable material specifications, and data showing conformance to the test requirements specified in MIL-H-6088, shall be made available to the purchaser for each lot of fittings.

5.2 CLASSIFICATION OF INSPECTIONS AND TESTS

The inspection and testing of fittings, nuts, and sleeves shall be classified as follows:

a) Qualification inspection
b) Quality conformance inspection.

5.2.1 Qualification Tests

Test assemblies shall consist of the parts specified under specimen preparation 5.5. Tests shall be conducted per 5.6 for each size and material for which qualification is required.

5.2.2 Quality Conformance Inspection

5.2.2.1 Non-Destructive Tests

Inspection for material, threads, finish, dimensions, marking, surface defects and workmanship shall be conducted on a sampling basis per MIL-STD-105 (ISO 2859).

a) Classification of Defects

Fitting defects are classified per Table 6 according to the effect they have on safety and usability. Definition of classes is in accordance with MIL-STD-105 (ISO 2859). However, minor defects are further categorized as follows:

Minor A - may have a slight effect on usability
Minor B - has no effect on usability

b) Level of Inspection

The following Accepted Quality Levels (AQL's) shall apply to the defect classifications (see clause 3) shown in Table 6.

Major - 1.5
Minor A - 4.0
Minor B - 6.5

All defects not identified in Table 6 will be inspected per the Minor A classification, AQL 4.0.

5.2.2.2 Destructive Tests

Sampling for all destructive tests—that is, hardness, burst pressure, grain flow, tube cut (sleeves only) and metallurgical properties (sleeve only) shall be performed in accordance with MIL-STD-105 (ISO 2859), inspection level S-1, AQL 4.0, acceptance number zero.

5.2.2.3 Inspection

Each individual lot of fittings, nuts and sleeves shall be subjected to the following examinations and tests, as specified in sections 4 and 5:

a) Examination of product
b) Chemical composition and mechanical properties
c) Grain flow
d) Internal passages

5.2.2.4 Rejection and Retest

Rejected lots shall be submitted for retest and acceptance in accordance with MIL-STD-105 (ISO 2859). Parts subjected to non-destructive tests and failing to conform to the requirements of these tests shall be rejected. Parts subjected to destructive tests shall be discarded.

5.3 QUALITY CONTROL RECORDS

The supplier shall maintain a record of inspection applied to each lot for a minimum of five years. Records of chemical composition analysis, mechanical property tests showing conformance with the applicable material specifications and metallurgical tests should be made available to the purchaser of each lot of fittings upon request.

5.4 QUALITY CONFORMANCE INSPECTION, PROCEDURES

5.4.1 Examination of Product

Each lot of fittings will be examined to determine conformance with this specification and the applicable standard with respect to material, dimensions, threads, wall thickness, surface defects, finish, marking and workmanship.

5.4.2 Material Certification

The manufacturer shall assure that all materials meet the requirements for chemical composition and mechanical properties as specified in the applicable material and heat treat specifications (see 5.3).

5.4.3 Grain Flow in Threads

The grain flow in rolled threads shall be determined by macro examination. Specimens shall be taken from the finished part by sectioning on a longitudinal plane across the threaded area. The specimens shall be etched to reveal the macro-structure adequately.

5.4.4 Fluid Passages

Each lot of fittings shall be inspected to determine conformance with 4.3.2. The offset between drill holes at intersections shall be inspected by rolling a steel ball with a diameter as specified under 4.3.2 through the fitting.

Table 6 - Classification of Defects*

Fitting End - Design Standard	
Class	Defects
Major	Depth, seal diameter to the tube stop Finish of seal area (cone and O-ring) Squareness, thread to hexagon face Concentricity, thread to conical seal
Minor A	Thread fit Seal angle Fluid bore diameter O-ring seal diameter Machining finish Diameters Thread, length, size and form Marking
Sleeve	
Class	Defects
Major	Hardness Finish, seal area Cutting edge, sharpness
Minor A	Bore diameter Outside diameters Concentricity of ID and OD Surface finish, Marking
Minor B	Turn length Overall length Width of shoulder Surface finish and color
Nut	
Class	Defects
Major	Thread, concentricity, thread to tube bore
Minor A	Thread length, size, and form Small bore diameter Hexagon dimension Concentricity of threads, minor diameter and small ID Marking

*Design standards and part standards for the 24 degree cone fitting are referred to for explanation of the terms used under column heading "Defects"

Table 6 - Classification of Defects* (Continued)

Nut	
Class	Defects
Minor B	Minor diameter and depth Countersink dimension Turned diameter and length Overall length Surface finish, radii, chamfer, color
Fitting - Union	
Class	Defects
Major	Incomplete holes, internal burrs Perpendicularity, threat to hexagon face
Minor A	Thread size and form Concentricity of threads, seat, and face Hexagon dimension Marking
Minor B	Overall length Surface finish, radii, chamfer, color and identification Bore diameter O-ring seal diameter
Fitting - Tee, Elbow	
Class	Defects
Major	Holes - incomplete or missing, internal burrs Wall thickness and depth of bore
Minor A	Fluid passage diameter Leg length, overall length, angle between legs Wrench pad dimension Marking
Minor B	Diameter of seat, leg angularity
Preparation for Delivery	
Class	Defects
Minor B	Marking - Missing, incorrect, incomplete, illegible, of improper size, location, sequence or method or application. Any nonconforming components; component missing, damaged, or otherwise defective. Inadequate assembly of components Number per container is more or less than stipulated. Gross or net weight exceeds the requirement

5.4.5 Sampling Instructions

Sampling shall be as specified in MIL-STD-1655 and in this standard under 5.2.2.1 for non-destructive and 5.2.2.2 for destructive tests.

5.5 TEST CONDITIONS

5.5.1 Test Fluids

Unless otherwise specified, tests shall be conducted using a petroleum base hydraulic fluid for type I (-55 to 70°C) and II (-55 to 135°C) and a silicate ester base hydraulic fluid for type II (-55 to 200°C per MA 2001) system fittings. Water may be used whenever practical for proof, burst, stress corrosion and repeated assembly testing. For other than hydraulic system applications it is preferable to use system fluid for leakage and proof testing.

5.5.2 Specimen Preparation

Test specimens shall be built as illustrated in Table 7. Sleeve installations on the tube end shall be in accordance with user instructions. The fitting shall be assembled using the maximum installing torque for one-half of the test specimens, and minimum torques for the other half.

5.5.3 Lubricants

Hydraulic system fitting shall be assembled using system fluid as lubricant, or another lubricant which is compatible with the system fluid and which has essentially the same lubricity characteristics.

5.5.4 Sampling Instructions

Qualification inspection samples shall consist of the component parts illustrated in table 7 and shall be tested in the quantities shown in Table 7. Qualification tests are required for each size and material for which qualification is desired.

5.6 QUALIFICATION TEST PROCEDURES

5.6.1 Proof Pressure Test

Test assemblies shall be connected to a source of pressure with one end free to move and proof pressure tested at a value equal to two times the nominal system pressure for a minimum period

of five miniutes. Rate of pressure rise shall be 150,000 ± 37,500 kPa (1,500 ± 375 bar) per miniute. The test shall be conducted at room temperature.

5.6.2 Gaseous Pressure Test

Test fittings shall be solvent cleaned and air dried prior to test, assembled with the use of a separate lubricant or compound on the thread and sleeve/nut shoulder (unless they have a solid film lubrication) and tightened to the torques as specified in Table 8. They shall then be pressurized with nitrogen to the specified system pressure and this pressure maintained for five minutes while the specimens are immersed in water or suitable oil. Specimens may be pressure tested at room temperature and as illustrated in Figure 2.

5.6.3 Impulse Test

Assemblies shall be impulse tested per MA 2002-ISO 6772. Type I specimens shall be tested at room temperature, types II, III at the temperatures and sequence as specified in MA 2002-ISO 6772.

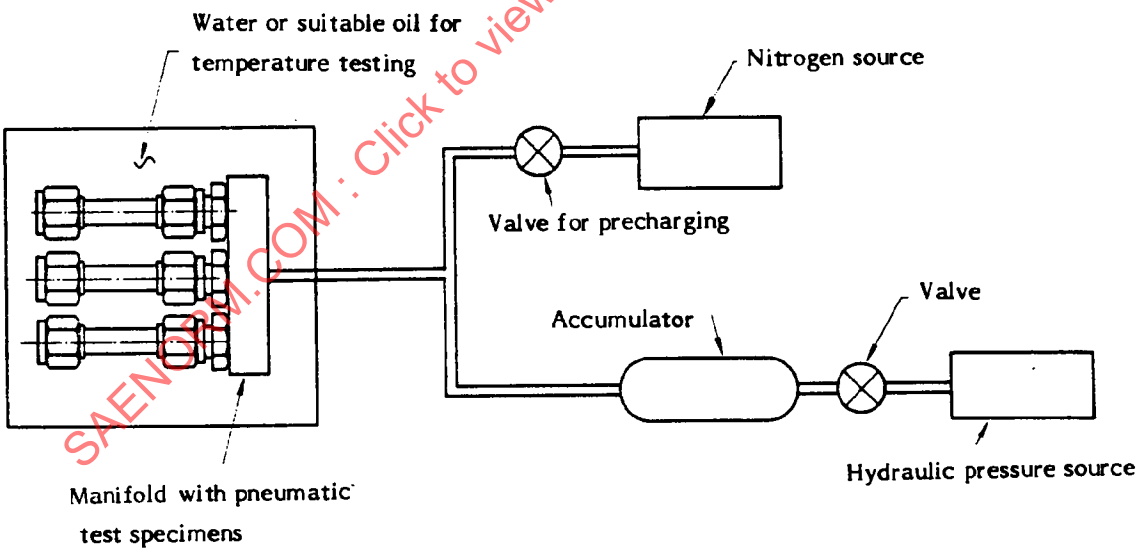
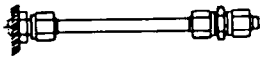
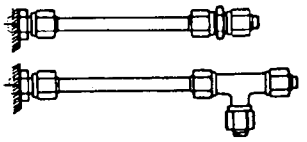
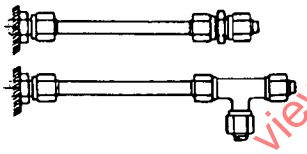
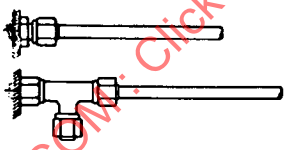
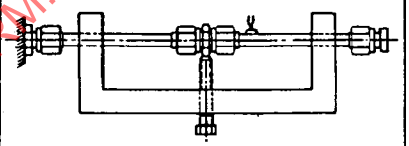
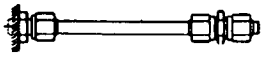
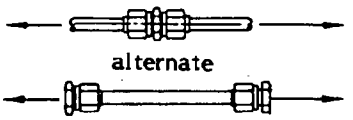
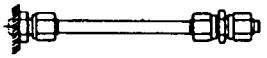
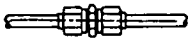


Figure 2 - Schematic for Gaseous Pressure Test

Table 7 - Testing and Test Samples for Qualifications

Test	Pro-cedure	Specimen	Specimen			Notes
			Quantity	number	Sizes	
Inspection Proof	5.6.1	All parts and assemblies All assemblies				
Gaseous pressure	5.6.2		6	1 to 6	All	1)
Impulse	5.6.3		3 3 } 6	7 to 9 10 to 12	All	3) 4)
Burst	5.6.4		3 3 } 6	13 to 15 16 to 18	All	2)
Flexure	5.6.5		6 2 } 8	19 to 24 25 to 26	All	1),3)
Stress corrosion	5.6.6		3	27 to 29	16	
Reuse	5.6.7		3	30 to 32	All	
Tensile	5.6.8		6	33 to 38	All	
Thermal shock	5.6.9		2	30 and 40	16	1)
Fire	5.6.10		2	41 and 42	16	