

International Standard



7169

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Aerospace construction — Separable tube fittings for fluid systems — General specification

Constructions aérospatiales — Raccordements séparables de tubes pour systèmes de fluides — Spécifications générales

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Aerospace construction — Separable tube fittings for fluid systems — General specification

1 Scope and field of application

1.1 Scope

This International Standard establishes the basic performance and quality criteria for screw-together tube fitting assemblies and port connectors. It was prepared to standardize 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° cone fitting, hydraulic

Performance and quality requirements are stated to which standard 24° cone fittings shall be qualified and manufactured to ensure reliable performance in aircraft hydraulic systems.

1.2.2 Other designs, hydraulic fittings

The performance and quality requirements in this International Standard shall be regarded as a baseline to which other fitting designs and materials shall be qualified for hydraulic use. Some of the requirements of this International Standard are particularly related to the 24° 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 manufactured to the general criteria in this International 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 International Standard shall be of the temperature types and pressure classes specified in ISO 6771.

2 References

ISO 468, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

ISO/TR 2685, *Aircraft — Environmental conditions and test procedures for airborne equipment — Resistance to fire in designated fire zones.*

ISO 2859, *Sampling procedures and tables for inspection by attributes*.

ISO 6771, *Aerospace construction — Fluid systems and components — Pressure and temperature classifications*.

ISO 6772, *Aerospace fluid systems — Impulse testing of hydraulic hose, tubing and fittings assemblies*.

ISO 6773, *Aerospace fluid systems — Thermal shock testing of piping and fittings*.

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment* (Endorsement of publications EUROCAE/ED-14 A and RTCA/DO-160 A).

ISO 7257, *Aircraft — Hydraulic tubing joints and fittings — Rotary flexure test*.

3 Definitions

3.1 Pressure terms

3.1.1 nominal pressure : The maximum steady working pressure (operating 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 pressure.

3.1.3 impulse pressure : A rapidly occurring pressure rise, peaking at a prescribed multiple of the nominal 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 fitting, 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 also used 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 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 subject to significant reheating, cracks usually are discoloured by scale.

3.3.3 fold : 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 during 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 manufacture 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.

NOTE — Quality control definitions used in clause 5 are further explained in ISO 2859.

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

4 Requirements

4.1 Qualification

Fitting parts supplied in accordance with this International Standard shall be representative of products which have been subjected to and successfully passed the tests specified in clause 5 of this International Standard.

4.2 Materials

4.2.1 Fittings

The fitting parts shall be manufactured from materials as given in table 1 or equivalents passing the specified qualification tests. The various materials shall be used according to the pressure and temperature requirements of the system (see tables 1 and 2).

NOTE — Temperature types and system pressure classes are defined in ISO 6771.

Table 1 — Materials, fittings and tubing

	Fittings				Tubing			
Part	Material	Type (as per ISO 6771)	Material code	Starting stock	Material	R_m min.* MPa	$R_{p0,2}$ min.** MPa	A % min.
Straight fittings and nuts	Aluminium alloy	I	D	Bar, rod	Cold worked corrosion resistant steel	725	515	20
Shaped fittings	Aluminium alloy	I	D	Bar and forgings				
Straight and shaped parts	Carbon steel	II	F	Bar, rod, forgings	High strength corrosion resistant steel	980	825	20
Straight and forged parts	Corrosion resistant steel	I	J	Bar and forgings	Titanium unalloyed	350	250	28
		II	J					
		III	S					
		IV	K					
Straight and shaped parts	Titanium alloy	IV	T	Bar and forgings	Titanium cold worked and stress relieved	860	720	10
Sleeves (bite type)	Carbon steel	II	F	Bar				
Sleeves (swaged and brazed)	Corrosion resistant steel	IV	P	Bar				

* R_m min. = Ultimate tensile strength, MPa minimum.** $R_{p0,2}$ min. = Yield strength(0,2 % proof stress) minimum.

Table 2 — Tubing wall thickness requirement for qualification of fittings

Dimensions in millimetres

Tempera- ture (see ISO 6771)	Type II (–55 to 135 °C)						Type III (–55 to 200 °C)	
	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)
Pressure (see ISO 6771)								
Tube material	Cold worked corrosion resistant steel	High strength corrosion resistant steel	Cold worked titanium	Unalloyed titanium	High strength corrosion resistant steel	Cold worked titanium	Cold worked titanium	Cold worked titanium
R_m min./ $R_{p0,2}$ min./A	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	—	—	—	—	—	—	—	—
Material code	F, J, S, T			T, F			T	

* DN = Nominal tube outside diameter. Example : DN05 = 5 mm ϕ tube.

4.2.2 Tubing

The tubing used with the assembled fittings shall be as described in table 2 or equivalent tubing passing the specified qualification tests.

4.3 Design and manufacture

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 $3,2 \mu\text{m}$ AA 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.

Table 3 — Maximum depth of laps and surface irregularities in rolled threads

Dimensions in millimetres

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

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 ISO 468.

4.4 Surface protection and colour identification

4.4.1 Surface protection

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

a) aluminium alloy fittings by sulfuric or chromic acid anodizing, 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, followed by a chromate post-plate treatment;

c) corrosion resistant steel fittings by passivation treatment. Sleeves may be cadmium plated;

d) titanium fittings by a fluoride conversion coating or anodizing process.

4.4.2 Colour identification

As a reference the material of the finished fitting may be distinguished by the colours as 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 DN08 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 colours

Code	Material	Colour (see 4.4.2)
D	Aluminium	Yellow (except for chromic acid anodized)
F	Carbon steel	Gold brown
J	Corrosion resistant steel	Bright metallic
K	Corrosion and acid resistant steel	
S	Heat-stabilized corrosion resistant steel	
P	Heat-treatable corrosion resistant steel	Metallic
T	Titanium	Dull grey

4.6 Performance

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

4.6.1 Proof pressure

The test assembly shall withstand pressure equal to twice the nominal pressure (3.1.1) of the system for 5 min without leakage, evidence of permanent deformation or other malfunction that might 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 given in 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 cold worked corrosion resistant steel tubing (R_m min. 725 MPa, as given in table 1), assemblies of type II, class D fittings shall withstand 10 million flexure cycles at a bending stress level of 107 MPa in sizes DN05 to DN16 and 72 MPa in sizes DN20 to DN40. This bending stress shall be determined prior to the application of internal pressure. In order to obtain the true bending stress, it is always necessary to measure the microstrain dynamically at the flexure test frequency. The tolerance for the specified bending stress shall be $\pm 10\%$.

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 10 million cycles. Steel 24° 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 24° cone fittings, 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° 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° cone type II, class D fitting and cold worked corrosion resistant steel tubing, that is all six specimens shall withstand 10 million flexure cycles without failure.

4.6.5.2 Flexure test for other temperature types and pressure classes

Fitting assemblies of other temperature types and pressure classes (see ISO 6771) shall be qualified by testing to the same deflection levels as obtained for testing in accordance with 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:

- indications of cracking or pitting of the exposed surfaces of the tube joint area when fittings and tubing are visually examined with X 10 magnification and the joint area is compared to the remainder of the tubing;
- 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.

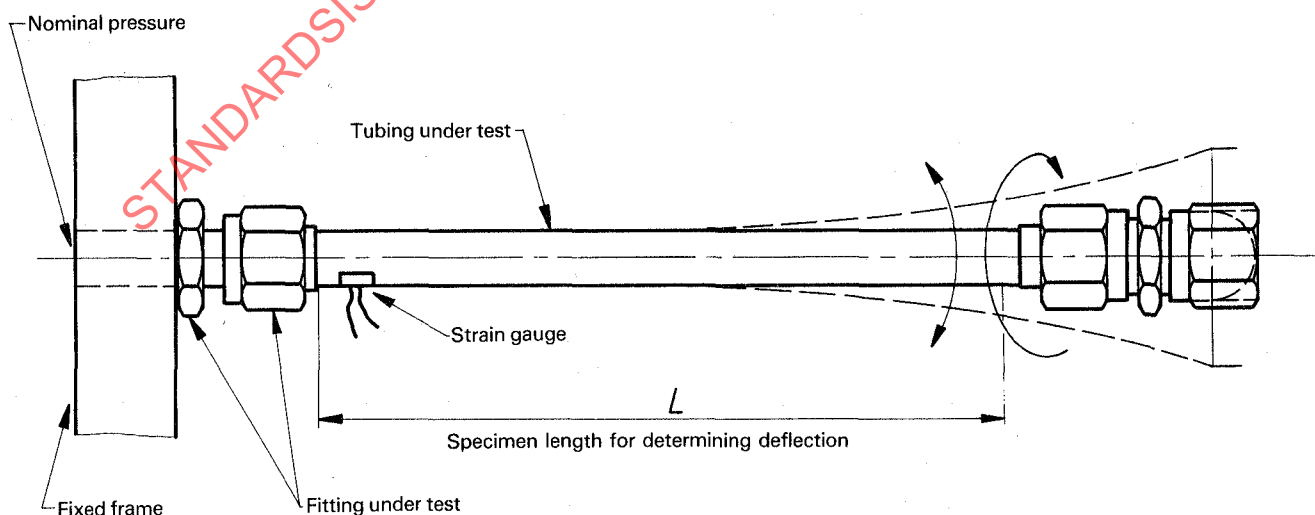


Figure 1 — Schematic diagram for flexure test specimen

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 in accordance with 5.6.2.

As the same test assemblies may be used subsequently for the burst test, they shall also meet the requirements laid down in 4.6.4.

4.6.8 Tensile load capability

Steel fitting assemblies shall withstand the axial loads specified in table 5 without rupture, when tested in accordance with 5.6.8. Other designs shall withstand, 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° cone fitting on cold worked corrosion resistant steel tubing

Values in kilonewtons

Size DN	05	06	08	10	12	14	16	20	25	32	40
Axial load min.	*	6,60	8,80	11,0	19,0	*	31,0	40,0	44,0	*	*

* 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 1 100 °C flame for 15 min without leakage. The test procedure shall be in accordance with 5.6.10.

4.7 Workmanship

Fitting parts shall conform with the requirements on the drawing and in this International Standard, and shall be free of burrs and slivers. Sealing surfaces shall be machined smooth to a finish of 1,6 µm AA. All other machined surfaces shall have a roughness of 3,2 µm AA or smoother. Unmachined surfaces of forgings or bar stock flats shall be of uniform quality and condition, and free of cracks, folds, fissures, pits or defects which could affect the serviceability of the part (see clause 3). Defects in the shear area along forging parting planes of aluminium alloy fittings may be explored by grinding (6,5 µm 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 considered as grounds 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 International Standard. Except as otherwise specified, the manufacturer may use his own facilities or any commercial laboratory acceptable to the purchaser. The purchaser has the right to perform any inspection laid down in this International Standard, whenever such inspections are deemed necessary to ensure that supplies and services conform to the prescribed requirements.

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 in 5.5.2. Tests shall be conducted in accordance with 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 in accordance with ISO 2859.

a) Classification of defects

Fitting defects are classified in table 6 according to the effect they have on safety and usability. Definition of classes is in accordance with ISO 2859. However, minor defects are further categorized as follows :

- Minor A — may have a slight effect on usability, and
- Minor B — has no effect on usability.

b) Level of inspection

The following Accepted Quality Levels (AQLs) 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 shall be inspected in accordance with the Minor A classification, AQL 4,0.

Table 6 — Classification of defects*

Fitting end — design standard		Fitting — union	
Class	Defects	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	Major	Incomplete holes, internal burrs Perpendicularity, thread to hexagon face
Minor A	Thread fit Seal angle Fluid bore diameter O-ring seal diameter Machining finish Diameters Thread, length, size and form Marking	Minor A	Thread size and form Concentricity of threads, seat, and face Hexagon dimension Marking
		Minor B	Overall length Surface finish, radii, chamfer, colour, and identification Bore diameter O-ring seal diameter
Sleeve		Fitting — tee, elbow	
Class	Defects	Class	Defects
Major	Hardness Finish, seal area Cutting edge, sharpness	Major	Holes — incomplete or missing, internal burrs Wall thickness and depth of bore
Minor A	Bore diameter Outside diameters Concentricity of ID and OD Surface finish, marking	Minor A	Fluid passage diameter Leg length, overall length, angle between legs Wrench pad dimension Marking
Minor B	Turn length Overall length Width of shoulder Surface finish and colour	Minor B	Diameter of seat, leg angularity
Nut		Preparation for delivery	
Class	Defects	Class	Defects
Major	Thread, concentricity, thread to tube bore, distance across hexagon	Minor B	Marking — missing, incorrect, incomplete, illegible, of improper size, location, sequence or method of application
Minor A	Thread length, size, and form Small bore diameter Hexagon dimension Concentricity of threads, minor diameter and small ID Marking		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
Minor B	Minor diameter and depth Countersink dimension Turned diameter and length Overall length Surface finish, radii, chamfer, colour		

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

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 ISO 2859, inspection level S-1, AQL 4,0, acceptance number 0.

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 clauses 4 and 5 :

- a) examination of product;
- b) material certification (chemical composition and mechanical properties);
- c) grain flow;
- d) internal fluid passages.

5.2.2.4 Rejection and retest

Rejected lots shall be resubmitted for retest and acceptance in accordance with 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 shall be examined to determine conformance with this International Standard and the applicable standards 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 treatment 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 in 4.3.2 through the fitting.

5.4.5 Sampling instructions

Sampling shall be as specified in 5.2.2.1 for non-destructive tests 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 types I and II and a silicate ester base hydraulic fluid for type III (see ISO 6771) system fittings. Water may be used, whenever practical, for proof, burst, stress corrosion and repeated assembly (re-use) 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 assembled 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 half of the test specimens, and minimum torques for the other half.

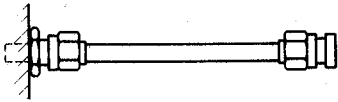
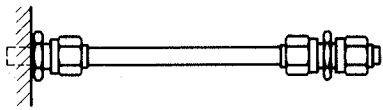
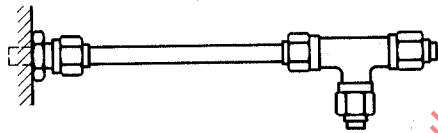
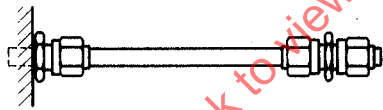
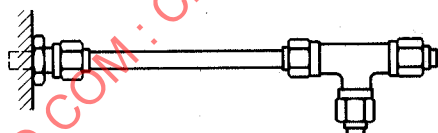
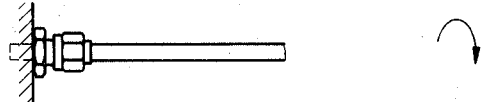
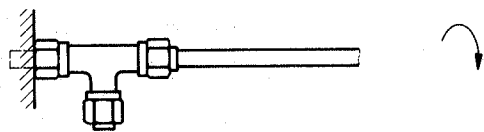
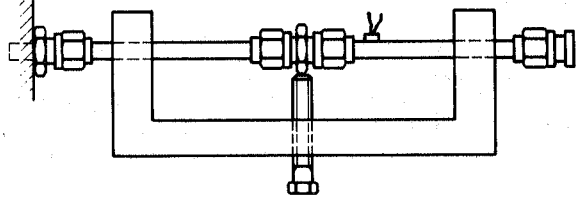
5.5.3 Lubricants

Hydraulic system fittings 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, as shown 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.

Table 7 — Testing and test samples for qualifications

Test	Test procedure	Specimen	Quantity	Specimen number	Sizes	See foot-notes
Inspection		All parts and assemblies				
Proof pressure	5.6.1	All assemblies				
Gaseous pressure	5.6.2		6	1 to 6	All	1)
Impulse	5.6.3		3	7 to 9	All	1), 4)
			3			
Minimum burst pressure	5.6.4		3	13 to 15	All	2), 4)
			3			
Flexure	5.6.5		6	19 to 24	All	1), 3)
			2			
Stress corrosion	5.6.6		3	27 to 29	DN16	