TC 20

International Standard 7169

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

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

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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

Part	Fittings				Tubing			
	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				
		II	J					
		III	S		Titanium unalloyed	350	250	28
		IV	K					
Straight and shaped parts	Titanium alloy	IV	T	Bar and forgings				
Sleeves (bite type)	Carbon steel	II	F	Bar	Titanium cold worked and stress relieved	860	720	10
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

Temperature (see ISO 6771)	Type II (−55 to 135 °C)						Type III (−55 to 200 °C)	
Pressure (see ISO 6771)	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	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 µm 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 $^{+10}_{0}$ %.

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 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 :

a) 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;

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.

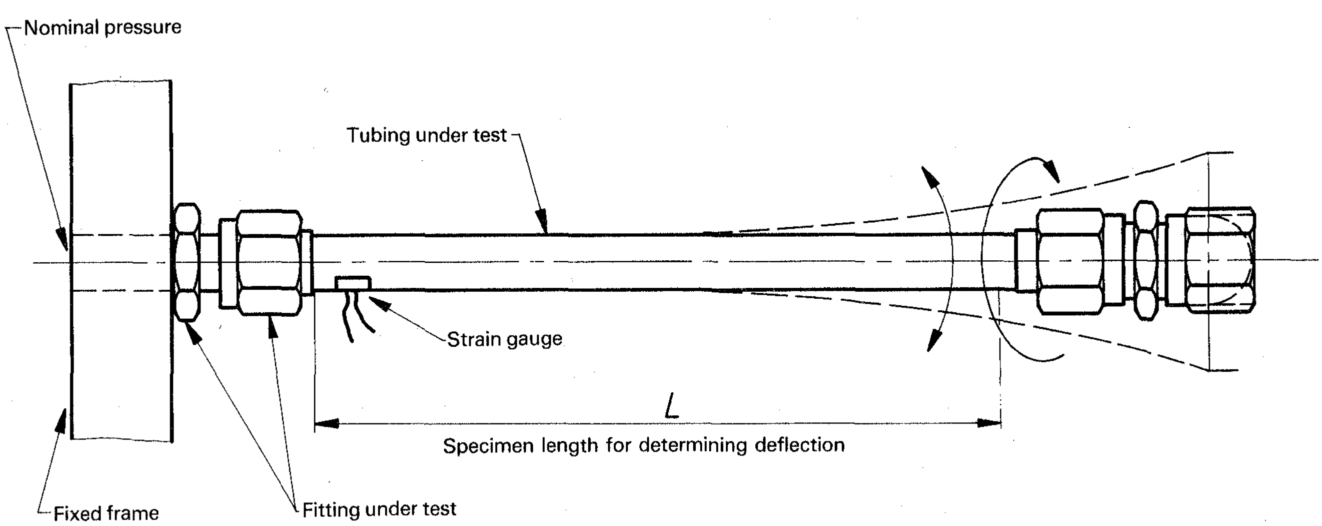

Figure 1 — Schematic diagram for flexure test specimen