INTERNATIONAL STANDARD

ISO 7169

Second edition
1993-05-15

Aerospace fluid systems — Separable tube fittings for 24° cone — General specification

Circuits de fluides pour l'aérospatiale — Raccordements séparables de tubes à cône de 24° — Spécifications générales

Reference number
ISO 7169:1993(E)

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. Each 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7169 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Sub-Committee SC 10, *Aerospace fluid systems and components*.

This second edition cancels and replaces the first edition (ISO 7169:1984), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Introduction

This International Standard establishes the basic performance and quality criteria for screw-together tube fitting assemblies and port connectors used in aerospace fluid systems.

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 ensure that fittings, which are procured in accordance with 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 that are used in control systems where a malfunction would affect the safety of flight.

Aerospace fluid systems — Separable tube fittings for 24° cone — General specification

1 Scope

This International Standard specifies performance and quality requirements for the qualification and manufacture of standard 24° cone fittings[1] to ensure reliable performance in aircraft hydraulic systems.

This International Standard specifies baseline criteria for the design and manufacture of system fittings that are qualification tested on engines.

This International Standard covers fittings of the temperature types and pressure classes specified in ISO 6771.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

ISO 2685:1992, *Aircraft — Environmental conditions and test procedures for airborne equipment — Resistance to fire in designated fire zones.*

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*

ISO 6771:1987, *Aerospace — Fluid systems and components — Pressure and temperature classifications.*

ISO 6772:1988, *Aerospace — Fluid systems — Impulse testing of hydraulic hose, tubing and fitting assemblies.*

ISO 7257:1983, *Aircraft — Hydraulic tubing joints and fittings — Rotary flexure test.*

ISO 8575:1990, *Aerospace — Fluid systems — Hydraulic system tubing.*

ISO 9538:—[2], *Aerospace — Hydraulic tubing joints and fittings — Planar flexure test.*

ISO 10583:1993, *Aerospace fluid systems — Test methods for tube/fitting assemblies.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 2859-1 and the following definitions apply.

3.1 Workmanship and surface defects

3.1.1 surface irregularity: Nonconformity with general surface appearance, possible defect.

1) The geometrical definition of a 24° cone fitting will be given in a future International Standard.

2) To be published.

3.1.2 crack: Clean (crystalline) fracture passing through or across the grain boundaries that possibly follows 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 re-heating, cracks are usually discoloured by scale.

3.1.3 fold: Doubling over of metal, which can occur during the forging operation. Folds can occur at or near the intersection of diameter changes and are especially prevalent with non-circular necks, shoulders and heads.

3.1.4 lap: Fold-like machining defect.

3.1.5 seam

(1) Usually a surface opening or crack resulting from a defect obtained during casting or forging.

(2) Extraneous material, stringer in the material, which is not homogeneous with base metal.

3.1.6 pit: Void or hole in the surface as caused, for example, by corrosion.

3.1.7 leakage

(1) Wetting or formation of a drop or drops of test fluid in pressure testing or of a bubble in pneumatic testing.

(2) Spillage of test fluid due to rupture.

3.2 Fitting components

Fitting components are designated as illustrated in figure 1.

3.3 Quality assurance

3.3.1 lot: Manufacturer's run of a given part number from the same batch of material, processed at the same time and in the same manner.

3.3.2 qualification test: Performance testing required to demonstrate successful performance of the fitting in simulated service and using overload, destructive and accelerated tests.

4 Requirements

4.1 Qualification

Fittings claiming conformity with this International Standard shall be representative of products which have successfully met the requirements and have passed the tests specified in this International Standard.

Fitting claiming conformity with this International Standard shall be representative of products which have 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 table 1).

4.2.2 Tubing

The tubing used with the fittings shall be in accordance with ISO 8575 or equivalent tubing passing the specified qualification tests. Equivalent tubing shall have the mechanical characteristics given in table 1.

WARNING — Titanium fittings and tubing shall not be used in oxygen systems.

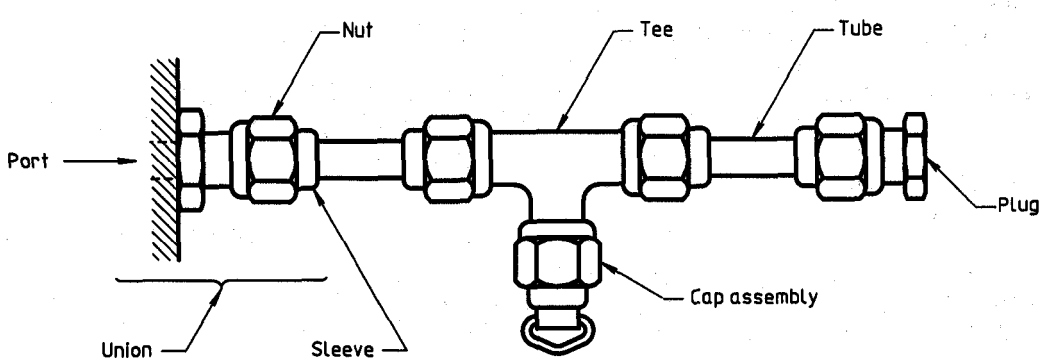

Figure 1 — Fitting assembly part designations

Table 1 — Materials, fittings and tubing

Part	Fittings					Tubing				
	Material	Type[1]	Material code[2]	Starting stock	Material No.[3]	Material	R_m min.[4] MPa	$R_{p0,2}$ min.[5] MPa	A min. %	Material No.[3]
Straight fittings and nuts	Aluminium alloy	I	D	Bar, rod	1	Aluminium alloy	290	241	10	13
			W		2					
Shape fittings	Aluminium alloy	I	D	Bar and forgings	3					
			W		2					
Straight and shape parts	Carbon steel	II	F	Bar rod, forgings	4	Cold-worked corrosion-resistant steel	725	515	20	14
Straight and shape parts	Corrosion-resistant steel, stabilized	I	J	Bar and forgings	5					
		II	J		5	High-strength corrosion-resistant steel	980	825	20	15
		III	S		6					
		IV	K		7					
Straight and shape parts	Titanium alloy	IV	T	Bar and forgings	8	Titanium, unalloyed	350	250	28	16
Sleeves (bite type)	Carbon steel	II	F	Bar	9					
Sleeves (swaged and brazed)	Corrosion-resistant steel	IV	P	Bar	10					
Sleeves (welded)	Corrosion-resistant steel	I, II, III, IV	C	Bar	11	Titanium, cold-worked and stress-relieved	860	720	10	17
	Titanium alloy	I, II, III, IV	T		12					

1) Temperature types and system pressure classes are defined in ISO 6771.

2) See table 3.

3) See also table A.1.

4) R_m min. = Minimum ultimate tensile strength.

5) $R_{p0,2}$ min. = Minimum yield strength (0,2 % proof stress).

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 an arithmetical mean deviation, R_a, of the profile of 3,2 µm or smoother in accordance with ISO 468. 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 3.1) 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 2, are acceptable on the crest and the non-pressure thread flank above the pitch diameter.

Table 2 — Maximum depth of laps and surface irregularities in rolled threads

Dimensions in millimetres

Size DN	Depth
05	0,15
06	0,18
08	0,18
10	0,2
12	0,23
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.

4.4 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 acid anodizing, then dyeing and dichromate or nickel acetate sealing;

b) **carbon steel fittings and sleeves:** by cadmium plating 0,007 mm to 0,012 mm thick, followed by a chromate postplate 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 3.

Table 3 — Material codes and colours

Material	Code	Colour
Aluminium	D	Yellow
Aluminium	W	Gold
Carbon steel	F	Gold brown
Corrosion-resistant steel	J	Bright metallic
Corrosion- and acid-resistant steel	K	Bright metallic
Heat-stabilized corrosion-resistant steel	S	Bright metallic
Corrosion-resistant stabilized steel	R	Bright metallic
Heat-treatable corrosion-resistant steel	P	Metallic
Titanium	T	Dull grey

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 laser marking, 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 not be in a location detrimental to the part or its surface protection and should preferably be visible when the part is assembled. When material code letters are used, the code letter (see table 3) shall also be laser marked, electro-etched or impression stamped on the part.

4.6 Performance

The tubing/fitting assembly shall be capable of the performance specified in 4.6.1 to 4.6.9.

4.6.1 Proof pressure

When tested in accordance with ISO 10583:1993, subclause 5.1, the test assembly shall withstand pressure equal to twice the nominal pressure[3] 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. All specimens, except tensile specimens, shall be proof tested.

4.6.2 Pneumatic pressure tightness

When tested in accordance with ISO 10583:1993, subclause 5.2, assemblies shall pass the gaseous pressure test to the specified nominal pressure without leakage or other failure. Six specimens shall be tested.

4.6.3 Hydraulic impulse resistance

When tested in accordance with ISO 6772 and ISO 10583:1993, subclause 5.3, the test assembly shall withstand 200 000 impulse pressure cycles without leakage. Six specimens shall be tested.

4.6.4 Minimum hydrostatic pressure capability

When tested in accordance with ISO 10583:1993, subclause 5.4, there shall be no leakage or burst at less than the specified minimum burst pressure. Tubing expansion is permissible. Six specimens shall be tested to failure.

3) In accordance with ISO 8574:1990, *Aerospace — Hydraulic system tubing — Qualification tests.*

4.6.5 Flexure resistance

4.6.5.1 Standard rotary flexure test, temperature type II, pressure class D

When tested in accordance with ISO 7257 and ISO 10583:1993, subclause 5.5, test assemblies shall not fail. Six specimens with straight unions shall be tested. Bulkhead tee fitting connections shall match the flexure fatigue life of straight unions. Two specimens with bulkhead tees shall be tested.

4.6.5.1.1 Basic qualification requirement for testing to 10^7 cycles

Steel 24° cone fittings shall be used with type II, class D, cold-worked corrosion-resistant steel tubing (material No. 14 in table A.1) and flexure fatigue tested to 135 MPa bending stress in sizes DN16 and under, and 108 MPa in sizes DN20 and over to a tolerance of $^{\ 0}_{-10}$ %.

NOTE 1 Under pressure and with dynamic load due to rotation, these stresses may be 172 MPa and 137 MPa respectively.

4.6.5.1.2 Alternative qualification test requirement

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 10^7 cycles, to the same fatigue life measured in 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 (material No. 14 in table A.1); that is, all six specimens shall withstand 10^7 flexure cycles without failure.

4.6.5.2 Rotary 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. The performance shall meet or exceed that of the type II, class D fitting.

4.6.5.3 Planar flexure test

As an alternative to the rotary flexure test, the planar method given in ISO 9538 may be used.

4.6.6 Stress corrosion resistance

When tested in accordance with ISO 10583:1993, subclause 5.6, there shall be none 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 magnification and the joint area is compared to the remainder of the tubing;

b) indications of intergranular or transgranular corrosive attack during metallurgical examination of longitudinal and transverse sections of the fitting and the fitting/tube junction.

Three specimens shall be tested.

4.6.7 Re-use capability

When tested in accordance with ISO 10583:1993, subclause 5.7, there shall be none of the following defects:

a) leakage during 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 4.6.2.

Because the same test assemblies may be used subsequently for the burst test, they shall also meet the requirements of 4.6.4 above. Three specimens shall be tested.

4.6.8 Tensile load capability

When tested in accordance with ISO 10583:1993, subclause 5.8, steel fitting assemblies of temperature type II, pressure class D shall withstand the axial loads specified in table 4 without rupture. Two specimens shall be tested.

Table 4 — Joint strength, steel 24° cone fitting on cold worked corrosion-resistant steel tubing

Values in kilonewtons

Size DN	Minimum axial load
05	1)
06	4,6
08	7,5
10	11
12	19
14	20
16	31
20	40
25	44
32	1)
40	1)

1) Values to be added when available.

4.6.9 Fire resistance

When tested in accordance with ISO 2685, tubing and fittings manufactured from steel or titanium shall not leak. Two specimens shall be tested.

This test shall be conducted for fittings used in fire zones.

4.7 Workmanship

Fitting parts shall conform with the requirements specified 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 with an R_a value of 1,6 µm in accordance with ISO 468. All other machined surfaces shall have a roughness value, R_a, of 3,2 µm maximum. Unmachined surfaces of forgings or bar stock flats shall be of uniform quality and condition and shall be free of cracks, folds, fissures, pits or defects, as visible to the unaided eye or by magnetic or dye-penetrant inspection, that could affect the serviceability of the part (see 3.1). Defects in the shear area along forging parting planes of aluminium alloy fittings may be explored by grinding (to a maximum roughness, R_a, of 6,5 µm) and etching. If the defects can be removed so that they do not re-appear 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. Unless otherwise specified, the manufacturer may use his own facilities or any commerical laboratory acceptable to the purchaser. The purchaser has the right to perform any inspection specified 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 (see 5.2.1);

b) quality conformance inspection (see 5.2.2).

5.2.1 Qualification inspection

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 2859-1.

5.2.2.1.1 Classification of defects

Fitting defects are classified in table 5 according to the effect they have on safety and usability. Definition of classes is as follows:

a) Major: will cause malfunction or will make the part unusable;

b) Minor A: may have a slight effect on usability; and

c) Minor B: has no effect on usability.

5.2.2.1.2 Acceptable quality level

The following acceptable quality levels (AQLs) apply to the defect classifications (see 5.2.2.1.1) shown in table 5.

a) Major: AQL 0,015

b) Minor A: AQL 0,040

c) Minor B: AQL 0,065

All defects not identified in table 5 shall be inspected in accordance with the Minor B classification (AQL 0,065).

5.2.2.2 Destructive tests

Sampling for all destructive tests [that is, burst pressure, grain flow, intergranular corrosion resistance of non-stabilized corrosion-resistant steel, tube cut (sleeves only) and tensile load capability (sleeves only)] shall be performed in accordance with ISO 2859-1, inspection level S-1, acceptance number 0.

Table 5 — Classification of defects

Fitting end — design standard	
Class	**Defects** [1]
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

Fitting — union	
Class	**Defects** [1]
Major	Incomplete holes, internal burrs
	Perpendicularity, thread 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, colour and identification
	Bore diameter
	O-ring seal diameter

Sleeve	
Class	**Defects** [1]
Major	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 colour

Fitting — tee elbow	
Class	**Defects** [1]
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

Nut	
Class	**Defects** [1]
Major	Thread, concentricity, thread to tube bore, distance across hexagon
Minor A	Thread length, size and form
	Small bore diameter
	Hexagon dimension
	Concentricity of threads, minor diameter and small ID
	Marking
Minor B	Minor diameter and depth
	Countersink dimension
	Turned diameter and length
	Overall length
	Surface finish, radii, chamfer, colour

Preparation for delivery	
Class	**Defects** [1]
Minor B	Marking: missing, incorrect, incomplete, illegible, of improper size, location, sequence or method of 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 (as specified by the part standard)

1) Refer to design standards and part standards for the 24° cone fitting for explanations of the terms used in this column.