INTERNATIONAL STANDARD

ISO 7169

Fourth edition
2007-02-01

Aerospace — Separable tube fittings for fluid systems, for 24° cones, for pressures up to 3 000 psi or 21 000 kPa — Procurement specification, inch/metric

Aéronautique et espace — Raccordements séparables de tubes à cône de 24° pour circuits de fluides jusqu'à 3 000 psi ou 21 000 kPa — Spécification d'approvisionnement, inch/métrique

Reference number
ISO 7169:2007(E)

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Published in Switzerland

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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. 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fourth edition cancels and replaces the third edition (ISO 7169:1998), which has been technically revised. Criteria for imperial dimension (inch-based) tube fittings, as used for commercial aviation, have been introduced.

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 — Separable tube fittings for fluid systems, for 24° cones, for pressures up to 3 000 psi or 21 000 kPa — Procurement specification, inch/metric

1 Scope

This International Standard specifies performance and quality requirements for the qualification and manufacture of standard 24° cone fittings and manufacture of 24° cone fittings to ensure reliable performance or equivalent inch-dimensioned fitting ends 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3161, *Aerospace — UNJ threads — General requirements and limit dimensions*

ISO 5855-3, *Aerospace — MJ threads — Part 3: Limit dimensions for fittings for fluid systems*

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

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

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

ISO 8574:1990, *Aerospace — Hydraulic system tubing — Qualification tests*

ISO 9538, *Aerospace — Hydraulic tubing joints and fittings — Planar flexure test*

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

3 Classification

Fittings furnished under this International Standard shall be classified as follows:

Type A — 3 000 psi (20 684 kPa) Pressure System

Type B — 21 000 kPa (3046 psi) Pressure System

When no classification is specified Type B shall apply.

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 in this International Standard.

4.1.1 Manufacturer qualification

Manufacturer approval shall be granted by an outside agency procedure (see Annex A, Table A.2, procedure No. 1).

4.1.2 Product qualification

Product approval shall be granted by an outside agency procedure (see Annex A, Table A.2, procedure No. 2).

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 tests. The various materials shall be used according to the pressure and temperature requirements of the system, as shown in Tables 2 to 5.

4.2.2 Tubing

The tubing used with the fittings shall be in accordance with the relevant specification or equivalent tubing passing the specified qualification tests.

Table 1 — Materials for fittings

Part	Material	Type [a]	Material code [b]	Starting stock	Material No. [c]
Straight fittings and nuts	Aluminium alloy	I	D [d]	Bar, rod	1
			W		2
Shape fittings	Aluminium alloy	I	D [d]	Bar and forgings	3
			W		2
Straight and shape fittings	Carbon steel	II	F [f]	Bar, rod, forgings	4
	Corrosion-resistant steel	I, II, III	J	Bar and forgings	5
		I, II, III	K		7
		I, II, III, IV	R		6
		I, II, III I, II, II, IV	P V		11 11
	Titanium alloy	I, II, III	T	Bar and forgings	8
Sleeves (bite type)	Carbon steel	II	F [e]	Bar	9
Sleeves (swaged, brazed)	Corrosion-resistant steel	I, II, II I, II, II, IV	P V	Bar	11 11
Sleeves (welded)	Corrosion-resistant steel	I, II, III, IV	V	Bar	11
	Titanium alloy	I, II, III, IV	T		8

[a] Temperature types and system pressure classes are defined in ISO 6771.
[b] See Table 7.
[c] See also Annex A, Table A.1.
[d] Inactive for new design, superseded by W.
[e] Inactive for new design, no replacement.
[f] Inactive for new design, superseded by V.

Table 2 — Test requirements, 3 000 psi steel or titanium fittings on steel or titanium tubing

Fitting and tube		Nominal pressure		Proof pressure		Burst pressure		Flexure test, bending stress 0 % to 10 %	
Metric	Inch								
Size [a]	Size [a]	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
—	–02	20 684	(3 000)	41 368	(6 000)	82 740	(12 000)	135 000	(20 000)
DN05	–03								
DN06	–04								
DN08	–05								
DN10	–06								
DN12	–08								
DN14	—								
DN16	–10								
DN20	–12							108 000	(16 000)
DN25	–16								
DN32	–20								
DN40	–24							108 000 [b]	(16 000 [b])
—	–32								

[a] Dash size in 1/16 in, example: –05 = 5/16 in diameter; DN size in millimetres, example: DN05: 5 mm.

[b] No data available to support this value.

Table 3 — Test requirements, 21 000 kPa steel or titanium fittings on steel or titanium tubing

Fitting and tube		Nominal pressure		Proof pressure		Burst pressure		Flexure test, bending stress 0 % to 10 %	
Metric	Inch								
Size [a]	Size [a]	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
—	–02	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	135 000	(20 000)
DN05	–03								
DN06	–04								
DN08	–05								
DN10	–06								
DN12	–08								
DN14	—								
DN16	–10								
DN20	–12							108 000	(16 000)
DN25	–16								
DN32	–20								
DN40	–24							108 000 [b]	(16 000 [b])
—	–32								

[a] Dash size in 1/16 in, example: –05 = 5/16 in diameter; DN size in millimetres, example: DN05: 5 mm.

[b] No data available to support this value.

Table 4 — Test requirements, return line aluminium fittings, up to 1 500 psi, on aluminium

Fitting and tube		Nominal pressure		Proof pressure		Burst pressure		Flexure test, bending stress 0 % to 10 %	
Metric	Inch								
Size [a]	Size [a]	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
—	−02	10 342	(1 500)	20 684	(3 000)	41 368	(6 000)	41 368	(6 000)
DN05	−03								
DN06	−04								
DN08	−05								
DN10	−06								
DN12	−08							37 922	(5 500)
DN14	—								
DN16	−10	6 845	(1 000)	13 790	(2 000)	27 579	(4 000)		
DN20	−12	6 206	(900)	12 411	(1 800)	24 824	(3 600)	34 474	(5 000)
DN25	−16							27 579	(4 000)
DN32	−20	4 137	(600)	8 274	(1 200)	16 548	(2 400)		
DN40	−24							27 579 [b]	(4 000 [b])
—	−32								

[a] Dash size in 1/16 in, example: −05 = 5/16 in diameter; DN size in millimetres, example: DN05: 5 mm.

[b] No data available to support this value.

Table 5 — Test requirements, return line aluminium fittings, 10 500 kPa, on aluminium tubing

Fitting and tube		Nominal pressure		Proof pressure		Burst pressure		Flexure test, bending stress 0 % to 10 %	
Metric	Inch								
Size [a]	Size [a]	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
—	−02	10 500	(1 522)	21 000	(3 046)	42 000	(6 091)	41 368	(6 000)
DN05	−03								
DN06	−04								
DN08	−05								
DN10	−06								
DN12	−08							37 922	(5 500)
DN14	—								
DN16	−10								
DN20	−12							34 474	(5 000)
DN25	−16							27 579	(4 000)
DN32	−20								
DN40	−24							27 579 [b]	(4 000 [b])
—	−32								

[a] Dash size in 1/16 in, example: −05 = 5/16 in diameter; DN size in millimetres, example: DN05: 5 mm.

[b] No data available to support this value.

4.3 Design and manufacture

4.3.1 Threads

All threads shall be in accordance with ISO 3161 for inch-size tube fittings, and with ISO 5855-3 for SI-metric tube fittings.

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 (0,125 µin) or smoother.

Rolled threads shall be free of laps, cracks, surface irregularities and seams on any part of the pressure thread flank, in the thread-root, or on the non-pressure thread flank. Laps and seams whose depths are within the limits of Table 6 are acceptable on the crest and the non-pressure thread flank above the pitch diameter.

Table 6 — Maximum depth of laps, seams and surface irregularities in rolled threads

Fitting size		Depth	
Metric	Inch		
Size	Size [a]	mm	(in)
—	–02	0,15	(0,006)
DN05	–03	0,15	(0,006)
DN06	–04	0,18	(0,007)
DN08	–05	0,18	(0,007)
DN10	–06	0,20	(0,008)
DN12	–08	0,22	(0,009)
DN14	—	0,25	(0,01)
DN16	–10	0,25	(0,01)
DN20	–12	0,25	(0,01)
DN25	–20	0,25	(0,01)
DN32	–16	0,25	(0,01)
DN40	–24	0,25	(0,01)
—	–32	0,25	(0,01)

[a] Dash size in 1/16 in, example: –05 = 5/16 in diameter; DN size in millimetres, example: DN05 = 5 mm.

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 (0,015 in). It shall be possible to pass through the fitting passage a ball whose diameter is 0,5 mm (0,020 in) 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 (process No. 18 in Table A.1).

b) Carbon steel fittings and sleeves: by cadmium plating 0,007 mm to 0,012 mm (0,000 30 in to 0,000 50 in) thick, followed by a chromate post-plate treatment (process No. 19 in Table A.1).

Note Cadmium plating is not to be used in new designs.

c) Corrosion-resistant steel fittings: by passivation treatment (process No. 12 in Table A.1). Sleeves may be cadmium plated (process No. 19 in Table A.1).

d) Titanium fittings: by a fluoride conversion coating or anodizing (process No. 20 or No. 21 in Table A.1).

4.4.2 Colour identification

As a reference, the material of the finished fitting may be distinguished by the colours as shown in Table 7.

Table 7 — Material codes and colours

Material	Code	Colour
Aluminium	D [a]	Green
Aluminium	W	Brown
Carbon steel	F [a]	Gold brown
Corrosion-resistant steel	J	Bright metallic
Corrosion- and acid-resistant steel	K	Bright metallic
Corrosion-resistant stabilized steel	R	Bright metallic
Heat-treatable corrosion-resistant steel	P [a, b]	Gold brown
Heat-treatable corrosion-resistant steel	V	Metallic
Titanium	T	Dull gray

[a] Inactive for new design.
[b] P designatives V material, cadmium plated.

4.5 Marking

Unless otherwise specified, 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 the DN10 (−06) size and under because of the size of the part, the marking may be limited to the basic part number, without a size designation. The marking shall not be in a location detrimental to the part of its surface protection, and should preferably be visible when the part is assembled. When material code letters are used, the code letter (see Table 7) shall also be laser marked, electro-etched or impression stamped on the part.

Laser marking shall not be used on weld-ends of titanium weld fittings.

4.6 Performance

The tubing/fitting assembly shall be capable of meeting the performance requirements specified in 4.6.1 to 4.6.7.

4.6.1 Proof pressure

When testing in accordance with ISO 10583:1993, 5.1, the test assembly shall withstand pressure equal to twice the nominal pressure in conformity with ISO 8574 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 Gaseous pressure

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

4.6.4 Minimum burst pressure

When tested in accordance with ISO 10583:1993, 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.

4.6.5 Flexure fatigue resistance

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

When tested in accordance with ISO 7257 and ISO 10583:1993, 5.5, the 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 flexure testing to 10^7 cycles

a) Steel 24° cone fittings shall be used with ISO 6771 type II, class D, 304 1/8 hard cold-worked corrosion-resistant steel tubing (material No. 14 in Table A.1). Inch sizes shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes −10 and under, and 108 MPa (16 000 psi) in sizes −12 and over to a relative tolerance of $^{0}_{-10}$ %.

   Metric sizes shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes DN16 and under, and 108 MPa (16 000 psi) in sizes DN20 and over, to a relative tolerance of $^{0}_{-10}$ %.

b) For use with type II, class D, 21-6-9 cold-worked tubing (Material No. 15 in Table A.1), inch size steel 24° cone fittings shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes −10 and under, and 108 MPa (16 000 psi) in sizes −12 and over, to a relative tolerance of $^{0}_{-10}$ %.

   Metric sizes shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes DN16 and under, and 108 MPa (16 000 psi) in sizes DN20 and over, to a relative tolerance of $^{0}_{-10}$ %.

c) Titanium 24° cone fittings shall be flexure fatigue tested with type II, class D, 3Al-2,5V cold-worked and stress-relieved tubing (material No. 17 in Table A.1). Inch sizes shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes −10 and under, and 108 MPa (16 000 psi) in sizes −12 and over, to a relative tolerance of $^{0}_{-10}$ %.

   Metric sizes shall be flexure fatigue tested to 135 MPa (20 000 psi) bending stress in sizes DN16 and under, and 108 MPa (16 000 psi) in sizes DN20 and over, to a relative tolerance of $^{0}_{-10}$ %.

4.6.5.1.2 Alternative qualification test requirements

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.

4.6.5.1.3 Alternative qualification test requirement using S-N curve

The S-N method of testing eight specimens given in ISO 7257 may be used as an alternative to the method of testing six specimens to 10^7 cycles at a specified bending or stress level (4.6.5.1.1).

NOTE This alternative method requires testing of at least eight specimens, two each at four stress levels, to produce an S-N curve. Such a curve shows cycles to failure for three sets of two specimens tested to different high stress levels, and one set of two specimens at one low stress level which lasts 10^7 cycles without failure.

4.6.5.2 Rotary flexure test for other temperature types and pressure classes

Fitting assemblies of temperature types and pressure classes other than those in 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 ISO 6771 type II, class D fitting.

4.6.6 Re-use capability

When tested in accordance with ISO 10583:1993, 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.

4.6.7 Tensile load capability

When tested in accordance with ISO 10583:1993, 5.8, steel fitting assemblies of temperature type II, and pressure class D, shall withstand the axial loads specified in Table 8 without rupture. Two specimens shall be tested.

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 (0,06 µin). All other machined surfaces shall have a roughness value, R_a, of 3,2 µm (0,125 µin). Unmachined surfaces of forgings or bar stock flats shall be of uniform quality and condition. They shall be free of cracks, folds, fissures, pits or defects, as visible to the unaided eye or by magnetic or dye-penetrant inspection. Defects that can be removed so that they do not reappear on re-etching, and where the required section thickness can be maintained, shall not be considered as grounds for rejection.

Table 8 — Minimum joint strength, steel 24° cone fitting on steel and titanium tubing

Fitting size				Tube wall thickness				Tensile strength	
Metric part	Inch part			Metric part		Inch part			
	Equivalent tube outside diameter								
Size	Size [a]	mm	(in)	mm	(in)	(in)	mm	kN	(lbs)
—	−02	3,175 0	(0,125 0)	0,3	(0,012)	(0,012)	0,30	1,78	(400)
DN05	−03	4,762 5	(0,187 5)	0,4	(0,016)	(0,016)	0,41	3,56	(800)
DN06	−04	6,350 0	(0,250 0)	0,5	(0,020)	(0,020)	0,51	4,60	(1 300)
DN08	−05	7,937 5	(0,312 5)	0,5	(0,020)	(0,020)	0,51	7,50	(1 800)
DN10	−06	9,525 0	(0,375 0)	0,7	(0,028)	(0,028)	0,71	11,0	(2 500)
DN12	−08	12,700 0	(0,500 0)	0,9	(0,035)	(0,035)	0,89	19,0	(4 200)
DN14	—	b	b	b	b	b	b	b	B
DN16	−10	15,875 0	(0,625 0)	1,1	(0,043)	(0,042)	1,07	31,0	(6 200)
DN20	−12	19,050 0	(0,750 0)	1,5	(0,060)	(0,058)	1,47	40,0	(8 800)
DN25	−16	25,400 0	(1,000 0)	1,6	(0,063)	(0,065)	1,65	44,0	(10 000)
DN32	−20	31,750 0	(1,250 0)	1,2	(0,047)	(0,049)	1,24	42,2	(9 500)
DN40	−24	38,100 0	(1,500 0)	b	b	b	b	b	b
—	−32	50,800 0	(2,000 0)	b	b	b	b	b	b

[a] Dash size in 1/16 in, example: −05 = 5/16 in diameter.
[b] These values will be added when available.

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 its own facilities or any commercial 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 Inspection lot

A lot shall consist of finished parts that are identified by one unique part number fabricated from one mill-heat of material. If parts are an assembly, each component part shall be from one mill-heat of material, produced by the same machining operation at approximately the same time, in one continuous production run. Splits of one production run into two parallel runs, that may be machined at different times, constitutes splitting the lot into two distinct lots. Processes such as heat treating, plating, baking, and dry lubricant application shall be performed at essentially the same time under the same conditions; processes not meeting the condition shall require the assigning of a distinguishing lot number. Parts which consist of assemblies (such as fittings with retained nuts) shall be identified with a separate number, which allows traceability of each part. Retaining wires need not be identified by heat lot.

5.2.1 Material certification

Records of the chemical composition analysis and mechanical property tests showing conformance to the material requirements of this specification shall be available to the purchaser upon request for each lot of fittings, except that, for aluminum alloys, a certificate of conformance of the chemical analysis requirements may be furnished in lieu of an actual chemical analysis report.

5.2.2 Heat-treating certification

Records of heat-treating performed on the materials after purchasing showing conformance to the applicable heat-treating specification shall be available to the purchaser upon request for each lot of fittings.

5.3 Classification of inspections and tests

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

a) qualification inspection (see 5.3.1);

b) quality conformance inspection (see 5.3.2).

5.3.1 Qualification inspection

Test assemblies shall consist of the parts specified in 5.6.2. Tests shall be conducted in accordance with 5.6.4 for each size and material for which qualification is required.

5.3.2 Quality conformance inspection

5.3.2.1 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, single sampling plan, inspection level II with an acceptable quality limit (AQL) as shown in Table 9, and acceptance number 0.

5.3.2.1.1 Classification of defects

Fitting defects are classified in Table 9 according to the effect they have on safety and usability. The 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;

c) Minor B: has no effect on usability.

5.3.2.1.2 Acceptable quality level

The following acceptable quality limits (AQLs) apply to the defect classifications (see 5.3.2.1.1) shown in Table 9.

a) Major: AQL 0,015

b) Minor A: AQL 0,040

c) Minor B: AQL 0,065

All defects not identified in Table 9 shall be inspected in accordance with the Minor B classification (AQL 0,065).

5.3.2.2 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.

5.3.2.3 Inspection

Each individual lot of fittings, nuts and sleeves shall be subjected to the following examinations and tests by the manufacturer, as specified in this clause and Clause 6:

a) examination of the product;

b) material certification (chemical composition and mechanical properties), for raw material as long as the product is not subjected to thermal treatment;

c) grain flow;

d) internal fluid passages.

5.3.2.4 Rejection and retest

Rejected lots shall be resubmitted for retest and acceptance in accordance with ISO 2859-1. 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.

5.4 Quality control records

The supplier shall maintain a record of inspection applied to each lot for a minimum of 5 years. Records of chemical composition analysis, mechanical property tests showing conformance with the applicable material specifications, and metallurgical tests shall be made available to the purchaser of each lot of fittings upon request.

5.5 Quality conformance inspection procedures

5.5.1 Examination of product

Each lot of fittings shall be examined by the manufacturer 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.

5.5.2 Material certification

The manufacturer shall ensure that all materials meet the requirements for chemical composition and mechanical properties, as specified in the applicable material and heat-treatment specifications (see 5.4).

5.5.3 Rolled threads

Thread flanks in rolled threads shall be examined by macro-examination. Specimens shall be taken from the finished part by sectioning a longitudinal plane across the threaded area to inspect for conformance with 4.3.1. The specimens shall be polished and etched to reveal the surface defects adequately.

5.5.4 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.

5.5.5 Sampling instructions

Sampling shall be as specified in 5.3.2.1 for non-destructive tests and 5.3.2.2 for destructive tests.

5.6 Test conditions

5.6.1 Test fluids

Test fluids shall be in accordance with ISO 10583.

For reasons of safety, the pneumatic testing shall be limited to leakage and/or proof testing. All other pressure tests shall be conducted with a liquid.

5.6.2 Specimen preparation

Test specimens shall be assembled as illustrated in Table 10. Sleeve installations on the tube end shall be in accordance with user instructions. The fitting shall be assembled to tightening torques as given in Table 11, using the maximum installing torque for half of the test specimens and the minimum torque for the other half. Steel fittings shall be tested with the material 304 1/8 hard (material No. 14 in Table A.1) or material 21-6-9 corrosion-resistant steel tubing (material No. 15 in Table A.1). Titanium fittings shall be tested with 3Al-2,5V tubing (material No. 17 in Table A.1), and aluminium fittings with 6061-T6 tubing (material No. 13 in Table A.1).

Table 9 — Classification of defects

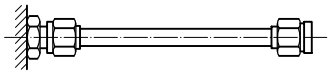
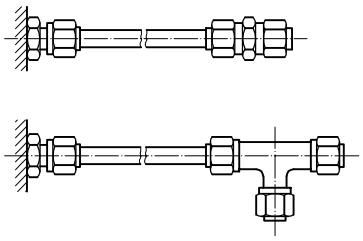
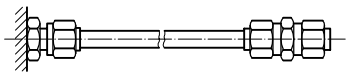
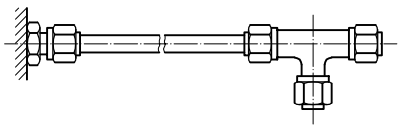
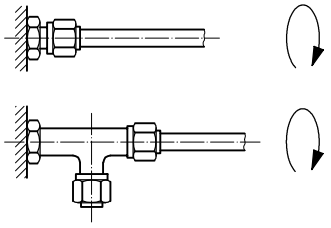
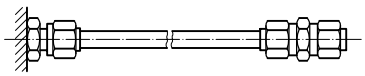
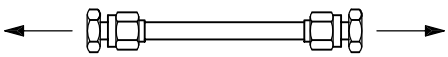
Fitting end — design standard		Fitting — union	
Class	**Defects** [a]	**Class**	**Defects** [a]
Major	Depth, seal diameter to the tube stop Finish of seal area (cone and O-ring) Squareness, thread to hexagon face Concentricity, thread to conical seal	Major	Incomplete holes, internal burrs Perpendicularity 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 dimensions Marking
		Minor B	Overall length Surface finish, radii, chamfer, colour and identification Bore diameter O-ring seal diameter

Sleeve		Fitting — tees, elbows, crosses	
Class	**Defects** [a]	**Class**	**Defects** [a]
Major	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 (OD) Concentricity of inside diameter (ID) and OD Surface finish, marking	Minor A	Fluid passage diameter Leg length, overall length, angle between legs Wrench pad dimensions 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** [a]	**Class**	**Defects** [a]
Major	Thread, concentricity, thread to tube bore, distance across hexagon		
Minor A	Thread length 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	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 in more or less than stipulated Gross or net weight exceeds the requirement (as specified by the part standard)

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

Table 10 — Testing and test samples for qualifications

Test	Test procedure	Specimen	Quantity	Specimen number	Sizes	See footnotes
Examination of product	5.5.1	All parts and assemblies				
Proof pressure	4.6.1	All assemblies				
Gaseous pressure	4.6.2		6	1 to 6	All	a
Hydraulic impulse resistance	4.6.3		3 3	7 to 9 10 to 12	All	a, b, e
Minimum burst pressure	4.6.4	 	3 3	13 to 15 16 to 18	All	b, c, e
Flexure fatigue resistance	4.6.5		6 2	19 to 24 25 to 26	All	a, d, e
Re-use capability	4.6.6		3	27 to 29	All	
Tensile load capability	4.6.7	 Alternative 	2	30 to 31	All	

a Half of the port fittings in each size, except for the largest, shall be reducer unions with the end inserted in the port one size larger than the end connected to the tube.

b The same specimens as those used in the re-use test may be tested.

c The same specimens as those used in the impulse test may be tested.

d Six specimens are used for basic qualification (see 4.6.5.1.1) with unions and two specimens with tees.

e Thrustwire configurations require qualification tests in addition to standard nut configuration.

Table 11 — Range of tightening torques

Fitting size				Steel and titanium		Aluminum alloy	
Metric part	Inch part						
	Equivalent tube outside diameter						
Size	Size[a]	mm	(in)	Nm	(lbf·in)	Nm	(lbf·in)
—	−02	3,175 0	(0,125 0)	5,6 to 6,8	(50 to 60)	[b]	[b]
DN05	−03	4,762 5	(0,187 5)	10,7 to 12	(95 to 105)	8,6 to 9,5	(76 to 84)
DN06	−04	6,350 0	(0,250 0)	15,2 to 17	(135 to 145)	10,7 to 13	(105 to 115)
DN08	−05	7,937 5	(0,312 5)	19,2 to 21,4	(170 to 190)	15,5 to 16,6	(133 to 147)
DN10	−06	9,525 0	(0,375 0)	24,3 to 27,2	(215 to 245)	18,23 to 20,1	(162 to 178)
DN12	−08	12,700 0	(0,500 0)	53 to 57,6	(470 to 510)	30 to 33,2	(266 to 294)
DN14	—	[b]	[b]	[b]	[b]	[b]	[b]
DN16	−10	15,875 0	(0,625 0)	70 to 76,7	(620 to 680)	38,6 to 42,7	(342 to 378)
DN20	−12	19,050 0	(0,750 0)	96,5 to 106,7	(855 to 945)	47,9 to 53,3	(428 to 472)
DN25	−16	25,400 0	(1,000 0)	128,7 to 142,2	(1 140 to 1 260)	80,4 to 88,9	(712 to 787)
DN32	−20	31,750 0	(1,250 0)	171,6 to 189,6	(1 520 to 1 680)	97,5 to 106,7	(855 to 945)
DN40	−24	38,100 0	(1,500 0)	214,4 to 237	(1 900 to 2 100)	97,5 to 106,7	(855 to 945)
—	−32	50,800 0	(2,000 0)	300,5 to 332,2	(2 660 to 2 940)	[b]	[b]

[a] Dash size in 1/16 in, example: −05 = 5/16 in diameter; DN size in millimetres, example: DN05 = 5 mm.

[b] These values will be added when available.

5.6.3 Lubricants

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

5.6.4 Qualification test procedures

Qualification test procedures shall be in accordance with ISO 10583.

5.6.5 Sampling instructions

Qualification inspection samples shall consist of the component parts, as shown in Table 10, and shall be tested in the quantities shown in Table 10. Qualification tests are required for each size and material.

NOTE The stabilized and non-stabilized corrosion-resistant steels are to be regarded as the same basic material not requiring separate qualification testing.

6 Preparation for delivery

6.1 Cleaning

Before packaging, all parts shall be free from grease, oil, dirt or other foreign matter.

6.2 Preservative material

No preservative compound shall be applied; except that cadmium-plated carbon steel fittings, nuts, and sleeves shall be dipped in oil prior to packaging.

6.3 Packaging

All fittings shall be packaged, as necessary, to prevent damage, corrosion, or deterioration during storage or shipment.

6.4 Package identification

Each package shall be identified with the following minimum information.

a) Manufacturer's identification (name and code number).

b) Manufacturer's part number.

c) Customer's part number if different from b).

d) Item description (noun).

e) Quantity and unit of issue.

6.5 Packing for shipment

Containers of parts shall be prepared for shipment, in accordance with commercial practice, to ensure carrier acceptance and safe transportation to the point of delivery.

6.6 Inspection

Packaging, packing and marking shall be sample inspected for those defects identified in Table 9 in the "Preparation for delivery" column. Sampling shall be in accordance with ISO 2859-1, inspection level S-3, AQL 4,0.

Annex A
(informative)

Equivalent materials and processes

International Standards giving specifications for appropriate materials or processes to be used in tube fitting assemblies in aircraft fluid systems are not currently available. For the time being, materials specified in national standards are given in Table A.1. Materials of equivalent properties and characteristics and processes as specified in other national standards may be used. However, it should be kept in mind, when selecting materials and components, that non-equivalent materials and processes can cause differences in test results and, more importantly, in the performance of fitting assemblies. Eventually, references to national standards will be deleted and replaced by references to International Standards when they become available.

Table A.1 — Equivalent materials and processes

Material/ process No.	Equivalent materials and processes						Modulus of elasticity kPa
	France		UK		USA		
	National standards applicable	Description	National standards applicable	Description	National standards applicable	Description	
1	—	—	BS — L — 65	—	AMS-QQ-A-225/6 (2024-T6, T851)	Aluminium Alloy Bar, Rod and Wire; Rolled, Drawn or Cold Finished, 2024	
2	—	—	BS — L — 95/96	—	AMS-QQ-A-225/9 (7075-T3)	Aluminium Alloy Bar, Rod, Wires and; Specials Shapes, Rolled, Drawn or Cold Finished, 7075	
3	—	—	—	—	QQ-A-367 (2014–T6)	Aluminium Alloy, Forgings, Heat Treated	
4	—	—	BS S 97	—	AMS-S-6758 [a] AMS-S-4130 [a]	Steel, Chrome-Molybdenum (4130) Bars and Reforging Stock (Aircraft Quality)	
5	—	—	BS S 129	—	AMS-QQ-S-763 304	Steel Bars, Wire Shapes and Forgings, Corrosion Resisting	$19{,}7 \cdot 10^7$
6	—	—	BS S 130	—	AMS-QQ-S-763 321	Steel Bars, Wire Shapes and Forgings, Corrosion Resisting	$19{,}7 \cdot 10^7$
7	—	—			AMS-QQ-S-763 316	Steel Bars, Wire Shapes and Forgings, Corrosion Resisting	$19{,}7 \cdot 10^7$

Table A.1 (*continued*)

Material/ process No.	Equivalent materials and processes						Modulus of elasticity kPa
	France		UK		USA		
	National standards applicable	Description	National standards applicable	Description	National standards applicable	Description	
8	—	—	BS Aerospace Series	Bar and Section for Machining/ Forging Stock	AMS 4928	Titanium Alloy BA's and Forgings, 6AL-4V, Annealed 120 000 psi (825 MPa) Yield	
			TA11	Forging of Titanium, (Tensile strength 900 MPa to 1 600 MPa)	(6AL-4V)		
			TA12				
			TA13				
9	—	—	—	—	ASTM A108 (1213, 1214)	Steel Bars, Carbon, Cold-Finished, Standard Quality Specification For	
10	—	—	—	—	AMS 5622 (17-4PH)	Steel Bars, Forgings, Tube, Solution Heat Treated	
11	—	—	—	—	AMS 5659 (15-5PH)	Steel Bars, Forgings and Rings 15Cr5Ni 0,03 (Cb + Ta)4Cu Cons. Elec. Melted	
12	—	—			AMS-QQ-P-35	Passivation Treatments for Corrosion-Resistant Steel	
13	—	—	—		AMS 4083 (6061-T6)	Tube, Aluminium Alloy, Seamless, Round, Drawn Aircraft Hydraulic System Quality	$7{,}0 \cdot 10^7$
14	—	—	—	—	AMS-T-6845 (304 1/8 h) [a]	Steel Tubing, Corrosion Resistant –304 Aerospace Hydraulic System 1/8 Hard Condition	
15	—	—	—		AMS 5561 (21-6-9)	Steel Tubing, Welded and Drawn, Corrosion and Heat Resistant, 21Cr-6Ni-9Mn, High Pressure Hydraulic	$20 \cdot 10^7$

Table A.1 (*continued*)

Material/ process No.	Equivalent materials and processes						Modulus of elasticity kPa
	France		UK		USA		
	National standards applicable	Description	National standards applicable	Description	National standards applicable	Description	
16	T40	—	TA2		AMS 4942 (CP 40)	Titanium Tubing, Seamless, Annealed, 40 000 psi (275 MPa) Yield Strength	
17	—	—	—	—	AMS 4945 (3AL-2,5V)	Titanium Alloy Tubing, Seamless, Texture Controlled	$10{,}3 \cdot 10^7$
18	—	—	—	—	MIL-A 8625	Anodic Coatings for Aluminium Alloys	
19	—	—	—	—	QQ-P-416 [b]	Plating, Cadmium (Electro-Deposited)	
20	—	—	—	—	AMS 2486	Conversion Coating of Titanium Alloys, Fluoride Phosphate Type	
21	—	—	—	—	AMS 2488	Anodic Treatment of Titanium and Titanium Alloys	

[a] See page 19. [b] Inactive for new design.

Table A.2 — Equivalent procedures

Procedure No.	AECMA Regional procedure	USA Aerospace industry procedure
1 (Manufacturer)	EN 9100	AS7003/AS7112
2 (Product)	EN 9133	PRI PD-2101

Bibliography

[1] ASTM A108, *Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished*

[2] EN 9100, *Aerospace series — Quality management systems — Requirements (based on ISO 9001:2000) and Quality systems — Model for quality assurance in design, development, production, installation and servicing (based on ISO 9001:1994)*

[3] EN 9133, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

[4] MIL-A-8625, *Anodic coatings for aluminium and aluminium alloys*

[5] PRI PD-2101, *Aerospace quality assurance, product standards, qualification procedure, fluid systems*

[6] QQ-A-367, *Aluminium alloy forgings*

[7] QQ-P-416, *Plating, cadmium (electrodeposited)*

[8] SAE AMS 2486, *Conversion Coating of Titanium Alloys Fluoride-Phosphate Type*

[9] SAE AMS 2488, *Anodic treatment, titanium and titanium alloys, solution pH 13 or higher*

[10] SAE AMS 4083, *Aluminium alloy tubing, hydraulic, seamless, drawn, round 1,0Mg – 0,60Si – 0,28Cu – 0,20Cr (6061-T6) solution and precipitation heat treated*

[11] SAE AMS 4130, *Aluminum alloy die forgings 4,4Cu – 0,85Si – 0,80Mn (2025-T6), solution and precipitation heat treated — UNS A92025*

[12] SAE AMS 4928, *Titanium alloy bars, wire, forgings, and rings 6Al – 4V annealed*

[13] SAE AMS 4942, *Titanium tubing, seamless annealed, 40 000 psi (275 MPa) yield strength*

[14] SAE AMS 4945, *Titanium alloy tubing, seamless, hydraulic 3Al – 2,5V, controlled contractile strain ratio cold worked, stress relieved*

[15] SAE AMS 5561, *Steel, Corrosion and Heat Resistant, Welded and Drawn Or Seamless and Drawn Tubing 9,0Mn – 20Cr – 6,5Ni – 0,28N High-Pressure Hydraulic*

[16] SAE AMS 5622, *Steel, Corrosion and Heat Resistant, Seamless Tubing, 9,0Mn – 20Cr – 6,5Ni – 0,28N, Solution Heat Treated*

[17] SAE AMS 5659, *Steel, corrosion resistant, bars, wire, forgings, rings and extrusions 15Cr – 4,5Ni – 0,30Cr – 3,5Cu consumable electrode melted solution heat treated, precipitation hardenable*

[18] SAE AMS 6758, *Steel, chrome-molybdenum (4130) bars and reforging stock (aircraft quality)*

[19] SAE AMS-QQ-A-225/6, *Aluminium alloy, 2024 bar, rod and wire; rolled, drawn or cold finished*

[20] SAE AMS-QQ-A-225/9, *Aluminium alloy 7075 bar, rod, wire and special shapes; rolled, drawn or cold finished*

[21] SAE AMS-QQ-S-763, *Steel bars, wire, shapes and forgings; corrosion resistant*

[22] SAE AMS-T-6845, *Tubing, steel, corrosion-resistant (S30400) aerospace vehicle hydraulic system 1/8 hard condition*

[23] SAE AS7003, *NADCAP Program Requirements*

[24] SAE AS7112, *National Aerospace and Defence Contractors Accreditation Program (NADCAP)*

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