INTERNATIONAL STANDARD

ISO 23933

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Aerospace — Aramid reinforced lightweight polytetrafluoroethylene (PTFE) hose assemblies, classification 135 °C/20 684 kPa (275 °F/3 000 psi) and 135 °C/21 000 kPa (275 °F/3 046 psi) — Procurement specification

Aéronautique et espace — Tuyauteries flexibles en polytétrafluoroéthylène (PTFE) renforcement aramide, série légère, classification 135 °C/20 684 kPa (275 °F/3 000 psi) et 135 °C/21 000 kPa (275 °F/3 046 psi) — Spécification d'approvisionnement

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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 23933 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

Aerospace — Aramid reinforced lightweight polytetrafluoroethylene (PTFE) hose assemblies, classification 135 °C/20 684 kPa (275 °F/3 000 psi) and 135 °C/21 000 kPa (275 °F/3 046 psi) — Procurement specification

1 Scope

This International Standard specifies requirements for aramid reinforced lightweight polytetrafluoroethylene (PTFE) hose assemblies for use in aircraft hydraulic, oil and fuel systems at temperatures between − 55 °C and 135 °C (− 65 °F and 275 °F) and at a nominal pressure of 21 000 kPa (210 bar) (3 046 psi) or 20 684 kPa (3 000 psi). The hose assemblies are also suitable for use within the same temperature and pressure limitations in aircraft pneumatic systems where some gaseous diffusion through the wall of the PTFE liner may be tolerated.

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 2685:1998, *Aircraft — Environmental test procedure for airborne equipment — Resistance to fire in designated fire zones*

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 3161:1999, *Aerospace — UNJ threads — General requirements and limit dimensions*

ISO 5855-3:1990, *Aerospace — MJ threads — Part 3: Limit dimensions for fittings for fluid systems*

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

ISO 7258:1984, *Polytetrafluoroethylene (PTFE) tubing for aerospace applications — Methods for the determination of the density and relative density*

ISO 8829-2, *Aerospace — Test methods for polytetrafluoroethylene (PTFE) innertube hose assemblies — Part 2: Non-metallic braid*

SAE AS 150, *Hose assembly, type classifications of, basic performance and fire resistance*

SAE AS 1055, *Fire testing of flexible hose, tube assemblies, coils, fittings and similar system components*

SAE AS 1241, *Fire resistant phosphate ester hydraulic fluid for aircraft*

3 Classification

Hose assemblies furnished under this International Standard shall be classified as follows:

— Type A: 20 684 kPa (3 000 psi) nominal pressure;

— Type B: 21 000 kPa (210 bar) (3 046 psi) nominal pressure.

When no classification is specified by reference to this standard, type B shall apply.

4 Requirements

4.1 Limits of application

The use of these hose assemblies in high-pressure pneumatic storage systems is not recommended. In addition, installations in which the limits specified in this International Standard are exceeded or in which the application is not covered specifically by this International Standard, for example for oxygen, shall be subject to the approval of the purchaser.

4.2 Qualification

4.2.1 General

Hose assemblies supplied in accordance with this International Standard shall be representative of products which have been subjected to and which have successfully passed the requirements and tests specified in this International Standard.

4.2.2 Manufacturer qualification

Manufacturer approval shall be granted by outside agency procedure (see Table B.1, Procedure no. 1).

4.2.3 Product qualification

Product approval shall be granted by outside agency procedure (see Table B.1, Procedure no. 2).

4.3 Materials

4.3.1 General

The hose assembly materials shall be as described in this International Standard. All materials not specifically described in this International Standard shall be of the highest quality and suitable for the purpose intended.

4.3.2 Metals

Metals used in the fittings shall conform to the applicable specifications described in Table 1 (or equivalent specifications; see Annex A). Welded and redrawn tubing shall not be used. Material no. 1 shall not be used for welded assemblies.

Table 1 — Metals to be used in hose assemblies

Form	Metal	Material no. (see Annex A)
Bars and forgings	Austenitic, annealed or as-rolled, corrosion-resistant steel	1
	Austenitic, annealed or as-rolled, stabilized, corrosion-resistant steel	2 and 3
	Precipitation-hardening, corrosion-resistant steel	4, 5 and 6
	Titanium 6Al-4V	7
Tubing	CPTi	8
	Austenitic, seamless or welded, annealed, corrosion-resistant steel	9
	Austenitic, seamless or welded, stabilized, corrosion-resistant steel	10 and 11
	Cold-worked, stress-relieved titanium alloy	12

4.4 Construction

4.4.1 General

To meet the construction and performance requirements laid down in this International Standard and as required for its intended use, the hose assembly shall consist of:

— a seamless PTFE inner tube (see 4.4.2);

— treated para-aramid reinforcement (see 4.4.3);

— outer cover or braid protection to meet qualification and usability requirements;

— corrosion-resistant steel and/or titanium end-fittings (see 4.4.4).

4.4.2 Inner tube

The inner tube shall be of a seamless construction of virgin PTFE resin of uniform gauge. It shall have a smooth bore and shall be free from pitting or projections on the inner surface. Additives may be included in the compound from which the tube is extruded with no more than 3 % of such additives being retained in the mixture.

4.4.3 Reinforcement

The reinforcement shall consist of a treated para-aramid braid and an outer braid or other coverage to protect the para-aramid.

The reinforcement shall be arranged on the outside surface of the inner tube so as to provide sufficient strength to ensure compliance with the requirements laid down in this International Standard. Broken, damaged, slack or missing reinforcement yarn shall be cause for rejection.

The outer cover, or braid, shall provide 100 % coverage to protect the para-aramid reinforcement from exposure to ultraviolet light when bending to minimum radius specified in Table 4.

A continuous lay line which can be interrupted with hose manufacturer's name or trademark, shall be permanently marked in contrasting colour along the hose length.

4.4.4 Fittings

4.4.4.1 General

It shall be proven that all fittings comply with the requirements laid down in this International Standard. Hose assemblies supplied under this International Standard shall be equipped with fittings qualified for their intended use.

4.4.4.2 Insert fittings

Insert fittings shall be manufactured in one piece wherever possible. Those made of other than one-piece construction shall be butt-welded, fabricated unless otherwise agreed by the purchaser, from corrosion-resistant steel or titanium tubing.

4.5 Inner tube requirements

4.5.1 Density and relative density

The relative density of the hose inner tube shall not exceed 2,155 g/cm^3, when tested in accordance with ISO 7258, either method A or method B (as specified in ISO 8829-2). The density shall not exceed 2,204 g/cm^3, when tested in accordance with ISO 7258, method C (as specified in ISO 8829-2).

4.5.2 Tensile strength

When tested in accordance with ISO 8829-2, 4.2, the longitudinal tensile strength for all sizes of tubes shall be at least 15,1 N/mm^2 (1 N/mm^2 = 1 MPa) (2 200 psi).

When tested in accordance with ISO 8829-2, 4.2, the transverse tensile strength for sizes DN 16 (– 10) and larger shall be at least 12,4 N/mm^2 (1 800 psi); for sizes under DN 16 (– 10), the transverse strength need not be tested.

4.5.3 Elongation

When tested in accordance with ISO 8829-2, 4.2, elongation shall be at least 200 %.

4.5.4 Tube roll

The tube shall not leak, split, burst or show any signs of malfunction, when tested through the sequence as specified in 4.3.2 of ISO 8829-2.

4.5.5 Tube proof pressure

After being subjected to the tube roll test sequence (see 4.5.4), the tube, without reinforcing yarns, shall not leak, burst or show any signs of malfunction, when tested as specified in 4.3.3 of ISO 8829-2.

4.5.6 Electrical conductivity

When tested in accordance with 4.4 of ISO 8829-2, the electrical current shall be equal to or greater than:

— 10 µA for sizes DN 06 to DN 12 inclusive (–04 to –08 inclusive);

— 20 µA for sizes DN 16 (–10) and over.

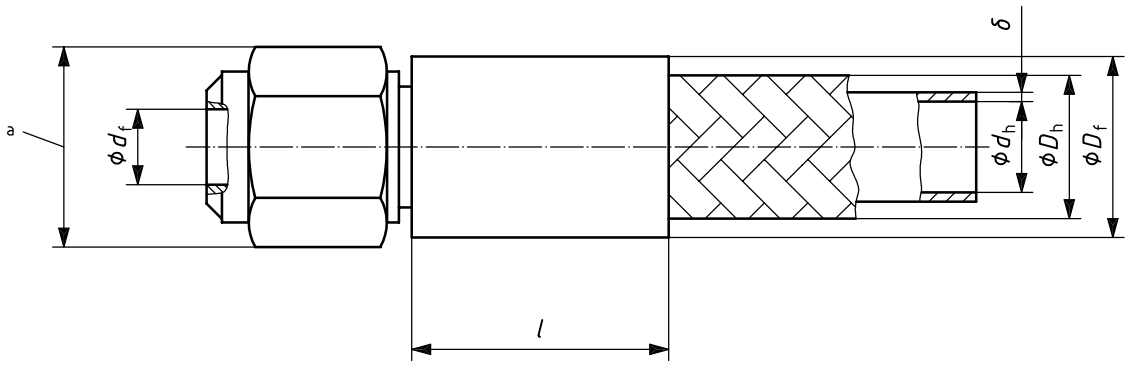
4.6 Hose assembly

4.6.1 Dimensional requirements

The hose assembly dimensions, except for length, shall be as specified in Figure 1 and Table 2A or Table 2B, as useful.

4.6.2 Physical requirements

The hose assembly shall comply with the physical and linear density (weight) requirements specified in Table 4.



Key

a width across corners of nut and socket hexagon

d_h inside diameter (hose)

D_h outside diameter (hose)

d_f inside diameter (fitting)

D_f outside diameter (fitting)

l attachment length

δ wall thickness of inner tube

Figure 1 — Hose and fitting dimensions

4.6.3 Bore check

When bent to appropriate minimum bend radius as specified in Table 4, the hose assembly shall permit the free passage of a solid rigid sphere throughout its length. The minimum diameter of the sphere is given in Table 2A or Table 2B, as useful.

4.6.4 Assembly length

Tolerances on hose assembly lengths shall be as follows (unless otherwise specified):

— ± 3,20 mm (± 0,125 in) for lengths under 500 mm (19,6 in);

— ± 6,35 mm (± 0,250 in) for lengths from 500 mm to 1 000 mm (19,6 in to 39,4 in) exclusive;

— ± 12,70 mm (± 0,500 in) for lengths from 1 000 mm to 1 500 mm (39,4 in to 59 in) exclusive;

— ± 1 % for lengths of 1 500 mm (59 in) and over.

4.7 Fitting threads

Unless otherwise specified (see 4.4.4), fitting threads shall be in accordance with ISO 5855-3 for SI (metric series) fittings and ISO 3161 for imperial (inch series) fittings. A 10 % increase in the tolerance of the fitting thread of the nut following proof pressure test shall not be cause for rejection of the hose assembly.

Table 2A — Hose and fitting dimensions as shown in Figure 1 — SI units

Dimensions in millimetres

Hose size (nom.)				Hose (braided)			Fitting		Attachment length	Wall thickness of inner tube	Spherical ball size for hose assembly inside diameter[b]	
Metric part	Inch part: Equivalent tube outside diameter			Inside diameter d_h	Outside diameter D_h		Inside diameter d_f	Outside diameter[a] D_f	l	δ	Straight fittings	Elbow fittings
Size	Size	mm	(in)	min.	min.	max.	min.	max.	max.	min.	min.	min.
DN 06	– 04	6,350	(0,250)	5,4	10,0	11,0	3,4	14	22	0,89	3,06	2,89
DN 10	– 06	9,525	(0,375)	7,6	12,6	14,0	6,1	18	35	0,89	5,49	5,19
DN 12	– 08	12,700	(0,500)	9,9	15,5	16,5	8,6	20	40	1,02	7,74	7,31
DN 16	– 10	15,875	(0,625)	12,3	19,0	20,0	10,4	24	47	1,14	9,36	8,84
DN 20	– 12	19,050	(0,750)	15,3	22,5	23,5	12,9	28	54	1,14	11,61	10,97
DN 25	– 16	25,400	(1,000)	21,6	31,4	32,5	19,3	37	66	1,14	17,37	16,41

[a] Width across corners of nut and socket hexagon may exceed the values given for D_f.

[b] Minimum specified inside diameter shall be verified by passing a spherical ball through the hose assembly (see 4.6.3).

Table 2B — Hose and fitting dimensions as shown in Figure 1 — Imperial units

Dimensions in inches

Hose size (nom.)				Hose (braided)			Fitting		Attachment length	Wall thickness of inner tube	Spherical ball size for hose assembly inside diameter[b]	
Metric part	Inch part: Equivalent tube outside diameter			Inside diameter d_h	Outside diameter D_h		Inside diameter d_f	Outside diameter[a] D_f	l	δ	Straight fittings	Elbow fittings
Size	Size	mm	(in)	min.	min.	max.	min.	max.	max.	min.	min.	min.
DN 06	– 04	6,350	(0,250)	0,213	0,394	0,433	0,134	0,551	0,866	0,035	0,120	0,114
DN 10	– 06	9,525	(0,375)	0,299	0,496	0,551	0,240	0,709	1,378	0,035	0,216	0,204
DN 12	– 08	12,700	(0,500)	0,390	0,650	0,650	0,339	0,787	1,575	0,040	0,305	0,288
DN 16	– 10	15,875	(0,625)	0,384	0,787	0,787	0,409	0,945	1,850	0,045	0,369	0,348
DN 20	– 12	19,050	(0,750)	0,602	0,886	0,925	0,508	1,102	2,126	0,045	0,457	0,432
DN 25	– 16	25,400	(1,000)	0,850	1,236	1,280	0,760	1,457	2,598	0,045	0,684	0,646

[a] Width across corners of nut and socket hexagon may exceed the values given for D_f.

[b] Minimum specified inside diameter shall be verified by passing a spherical ball through the hose assembly (see 4.6.3).

4.8 Part numbering of interchangeable parts

All parts complying with this International Standard and having the same manufacturer's or standard part number shall be functionally and dimensionally interchangeable.

4.9 Identification of products

4.9.1 General

The hose assembly and its removable component parts shall be permanently marked.

4.9.2 Fittings

The manufacturer's name or trademark shall be permanently marked on one element of all removable end fittings.

4.9.3 Hose assembly

A permanent marking shall be applied on a permanent rigid part and/or on a permanent band or bands securely attached to the hose. Bands shall be no wider than 25,4 mm (1 in) and shall not impair the flexibility or the performance of the hose. Unless otherwise specified by the purchaser, the marking on the fitting or band shall include the following information:

— the hose assembly manufacturer's name, trademark (optional);

— the hose assembly manufacturer's CAGE/NATO code;

— the complete hose assembly part number;

— the number of this International Standard followed by either the applicable type (A or B) or the applicable nominal pressure ("21 000 kPa" or "3 000 psi");

— the maximal operating temperature "135 °C" (275 °F) if and as required by the purchaser;

— the pressure test symbol "PT" or quality control label;

— the date of hose assembly manufacture or batch number as required by the purchaser;

— the fire resistance type per ISO 2685, SAE AS 1055 or SAE AS 150 if applicable and as required by the purchaser.

4.10 Workmanship

4.10.1 General

Workmanship shall be of such quality as to assure that hose assemblies furnished under this International Standard are free of defects that compromise, limit or reduce performance or intended use.

Hose assemblies shall be free of burrs, scratches, sharp edges, loose components, chips or foreign materials.

4.10.2 Dimensions and tolerances

All pertinent dimensions and tolerances, where interchangeability, operation or performance of the hose assembly may be affected, shall be specified on all drawings.

4.10.3 Cleaning

All hose assemblies shall be free from water, oil, grease, dirt or other foreign materials, both internally and externally.

4.11 Hose assembly — Test and performance requirements

4.11.1 Proof pressure

When tested in accordance with ISO 8829-2, 5.8, each hose assembly shall withstand the proof pressure specified in Table 3A or Table 3B, as applicable, without malfunction or leakage.

Table 3A — Pressure requirements of type A hose assemblies

Hose size				Nominal pressure		Proof pressure		Minimum burst pressure at			
Metric part	Inch part							room temperature		high temperature	
	Equivalent tube outside diameter										
Size	Size	mm	(in)	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
DN 06	– 04	6,350	(0,250)	20 684	(3 000)	41 370	(6 000)	110 320	(16 000)	82 740	(12 000)
DN 10	– 06	9,525	(0,375)	20 684	(3 000)	41 370	(6 000)	96 530	(14 000)	72 398	(10 500)
DN 12	– 08	12,700	(0,500)	20 684	(3 000)	41 370	(6 000)	96 530	(14 000)	72 398	(10 500)
DN 16	– 10	15,875	(0,625)	20 684	(3 000)	41 370	(6 000)	82 740	(12 000)	62 055	(9 000)
DN 20	– 12	19,050	(0,750)	20 684	(3 000)	41 370	(6 000)	82 740	(12 000)	62 055	(9 000)
DN 25	– 16	25,400	(1,000)	20 684	(3 000)	41 370	(6 000)	82 740	(12 000)	62 055	(9 000)

Table 3B — Pressure requirements of type B hose assemblies

Hose size				Nominal pressure		Proof pressure		Minimum burst pressure at			
Metric part	Inch part							room temperature		high temperature	
	Equivalent tube outside diameter										
Size	Size	mm	(in)	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
DN 06	– 04	6,350	(0,250)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)
DN 10	– 06	9,525	(0,375)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)
DN 12	– 08	12,700	(0,500)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)
DN 16	– 10	15,875	(0,625)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)
DN 20	– 12	19,050	(0,750)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)
DN 25	– 16	25,400	(1,000)	21 000	(3 046)	42 000	(6 091)	84 000	(12 183)	63 000	(9 137)

4.11.2 Elongation and contraction

When sample hose assemblies are tested in accordance with ISO 8829-2, 5.5, there shall be no change in length by more than ± 2 % in a 250 mm (10 in) gauge length.

4.11.3 Volumetric expansion

When sample hose assemblies are tested in accordance with ISO 8829-2, 5.6, the volumetric expansion shall not exceed the limits specified in Table 4.

Table 4 — Physical requirements of hose assemblies and linear density (weight) of hose

Hose size				Linear density (weight) of hose[a]		Bend radius at inside of bend		Volumetric expansion	
Metric part	Inch part			max.		min.		max.	
	Equivalent tube outside diameter								
Size	Size	mm	(in)	kg/m	(lb/in)	mm	(in)	ml/m	(cm^3/in)
DN 06	– 04	6,350	(0,250)	0,100	(0,006)	38	(1,50)	3,5	(0,089)
DN 10	– 06	9,525	(0,375)	0,120	(0,007)	63	(2,48)	5,2	(0,132)
DN 12	– 08	12,700	(0,500)	0,170	(0,010)	73	(2,87)	7,4	(0,188)
DN 16	– 10	15,875	(0,625)	0,235	(0,013)	82	(3.23)	15,1	(0,384)
DN 20	– 12	19,050	(0,750)	0,300	(0,017)	101	(3,98)	19,4	(0,493)
DN 25	– 16	25,400	(1,000)	0,530	(0,030)	127	(5,00)	44,6	(1,133)

[a] The linear density (weight) of the hose shall be determined on a minimum length of 300 mm (11,8 in).

4.11.4 Leakage

When sample hose assemblies are tested in accordance with ISO 8829-2, 5.7, there shall be no leakage.

4.11.5 Thermal shock

4.11.5.1 Preconditioning

Following sample hose assemblies shall be tested:

— one test specimen shall be oil/air-aged;

— one test specimen shall be light ray-aged (when required); and

— one test specimen shall be unaged (see 5.5.6).

4.11.5.2 Requirement

When tested in accordance with ISO 8829-2, with a maximum temperature of 135 °C (275 °F), the test specimens shall neither leak nor show any signs of malfunction during the proof pressure phase of the test; during the burst pressure phase of the test, if leakage or signs of malfunction occur below the minimum burst pressure at the high temperature specified in Table 3A or Table 3B, as applicable, the sample shall be deemed to have failed.

4.11.6 Impulse

4.11.6.1 Preconditioning

Following sample hose assemblies having a 90° elbow fitting on one end of the hose and a straight fitting on the other end of the hose shall be tested. Two test specimens shall be oil/air-aged, two shall be light ray-aged

(when required) and two unaged (see 5.5.6). If approval is being sought for both the bent-tube and the forged elbow configuration, then one half of the specimens shall be of each configuration.

After this initial preconditioning, the test specimens shall be subjected at room temperature to the proof pressure specified in Table 3A or Table 3B, as applicable, for at least 5 min. The test specimens shall then be pressurized to the nominal pressure specified in Table 3A or Table 3B, as applicable.

4.11.6.2 Requirement

When tested for 250 000 cycles at nominal pressure specified in Table 3A or Table 3B, as applicable, in accordance with ISO 8829-2 (i.e. in accordance with ISO 6772), with a maximum temperature of 135 °C (275 °F), the sample hose assemblies shall comply with the test requirements without any signs of leakage [see also item g) in Clause 7]. The test specimens shall be mounted in a test setup shown in ISO 8829-2 having the dimension specified in Table 5.

For sizes over DN16 (-10), the hose assembly may be bent in a 90° configuration, in lieu of 180° as defined in 5.10 of ISO 8829-2, at a reduced length as noted in Table 8, to reduce fluid volume.

4.11.7 Flexure

When sample hose assemblies are flexure-tested in accordance with ISO 8829-2, with a maximum temperature of 135 °C (275 °F), they shall not leak or show any other signs of malfunction. The test specimens shall be mounted in a test setup shown in ISO 8829-2 having the dimension specified in Table 5.

Table 5 — Flexure test and impulse test dimension

Hose size				length *l*	
Metric part	Inch part	Equivalent tube outside diameter		(approx.)	
Size	Size	mm	(in)	mm	(in)
DN 06	– 04	6,350	(0,250)	89	(3,5)
DN 10	– 06	9,525	(0,375)	143	(5,6)
DN 12	– 08	12,700	(0,500)	165	(6,5)
DN 16	– 10	15,875	(0,625)	184	(7,3)
DN 20	– 12	19,050	(0,750)	229	(9,0)
DN 25	– 16	25,400	(1,000)	282	(11,1)

4.11.8 Stress degradation

When sample hose assemblies are tested in accordance with ISO 8829-2, with a maximum temperature of 135°C (275 °F), they shall not exceed an average rate of effusion of 78 ml/min per metre of hose length (2,0 cm^3/min per inch of hose length) for any size.

4.11.9 Pneumatic surge

When sample hose assemblies are tested in accordance with ISO 8829-2, the inner tubes of the test specimens shall not collapse or show signs of degradation.

4.11.10 Pneumatic effusion

When sample hose assemblies are tested in accordance with 5.2 of ISO 8829-2, they shall not exceed a total rate of effusion of 26 ml per metre of hose length (8,0 cm^3 per foot of hose length) for any size.

4.11.11 Repeated installation

4.11.11.1 Procedure

Sample hose assemblies shall be tested as follows. Screw end fittings of the hose assemblies to appropriate union adaptors eight times using system fluid or an equivalent lubricant. Tighten fitting nuts to the torque values applicable to the coupling type and material. If they don't exist, apply the torque values specified in Table 6; test one half of the sample to the minimum tightening torque and test the other half to the maximum tightening torque. Each of the eight cycles shall include the complete removal of the hose fitting from the manifold union. Following the first, fourth and eighth installation, carry out proof pressure tests in accordance with 4.11.1. Following the eighth installation, pressure-test the hose fittings with air or nitrogen gas for 5 min at the nominal pressure.

4.11.11.2 Requirement

The hose assembly end fittings shall show no signs of leakage, galling of other malfunction.

Table 6 — Repetitive installation torque values

Hose size				Dynamic beam fitting				24° cone fitting			
Metric part	Inch part			N · m		lbs · in		N · m		lbs · in	
	Equivalent tube outside diameter										
Size	Size	mm	(in)	min.	max.	min.	max.	min.	max.	min.	max.
DN 06	– 04	6,350	(0,250)	17	19	151	168	15	22	135	190
DN 10	– 06	9,525	(0,375)	31	34	270	300	24	32	215	280
DN 12	– 08	12,700	(0,500)	49	54	432	480	53	62	470	550
DN 16	– 10	15,875	(0,625)	67	75	594	660	70	84	620	745
DN 20	– 12	19,050	(0,750)	87	95	756	840	97	119	855	1 055
DN 25	– 16	25,400	(1,000)	104	115	918	1 020	129	155	1 140	1 370

4.11.12 Burst pressure at room temperature

When sample hose assemblies are tested in accordance with 5.9.3 of ISO 8829-2, they shall not leak or burst at any pressure below the burst pressure at the room temperature specified Table 3A or Table 3B, as applicable.

4.11.13 Electrical conductivity

When tested in accordance with ISO 8829-2, 5.3, hose assemblies shall be capable of conducting a direct current equal to or greater than:

— 6 µA for sizes DN 06 to DN 12 inclusive (– 04 to - 08 inclusive);

— 12 µA for sizes DN 16 (– 10) and over.

4.11.14 Push-pull test

If the hose assemblies are required to withstand to push-pull test [see also item h) in Clause 7], the sample hose assembly shall be tested in accordance with ISO 8829-2. The hose assembly shall then be pressure tested to nominal pressure for at least 5 min. There shall be no leakage.

4.11.15 Fire resistance

4.11.15.1 Procedure

If the hose assemblies are required to withstand a specified resistance to fire [see also item i) in Clause 7], sample hose assemblies may have a fire protection. Refer to Table B.2 for appropriate fire test specification.

On occasions, a test may not be valid because of failure to hold the flame temperature at the specified value; for this reason it is advised to prepare additional hose assemblies for this test.

4.11.15.2 Requirement

The test specimens shall withstand the effects of the flame without leakage for the following period, as applicable:

— fire-resistant hose assemblies: 5 min;

— fire proof hose assemblies: 15 min.

5 Quality assurance

5.1 Responsibility for inspection

Unless otherwise specified in the contract or purchase order, the supplier is responsible for carrying out all inspections and tests in accordance with the requirements specified in this International Standard.

Unless otherwise specified, the supplier may use his own facilities or any commercial laboratory acceptable to the procuring activity. The purchaser reserves the right to perform any of the inspections set out in the procurement specification (i.e. this International Standard) where such inspections are deemed necessary to ensure that supplies and services conform to specified requirements.

5.2 Classification of inspections

The examining and testing of hoses assemblies shall be classified as:

— qualification inspections (see 5.3);

— quality conformance inspections (see 5.4).

5.3 Qualification inspections

5.3.1 Qualification test samples

Test samples shall consist of the number of test specimens specified in Table 7 and the number and lengths of test specimens specified in Table 8.

Table 7 — Qualification test sequence and number of test specimens in sample

Relevant inspection/test			Inner tube	Sample hose assemblies Test specimen No.																	
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
4.4	Construction (General examination)[a]		X	X																		
4.5.1	Density and relative density[a]		X	X																		
4.5.2	Tensile strength[a]		X	X																		
4.5.3	Elongation[a]		X	X																		
4.5.4	Tube roll[a]		X	X																		
4.5.5	Tube proof pressure[a]		X	X																		
4.5.6	Electrical conductivity[a]		X	X																		
4.6 to 4.10	(General examination)			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.11.1	Proof pressure			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
4.11.2	Elongation and contraction			X	X																	
4.11.3	Volumetric expansion					X	X															
4.11.4	Leakage							X	X													
4.11.5	Thermal shock	Unaged						X														
		Oil/air-aged							X													
		Light ray-aged								X												
4.11.6	Impulse[b]	Unaged									X	X										
		Oil/air-aged											X	X								
		Light ray-aged													X	X						
4.11.7	Flexure			X	X																	
4.11.8	Stress degradation																X	X				
4.11.9	Pneumatic surge																X	X				
4.11.10	Pneumatic effusion					X	X															
4.11.11	Repeated installation			X	X																	
4.11.12	Burst pressure at room temperature					X	X															
4.11.13	Electrical conductivity																		X			
4.11.14	Push-pull test (when required)																			X		
4.11.15	Fire resistance (when required)																				X	X

NOTE 1 X means one inspection/test.

NOTE 2 Grey-marked areas mean not applicable.

[a] Production lot records may be used to verify conformance to these tests if the PTFE tube of hose assembly being used is an established production item.

[b] These test specimens shall have a 90° elbow fitting on one end of the hose and a straight-type fitting on the other end of the hose. If approval is being sought for both the bent-tube and the forged-elbow configuration, the one-half of the sample (i.e. three test specimens) shall use the bent elbows, while the other half of the sample shall have the forged elbows.

Table 8 — Length of test specimens

Hose size				for impulse tests (4.11.6) and push-pull test (4.11.14)		for flexure tests (4.11.7)		for electrical conductivity test (4.11.13)	for fire resistance (4.11.15)		for other tests	
Metric part	Inch part Equivalent tube outside diameter											
Size	Size	mm	(in)	mm	(in)	mm	(in)		mm	(in)	mm	(in)
DN 06	– 04	6,350	0,250	260	10,2	365	14,4	Length as specified in ISO 8829-2	600	23,6	500	19,7
DN 10	– 06	9,525	0,375	370	14,6	475	18,7		600	23,6	500	19,7
DN 12	– 08	12,700	0,500	430	16,9	535	21,1		600	23,6	500	19,7
DN 16	– 10	15,875	0,625	500	19,7	605	23,8		600	23,6	500	19,7
DN 20	– 12	19,050	0,750	600 450[a]	23,6 18[a]	705	27,8		600	23,6	500	19,7
DN 25	– 16	25,400	1,000	875 600[a]	34,4 23,6[a]	875	34,4		600	23,6	500	19,7

[a] Reduced assembly length if testing is performed at 90° bend instead of 180°.

5.3.2 Test report, test samples and data for the purchaser

If the tests are carried out at a location other than the laboratory of the purchaser, the following information shall be made available to the purchaser on request:

— Test report: one copy which shall include a report of all tests and outline description of the tests and conditions. Log sheets, containing required test data, shall remain on file at the source test facility and are not to be sent to the purchaser or qualifying authorities unless specifically requested.

— Test samples: those that were tested, when requested by the purchaser.

— Drawings: the assembly, each subassembly and each components drawings. The assembly drawings shall have a cut-away section showing all detail components in their normal assembly position and shall define all details and subassemblies.

— List of sources of hose or hose components including name of source and product identification for inner tube, hose and assembly.

5.3.3 Qualification testing

Qualification testing shall consist of all the examination and tests specified in 4.4 to 4.11; the test sequence shall be as shown in Table 7.

5.3.4 Criteria for requalification

— Any change in a previously qualified hose-to-fitting joint and/or hose construction relative to design material or method of attachment or manufacturing and assembly process would require a full requalification.

— For qualification approval of other types of end fitting connection designs from those previously qualified, utilizing a previously qualified hose-to-fitting joint design, the following additional testing shall be performed:

  — General examination (see 4.4);

— proof pressure test (see 4.11.1);

— leakage test (see 4.11.4);

— repeated installation (see 4.11.11);

— room temperature burst (see 4.11.12).

— If a previously qualified hose is procured from a new manufacturing source, then complete requalification testing is required.

5.4 Quality conformance inspections

5.4.1 General

Quality conformance inspections shall be sampled in accordance with the procedure laid down in ISO 2859-1 and shall consist of the following tests:

— individual tests: 100 % inspection (see 5.4.2);

— sampling tests (see 5.4.3);

— periodic control tests (see 5.4.4).

5.4.2 Individual tests

Each hose assembly shall be subjected to the following tests:

— general examination of product (see 4.6 to 4.10);

— proof pressure tests (see 4.11.1).

Production samples that are proof-pressure-tested with water shall be air-dried prior to capping (see cleaning requirements in 4.10.3).

5.4.3 Sampling tests

The following inspections or tests shall be carried out in the order indicated:

a) internal cleanliness (see 4.10.3);

b) leakage tests (see 4.11.4);

c) burst pressure at room temperature (see 4.11.12).

The inspections or tests shall be carried out on eight hose assemblies, selected at random from each inspection lot. The inspection lot shall consist of not more than 3 000 hose assemblies, all of one size, manufactured under essentially the same conditions. One hose assembly tested from each lot of 375 hose assemblies is also permitted.

5.4.4 Periodic control tests

5.4.4.1 General

The inspections and tests specified in 5.4.4.2 and 5.4.4.3 shall be carried out as indicated on 10 hose assemblies manufactured from bulk hose lengths selected at random from each inspection lot. The inspection lot shall consist of not more than 6 000 m (20 000 ft) of hose, all of one size manufactured under essentially

the same conditions. The use of two hose assemblies manufactured and tested from each lot of not more than 1 500 m (5 000 ft) of hose is also permitted.

5.4.4.2 Assembly and braid

Six hose assemblies from a lot of not more than 6 000 m (20 000 ft) [or one hose assembly from a lot of not more than 1 500 m (5 000 ft)] shall be subjected to the following tests in the order indicated.

a) elongation and contraction (see 4.11.2);

b) impulse (see 4.11.6) on unaged samples, only those which may have straight fittings on both ends.

5.4.4.3 Hose inner liner

Four hose assemblies from a lot of not more than 6 000 m (20 000 ft) [or one hose assembly from a lot of not more than 1 500 m (5 000 ft)] shall be subjected to the following tests in the order indicated:

a) stress degradation (see 4.11.8);

b) electrical conductivity (see 4.11.13).

5.4.5 Rejection and re-test

5.4.5.1 Rejection

If one or more items selected from a lot fails to meet the requirements of this International Standard, the lot shall be rejected.

5.4.5.2 Resubmitted lots

Once a lot (or part of a lot) has been rejected by the purchaser, it may be resubmitted for tests after the manufacturer, in writing, has supplied full particulars concerning the cause of previous rejection and the action taken to correct the defects in the lot.

5.4.6 Changes in inspection procedures

Changes in inspection severity levels (for example from normal to tightened inspection) shall be in accordance with ISO 2859-1. All inspection plans shall be single sampling plans with an acceptable number of zero.

5.4.7 Destructive test sample

Prior to testing, a letter “D” shall be permanently marked on each end fitting of those assemblies used for destructive tests (see 5.4.3 and 5.4.4).

5.5 Test conditions

5.5.1 Assembly, ends and hose

5.5.1.1 Assembly ends

Qualification tests shall be carried out on assemblies using straight-type ends with dimensions as shown in Figure 1 and Table 2A or Table 2B, as useful, except for the test specimens requiring a 90° elbow fitting on one end.

5.5.1.2 Assembly, hose

Qualification shall be carried out on assemblies using one hose construction and one hose manufacturer. Separate qualification tests shall be carried out for each hose manufacturer and each different construction.

5.5.2 End connections

Each hose end shall be connected to a fitting and shall be torque-tightened.

5.5.3 Test fluids

Test fluids shall be as specified in ISO 8829-2.

5.5.4 Temperature measurements

Unless otherwise specified, outside temperature measurements shall be taken within 150 mm (6 in) of the hose assemblies under test. Unless otherwise specified, all temperatures shall have a tolerance of $^{+8}_{-3}$ °C ($^{+15}_{-5}$ °F).

5.5.5 Pressure measurements

Unless otherwise specified, all pressures shall have a tolerance of ± 500 kPa (± 100 psi).

5.5.6 Preparation of test specimens

5.5.6.1 Oil/air aging

In all of the tests using oil/air aged samples, the hose assemblies shall be fully preconditioned in MIL-H-83282 or SAE AS 1241 Type IV or other system fluid, as applicable. Preconditioning shall be done in two phases:

1) The hose assemblies shall be filled with applicable system fluid and then pressurized to Nominal Pressure and, while maintaining this pressure at room temperature, the hose assemblies shall be immersed in applicable or system fluid for 8 min to 10 min, then allowed to air dry for the remainder of 1 h. This sequence of immersion and air drying shall be repeated no less than 50 times.

2) After completing item (1), fill hose with applicable system fluid (exclude all air), pressurize to nominal pressure and age at 135 °C (275 °F) in air for 7 days.

5.5.6.2 Light ray aging

In all of the tests using oil/air aged samples [see also item j) in Clause 7], the hose assemblies shall be aged in accordance with ISO 8829-2.

5.5.6.3 Unaged test specimens

Unaged assemblies shall be as manufactured.

5.6 Inspection methods

5.6.1 Examination of product

5.6.1.1 Inner tube

Each length of tubing shall be examined to determine conformance to the requirements laid down in 4.4.2 with respect to material, size, workmanship and dimensions.

5.6.1.2 Hose assembly

Each hose assembly shall be visually inspected to determine conformance to this International Standard and inspected for compliance with construction and reinforcement requirements (see 4.4). In addition, each hose assembly shall be checked to determine conformance with respect to dimensions and linear density (see 4.6).

6 Preparation for delivery

6.1 Storage and packaging

All openings shall be sealed with appropriate caps or plugs. Storage and packaging shall be to the customer's requirements.

Packaging shall assure sufficient opacity to UV light.

6.2 Marking

Interior and exterior containers shall be marked according to the customer's requirements.

7 Ordering data

The following information shall be included in the purchase order or in documents referenced on it:

a) reference to this International Standard (i.e. title number and date of edition);

b) the details of parts required (part number, hose size, hose assembly length, protection if required);

c) end fittings type, size and orientation in case of elbows or tee fittings or special features of desired (see 4.4.4);

d) data requirements (see 5.3.2);

e) applicable levels of presentation, packaging and marking requirements (see 6.1 and 6.2);

f) a statement in the event of a special request that test specimens subjected to destructive testing are to be considered or shipped as part of the contract or order;

g) any deviations to the parameters for impulse testing specified in ISO 6772 and ISO 8829-2 (see 4.11.6);

h) whether resistance to push-pull test is required;

i) whether fire resistance or fire proofing is required;

j) whether class A or class B resistance to light ray is required.

Annex A
(informative)

Equivalent materials

A.1 General

As yet, International Standards giving specifications for appropriate materials to be used in hose assemblies in aircraft fluid systems are not yet available. For the time being, materials specified in national standards are given in Table A.1.

Materials of equivalent properties and characteristics as specified in other national standards may be used; however, it should be borne in mind when selecting materials that non-equivalent materials may cause differences in test results and, more importantly, in the performance of hose assemblies. Eventually, references to national standards will be deleted and replaced by references to International Standards when they become available — some specifications for materials and forms have reached the stage of draft proposal, and reference is made to these for information purposes in the far-right column of Table A.1.

Table A.1 — Equivalent materials

Material No	Equivalent materials						
	France		UK		USA		ISO
	National standard applicable	Designation	National standard applicable	Description	National standard applicable[a]	Description	Future work items
1	AIR 9160	Z2 CN 18-10 Z6 CN 18-09	Same as for USA		SAE AMS 5639 (304)	Steel bars, wire, forgings, tubing and rings, corrosion-resistant 19Cr-10Ni solution heat treated	In preparation for bars and forgings
2	EN 3468	Aerospace series, Steel FE-PA13, Softened, $500 \leqslant R_m \leqslant 700$ MPa, Forgings, $D_e \leqslant 100$ mm	BS 2S 129	18/9 chromium-nickel corrosion-resisting steel (titanium stabilized) billets, bars, forgings and parts	SAE AMS 5645 (321)	Steel bars, wire, forgings, tubing and rings, corrosion- and heat-resistant 18Cr-10Ni-0,4Ti (SAE 30321), solution heat treated	In preparation for bars
3	EN 3487	Aerospace series, Steel FE-PA13, Softened $500 \leqslant R_m \leqslant 700$ MPa, Bars for machining, $D_e \leqslant 100$ mm	BS 2S 130	18/9 chromium-nickel corrosion-resisting steel (niobium stabilized) billets, bars, forgings and parts	SAE AMS 5646 (347)	Steel bars, wire, forgings, tubing and rings, corrosion- and heat-resistant 18Cr-11Ni-0,60Cb (SAE 30347), solution heat treated	In preparation for bars

Table A.1 *(continued)*

Material No	Equivalent materials						
	France		UK		USA		ISO
	National standard applicable	Designation	National standard applicable	Description	National standard applicable[a]	Description	Future work items
4	EN 2539 EN 3161 EN 3162	Z6CNU 17-04	BS 2S 145	Chromium-nickel-copper-molybdenum corrosion-resisting steel (precipitation hardening) billets, bars, forgings and parts	SAE AMS 5643 (17-4)	Steel bars, wire, forgings, tubing and rings, corrosion-resistant 16Cr-4,0Ni-0,30Cb--4,0Cu	In preparation for bars for machining and for bars for forgings
5	—	—	Same for USA		SAE AMS 5644	Steel bars and forgings, corrosion-resistant 17Cr-7Ni-1Al	—
7	EN 3311	TA6V	In preparation		SAE AMS 4928 (6-4)	Titanium alloy bars, wire, forgings and rings 6A1-4V, annealed 825 Mpa (120 000 psi) yield strength	In preparation for forgings
8	In preparation	T35 T40 T60	In preparation		ASTM-B-348 (Grade 2)	CPTi	In preparation
9	AIR 9423	Z2 CN 18-10Z6 CN 18-09			MIL-T-8504 (394)	Steel corrosion-resisting (394), aerospace vehicle hydraulic systems, annealed, seamless and welded	In preparation for tubes
10		Z6 CNT 18-10	BS T 72-T 73	18/10 chromium-nickel corrosion-resisting steel tube for hydraulic purposes (niobium/titanium stabilized: 550 Mpa)	MIL-T-8808 (321)	Tubing, steel, corrosion-resistant (18-8 stabilized), aircraft hydraulic quality (composition 321)	In preparation for tubes
11		Z10 CNT 18-10			MIL-T-8808 (347)	Tubing, steel, corrosion-resistant (18-8 stabilized), aircraft hydraulic quality (composition 347)	In preparation for tubes
12		TA3V2,5	—	—	SAE AMS 4945	Titanium alloy tubing 3Al-2,5V, controlled contractile strain ratio	—

[a] Material designation is given in bold type in parentheses after the standard number.

Annex B
(informative)

Qualification procedures and fire resistance specifications

International Standards for the qualification of hose assembly manufacturers and a qualified product listing applicable to this International Standard are not yet available. For the time being, national procedures are listed in Table B.1.

Table B.1 — Manufacturer — Qualification procedure

Procedure no.	AECMA regional procedure	USA aerospace procedure
1 (Manufacturer)	EN 9100	AS 7003/AS 7112
2 (Product)	EN 9133	PRI PD-2101

Adoption of an International Standard for the fire resistance testing of hose assemblies has not, as yet, been agreed upon. For the time being, analogue standards are listed in Table B.2

Table B.2 — Fire resistance test specifications

ISO specification	USA/SAE specification
ISO 2685 — Test conditions for fluid system components	**AS 1055** — Fire testing of flexible hose, tube assemblies, coils, fittings and similar system components

Bibliography

[1] prEN 2539:1999, *Aerospace series — Steel FE-PM3801 (X5CrNiCu17-4) air melted, solution treated and precipitation treated — Bar a or* $D \leqslant$ *200 mm,* $R_m \geqslant$ *965 MPa*

[2] prEN 3162:1999, *Aerospace series — Steel FE-PM3801 (X5CrNiCu17-4) air melted, solution treated and precipitation treated — Sheet and strip, a* $\leqslant$ *6 mm,* $R_m \geqslant$ *930 MPa*

[3] prEN 3311:1994, *Aerospace series — Titanium alloy TI-P64001, annealed — Bar for machining* $D \leqslant$ *150 mm*

[4] prEN 3468, *Aerospace series — Steel FE-PA13 softened,* $500 \leqslant R_m \leqslant$ *700 MPa, forgings,* $D_e \leqslant$ *100 mm*

[5] prEN 3487, *Aerospace series — Steel FE-PA13 softened,* $500 \leqslant R_m \leqslant$ *700 MPa, bars for machining,* $D_e \leqslant$ *100 mm*

[6] EN 9100:2003, *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)*

[7] prEN 9133:2004, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

[8] AIR 9160, *Conditions générales de recette et d'emploi des aciers corroyés utilisés dans les constructions aéronautiques*

[9] AIR 9423, *Conditions de contrôle des tubes en aciers inoxydables et alliages corroyés résistant à chaud destinés aux circuits de fluides sous pression utilisés dans les constructions aéronautiques*

[10] ASTM B 348:2003, *Standard Specification for Titanium and Titanium Alloy Bars and Billets*

[11] BS 2S 129:1976, *Specification for 18/9 chromium-nickel corrosion-resisting steel (titanium stabilized) billets, bars, forgings and parts (540 MPa; limiting ruling section 150 mm)*

[12] BS 2S 130:1976, *Specification for 18/9 chromium-nickel corrosion-resisting steel (niobium stabilized) billets, bars, forgings and parts (540 MPa; limiting ruling section 150 mm)*

[13] BS 2S 145:1976, *Specification for chromium-nickel-copper-molybdenum corrosion-resisting steel (precipitation hardening) billets, bars, forgings and parts (1270-1470 MPa)*

[14] BS T 72-T 73:1977, *Specifications for 18/10 chromium-nickel corrosion-resisting steel tube for hydraulic purposes (niobium/titanium stabilized: 550 MPa)*

[15] MIL-T-8504 (394), *Steel, corrosion-resisting (394), aerospace vehicle hydraulic systems, annealed, seamless and welded*

[16] MIL-T-8808 (321), *Tubing, steel, corrosion-resistant (18-8 stabilized), aircraft hydraulic quality (composition 321)*

[17] MIL-T-8808 (347), *Tubing, steel, corrosion-resistant (18-8 stabilized), aircraft hydraulic quality (composition 347)*

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

[19] SAE AMS 4928Q:2001, *Titanium alloy bars, wire, forgings and rings 6Al 4V annealed*

[20] SAE AMS 4945B:2001, *Titanium alloy tubing, seamless, hydraulic 3Al 2.5V, controlled contractile strain ratio cold worked, stress relieved*

[21] SAE AMS 5643Q:2003, *Steel, corrosion-resistant, bars, wire, forgings, tubing and rings 16Cr 4.0Ni 0.30Cb 4.0Cu solution heat treated, precipitation hardenable*

[22] SAE AMS 5644D:1964, *Bars and forgings, 17Cr 7Ni 1Al (Note: reaffimed 1994-04)*

[23] SAE AMS 5639H:2002, *Steel, corrosion-resistant, bars, wire, forgings, tubing, and rings 19Cr 10Ni solution heat treated*

[24] SAE AMS 5645P:2001, *Steel, corrosion and heat resistant, bars, wire, forgings, tubing, and rings 18Cr 10Ni 0.40Ti (SAE 30321) solution heat treated*

[25] SAE AMS 5646M:2001, *Steel, corrosion and heat resistant, bars, wire, forgings, tubing, and rings 18Cr 11Ni 0.60Cb (SAE 30347) solution heat treated*

[26] SAE AS 7003B:1997, *National aerospace and defense contractors accreditation program (NADCAP) program requirements*

[27] SAE AS 7112/2:1997, *National aerospace and defense contractors accreditation program (NADCAP) requirements for fittings and other machined components*

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