
**Aerospace — Test methods for
polytetrafluoroethylene (PTFE) inner-tube
hose assemblies —**

**Part 2:
Non-metallic braid**

*Aéronautique et espace — Méthodes d'essai des tuyauteries flexibles
à tube intérieur en polytétrafluoroéthylène (PTFE) —*

Partie 2: Tuyauteries à gaine non métallique



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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 8829-2 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

ISO 8829-2 cancels and replaces ISO 8829:1990, which has been technically revised.

ISO 8829 consists of the following parts, under the general title *Aerospace — Test methods for polytetrafluoroethylene (PTFE) inner-tube hose assemblies*:

- *Part 1: Metallic (stainless steel) braid*
- *Part 2: Non-metallic braid*

Introduction

This part of ISO 8829 is intended to standardize the test methods for qualification of polytetrafluoroethylene (PTFE) hose and hose assemblies used in aircraft fluid systems. The tests are intended to simulate the most strenuous demands encountered in aircraft. Compliance with these test methods is necessary for hose and hose assemblies which are used in systems where a malfunction could affect the safety of flight.

Aerospace — Test methods for polytetrafluoroethylene (PTFE) inner-tube hose assemblies —

Part 2: Non-metallic braid

1 Scope

This part of ISO 8829 specifies test methods for flexible polytetrafluoroethylene (PTFE) inner tubes with non-metallic braided hose and hose assemblies used in aircraft fluid systems, in the pressure and temperature ranges covered by pressure classes and temperature types, as specified in ISO 6771.

This part of ISO 8829 applies to the hose and the hose coupling. The tests and assembly requirements for the connecting end fittings are covered in the procurement specification.

This part of ISO 8829 is applicable when reference is made to it in a procurement specification or other definition document.

NOTE Fluids used for the tests are listed in Annex A.

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 6771¹⁾, *Aerospace — Fluid systems and components — Pressure and temperature classifications*

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

ISO 6773:1994, *Aerospace — Fluid systems — Thermal shock testing of piping and fittings*

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

1) To be published. (Revision of ISO 6771:1987)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1
fire sleeve**
flame- and heat-retardant element, normally tubular, slipped over the hose assembly and fastened to the hose fitting

**3.2
fire-cover**
flame- and fire-retardant element, normally (silicone) rubber, moulded over the hose and hose fittings

4 Test temperature

Unless otherwise specified, tests shall be conducted between 15 °C and 32 °C (59 °F and 90 °F).

5 Tests on PTFE inner tubes

5.1 Density and relative density

5.1.1 Principle

The test is intended to control the crystallinity of PTFE inner tubes.

5.1.2 Test methods

The relative density of the PTFE tubing shall be measured in accordance with ISO 7258:1984, method A or method B. The density of the PTFE tubing shall be measured in accordance with ISO 7258:1984, method C.

5.2 Tensile tests

5.2.1 Principle

This test is intended to determine the mechanical properties of the PTFE tubing.

5.2.2 Test conditions

Test specimens shall be conditioned for at least 2 h at room temperature prior to testing.

5.2.3 Apparatus

5.2.3.1 Testing machine

The test shall be carried out using a power-driven machine which is capable of maintaining a uniform rate of jaw separation at 50 mm/min (2 in/min) and which has a suitable dynamometer and a device for measuring the force applied within $\pm 2\%$. If the capacity range cannot be changed during a test, as in the case of pendulum dynamometers, the force applied at breaking point shall be measured within $\pm 2\%$, and the smallest tensile force measured shall be accurate to within $\pm 10\%$. If the dynamometer is of the compensating type for measuring tensile stress directly, means shall be provided to make adjustments for the cross-sectional area of the test specimen. The response of the recorder shall be sufficiently rapid for the force applied to be measured accurately during the elongation of the test specimen to breaking point. If the test machine is not equipped with a recorder, a device shall be provided that indicates, after fracture, the maximum force applied during elongation. Testing machines shall be capable of measuring elongation in increments of 10 %.

5.2.3.2 Micrometer

The micrometer used for measuring flat test specimen thickness shall be capable of exerting a pressure of $25 \text{ kPa} \pm 5 \text{ kPa}$ ($3,63 \text{ psi} \pm 0,7 \text{ psi}$) on the test specimens, and of measuring the thickness to within $\pm 0,025 \text{ mm}$ ($0,001 \text{ in}$).

Dial micrometers exerting either a force of $0,8 \pm 0,15 \text{ N}$ ($0,18 \text{ lbf} \pm 0,034 \text{ lbf}$) on a circular foot $6,35 \text{ mm}$ ($0,25 \text{ in}$) in diameter or a force of $0,2 \pm 0,04 \text{ N}$ ($0,045 \text{ lbf} \pm 0,009 \text{ lbf}$) on a circular foot $3,2 \text{ mm}$ ($0,125 \text{ in}$) in diameter conform to the pressure requirement specified above. A micrometer should not be used to measure the thickness of test specimens narrower in width than the diameter of the foot, unless the contact pressure is properly adjusted.

5.2.4 Calibration of testing machine

The testing machine shall be calibrated.

If the dynamometer is of the strain-gauge type, the test machine shall be calibrated at one or more forces at regular intervals.

5.2.5 Test specimens

The specimens shall be in accordance with Figure 1.

NOTE Careful maintenance of the cutting edges of the die is extremely important and can be achieved by light daily honing and touching up of the cutting edges with jeweler's hard honing stones. The condition of the die may be assessed by determining the breaking point on any series of broken test specimens. When broken test specimens are removed from the jaws of the test machine, it is advantageous to pile these test specimens and note if there is any tendency to break at or near the same portion of each test specimen. Breaking points consistently occurring at the same place may be an indication that the die is dull, nicked or bent at that particular position.

Dimensions in millimetres

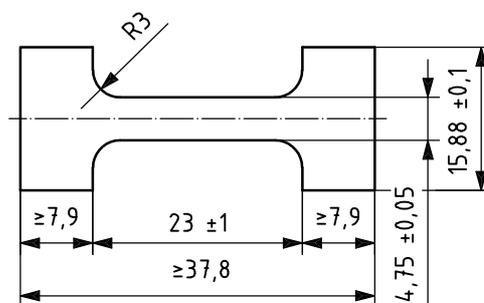


Figure 1 — Test specimen for tensile test

5.2.6 Determination of tensile strength and elongation

5.2.6.1 Procedure

Place the test specimens (see 5.2.5) in the jaws of the testing machine (5.2.3.1), taking care to adjust the specimen symmetrically so that the tension will be distributed uniformly over the cross-section. Start the machine and note continuously the distance between the jaws, taking care to avoid parallax. At fracture, measure and record the elongation to the nearest 10 % on the scale.

5.2.6.2 Expression of results

Calculate the tensile strength, R_m , in newtons per square millimetre²⁾, using the following equation:

$$R_m = \frac{F}{S}$$

where

F is the measured force, in newtons, required to fracture the test specimens;

S is the cross-sectional area, in square millimetres, of the test specimen before application of force.

Calculate the percentage total elongation at fracture, A_t , using the following equation:

$$A_t = \left(\frac{L_u - L_o}{L_o} \right) \times 100$$

where

L_u is the length measured between the jaws at fracture of the test specimen;

L_o is the original length measured between the jaws before application of force.

5.3 Rolling and proof-pressure tests

5.3.1 Principle

This test is intended to check that there are no flaws in the sintered tube.

5.3.2 Rolling test — Procedure

Pass each tube, in a single pass, through six sets of metal rollers so that it is subjected to the sequence of diametral flexings specified in Table 1; rollers shall be arranged to prevent inadvertent rotation in the tube. It is assumed that the tube is in a horizontal position and that pressure of the first set of rollers is exerted vertically; angles given for the final three sets of rollers may be taken as either clockwise or counterclockwise from the vertical diameter of the tube. Roller angles shall be as specified in Table 1. A tolerance of $\pm 2^\circ$ is allowed on each roller angle. The roller gap dimensions shall not be larger than those specified in Table 2 for each size.

Table 1 — Roller functions and angles

Set of metal rollers	Type of action	Roller angle
1	Flattening	0°
2	Flattening	90°
3	Rounding	0°
4	Flattening	45°
5	Flattening	135°
6	Rounding	45°

2) 1 N/mm² = 1 MPa

Table 2 — Roller gap dimensions³⁾

Hose size				Flattening gap				Rounding gap			
Metric part	Inch part			max.		max.		max.		max.	
	Equivalent outside diameter of tube			Class B 10 500 kPa (1 523 psi) and lower nominal pressure		Class D 21 000 kPa (3 046 psi) and higher nominal pressure		Class B 10 500 kPa (1 523 psi) and lower nominal pressure		Class D 21 000 kPa (3 046 psi) and higher nominal pressure	
Size	Size	mm	(in)	mm	(in)	mm	(in)	mm	(in)	mm	(in)
DN05	– 03	4,762	(0,187)	5,2	(0,203)	5,2	(0,203)	5,5	(0,218)	6,4	(0,250)
DN06	– 04	6,350	(0,250)	5,5	(0,218)	7,1	(0,281)	5,5	(0,218)	6,4	(0,250)
DN08	– 05	7,937	(0,312)	5,5	(0,218)	—	—	6,4	(0,250)	—	—
DN10	– 06	9,525	(0,375)	5,5	(0,218)	7,1	(0,281)	7,9	(0,312)	8,3	(0,328)
DN12	– 08	12,700	(0,500)	5,9	(0,234)	8,3	(0,328)	9,5	(0,375)	11,9	(0,469)
DN16	– 10	15,875	(0,625)	6,4	(0,250)	8,3	(0,328)	12,7	(0,500)	14,7	(0,578)
DN20	– 12	19,050	(0,750)	6,4	(0,250)	8,3	(0,328)	12,7	(0,500)	17,5	(0,688)
DN25	– 16	25,400	(1,000)	6,4	(0,250)	8,3	(0,328)	19,1	(0,750)	21,0	(0,828)
DN32	– 20	31,750	(1,250)	7,9	(0,312)	11,1	(0,438)	22,2	(0,875)	25,4	(1,000)
DN40	– 24	38,100	(1,500)	9,5	(0,375)	—	—	31,8	(1,250)	—	—

5.3.3 Proof-pressure test — Procedure

After the roll test, hold the tube for not less than 2 min. at proof pressures as shown in Table 3, using water or air as the test medium.

Table 3 — Proof pressure³⁾

Hose size				Proof pressure							
Metric part	Inch part			Class B 10 500 kPa (1 523 psi) and lower nominal pressure		Class D 21 000 kPa (3 046 psi) and higher nominal pressure		Nominal pressure 10 342 kPa (1 500 psi) and lower nominal pressure		Nominal pressure 20 684 kPa (3 000 psi) and higher nominal pressure	
	Equivalent outside diameter of tube			kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
Size	Size	mm	(in)	kPa	(psi)	kPa	(psi)	kPa	(psi)	kPa	(psi)
DN05	– 03	4,762	(0,187)	2 690	(390)	3 310	(480)	2 690	(390)	3 310	(480)
DN06	– 04	6,350	(0,250)	2 480	(360)	2 620	(380)	2 480	(360)	2 620	(380)
DN08	– 05	7,937	(0,312)	2 000	(290)	—	—	2 000	(290)	—	—
DN10	– 06	9,525	(0,375)	1 590	(230)	1 930	(280)	1 590	(230)	1 930	(280)
DN12	– 08	12,700	(0,500)	1 240	(180)	1 520	(220)	1 240	(180)	1 520	(220)
DN16	– 10	15,875	(0,625)	1 170	(170)	1 170	(170)	1 170	(170)	1 170	(170)
DN20	– 12	19,050	(0,750)	965	(140)	890	(130)	965	(140)	890	(130)
DN25	– 16	25,400	(1,000)	621	(90)	660	(95)	621	(90)	660	(95)
DN32	– 20	31,750	(1,250)	448	(65)	660	(95)	448	(65)	660	(95)
DN40	– 24	38,100	(1,500)	310	(45)	—	—	310	(45)	—	—

3) Special size high pressure hose assembly callout shall utilize lower hose size value noted.

5.4 Electrical conductivity test

5.4.1 Preconditioning

The test specimen shall be a 350 mm (13,78 in) length of PTFE hose tube (without braid). The inner surface of the tube shall be washed first with degreasing fluid (test fluid No. 1; see Annex A) and then with isopropyl alcohol (test fluid No. 2; see Annex A) to remove surface contamination. The inside of the tube shall then be thoroughly dried at room temperature.

5.4.2 Procedure

Arrange the test specimen vertically as shown in Figure 2. The relative humidity shall be kept below 70 %. Apply $1\,000\text{ V} \pm 10\text{ V}$ d.c. between the upper and lower electrodes (salt water solution). The salt water solution shall be a solution of sodium chloride in chemically pure water [ρ (NaCl) = 450 g/l].

Measure the current with an instrument having a sensitivity of at least $1\ \mu\text{A}$ ($= 1 \times 10^{-6}\text{ A}$).

6 Test on hoses and hose assemblies

6.1 Stress degradation test

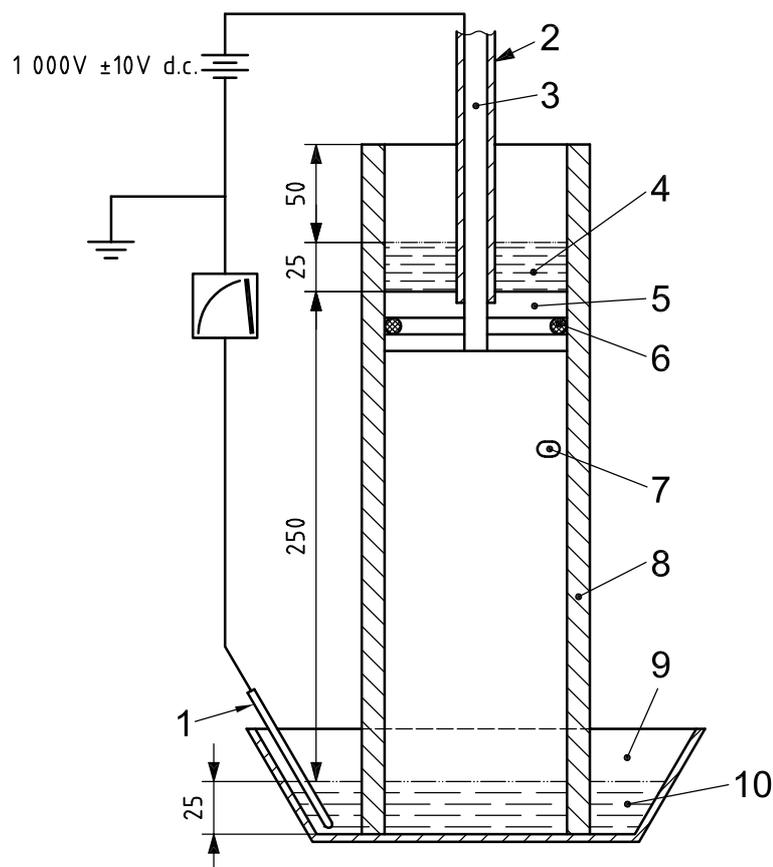
6.1.1 Principle

This test is intended to verify that the inner tube of the hose has been sintered and quenched to the proper crystallinity to eliminate stress cracking or creep with subsequent leakage.

6.1.2 Procedure

6.1.2.1 Fill the hose assemblies with a high-temperature test fluid (test fluid No. 3; see Annex A) and place in an oven maintained at the maximum working temperature specified in the procurement specification. Apply to the hose assemblies the nominal pressure specified in the procurement specification, and hold that pressure for at least 20 h.

Precautions shall be taken to ensure that the hose assemblies do not come into contact with parts of the oven that are at a higher temperature.



Key

- 1 probe
- 2 conductor tube
- 3 vent
- 4 upper electrode (salt water solution)
- 5 non-conductive plug
- 6 O-ring
- 7 vent (if any)
- 8 polytetrafluoroethylene (PTFE) (inner tube of the hose)
- 9 non-conductive container
- 10 lower electrode (salt water solution)

Figure 2 — Test set-up for electrical conductivity test on inner tubes

6.1.2.2 Gradually release the pressure, remove the assemblies from the oven, drain and cool to room temperature. Then flush the assemblies with a quantity of fresh high-temperature test fluid (test fluid No. 3; see Annex A) equivalent in volume to at least twice the volume of the test specimen volume, and drain.

6.1.2.3 Fill the hose assemblies with hydraulic test fluid (test fluid No. 4; see Annex A). Apply to the hose assemblies the nominal pressure specified in the procurement specification, and hold that pressure for at least 2 h at room temperature.

6.1.2.4 Repeat the procedure specified in 6.1.2.1 to 6.1.2.3 a total of three times.

6.1.2.5 Within 4 h after the final pressurization period of 2 h, drain the hose assemblies, flush them using a suitable cleaning process and place in an oven for at least 1 h at a temperature of $70\text{ °C} \pm 5\text{ °C}$ ($158\text{ °F} \pm 9\text{ °F}$).

6.1.2.6 Within 8 h after the drying process has been completed, remove the hose assemblies from the oven, cool to room temperature, and then subject them to a pneumatic effusion (air under water) test. For this test, install the hose assemblies in a test set-up constructed similarly to that shown in Figure 3.

6.1.2.7 Immerse the test set-up with the hose assemblies installed in water. Apply nominal pressure for at least 15 min to allow any entrapped air in the hose to escape.

6.1.2.8 Hold the pressure for a further period of 5 min. During this time, collect the gas escaping from the test specimen, including the juncture of the hose and the fitting, but not including the juncture of the fitting to the test set-up. After the pressurization period of 5 min, calculate the average rate of effusion through the hose and two fittings, expressed as millilitres per minute per metre of the hose length.

6.2 Pneumatic effusion test

6.2.1 Principle

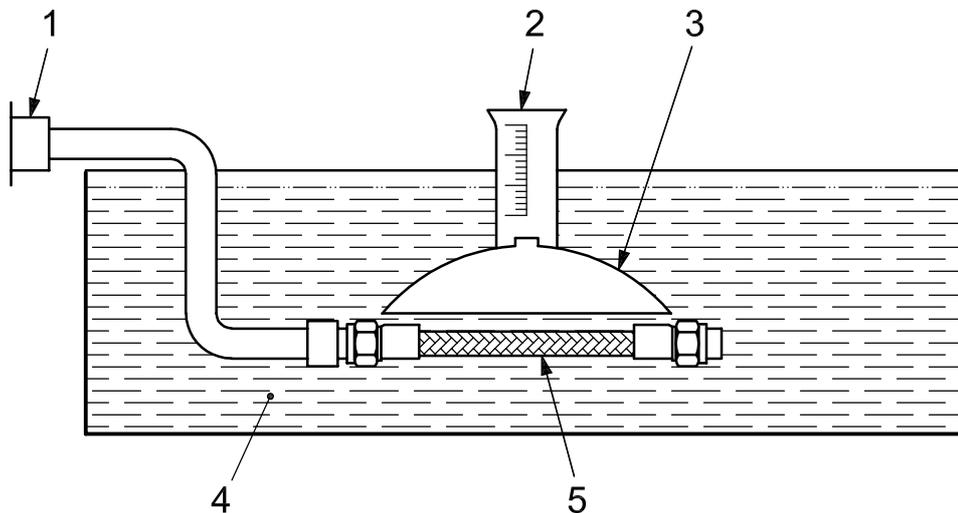
This test is intended to show that the inner tube of the hose does not have excessive porosity.

6.2.2 Procedure

Subject the hose assemblies for 1 h to nominal pressure using dry air or nitrogen gas (N_2) at room temperature.

Collect and measure the gas escaping from the hose assembly during the second half-hour, using the water displacement method and an air-collecting device similar to that shown in Figure 3.

The fluid in the test set-up shall be water which has been treated for pH control and wetting of the hose by adding 1,5 % (V/V) of water softener or wetting agent.



Key

- 1 air or nitrogen gas source
- 2 inverted graduated flask
- 3 funnel to cover hose plus one-half of each socket
- 4 water bath
- 5 hose assembly under test

Figure 3 — Test set-up for pneumatic effusion tests

6.3 Electrical conductivity test

6.3.1 Principle

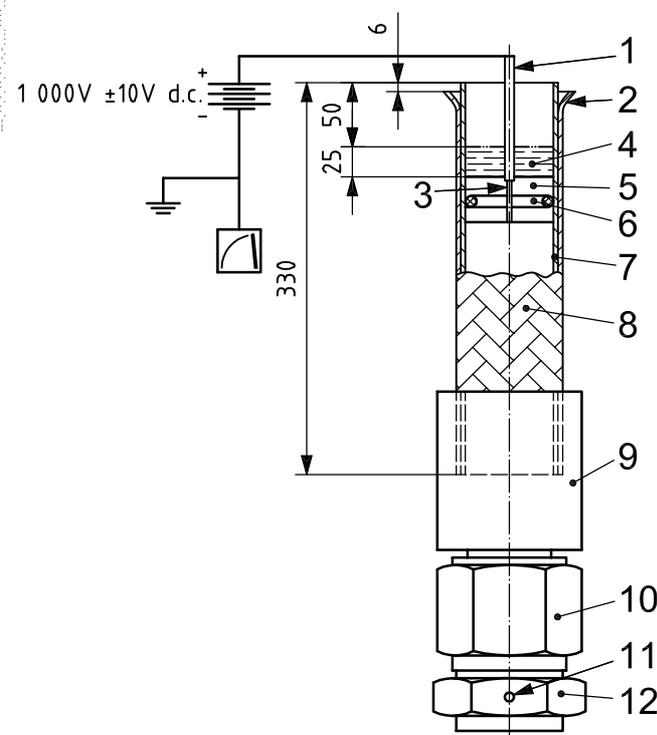
This test is intended to show that the hose is sufficiently conductive to prevent build-up of excessive electrostatic charges which could cause arcing and pin holes.

6.3.2 Preconditioning

The test specimen shall be a length of hose (with braid and one end fitting) as shown in Figure 4a) or 4b). The inner surface of the tube shall be washed first with degreasing fluid (test fluid No. 1; see Annex A), and then with isopropyl alcohol (test fluid No. 2; see Annex A) to remove surface contamination. The hose shall then be thoroughly dried at room temperature. The wire braid shall flare out, as shown in Figure 4a) or 4b), to prevent contact with the end of the PTFE inner tube.

One steel adaptor of appropriate size shall be fitted as shown in Figure 4a) or 4b).

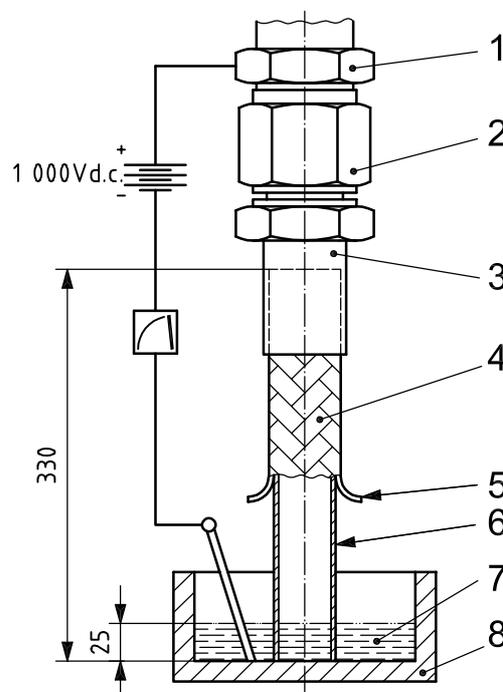
Dimensions in millimetres



Key

- 1 conductor threaded into ring
- 2 flare braid(s)/spiral
- 3 vent
- 4 upper electrode (salt water solution)
- 5 non-conductive plug
- 6 O-ring
- 7 PTFE hose
- 8 hose braid/spiral
- 9 fitting body
- 10 fitting nut
- 11 vent (alternative)
- 12 adaptor (insulate electrode from ground)

Figure 4a)



Key

- 1 electrode /2/
- 2 fitting nut
- 3 fitting body
- 4 hose braid
- 5 flared braid
- 6 polytetrafluoroethylene tube
- 7 electrode /1/
- 8 non-metallic container

Figure 4b)

Figure 4 — Alternative test set-ups for electrical conductivity test on hose assemblies

6.3.3 Procedure

Arrange the test specimen vertically as shown in Figure 4a) or 4b). The relative humidity shall be kept below 70 %. Apply $1\,000\text{ V} \pm 10\text{ V d.c.}$ between the upper (salt water solution) electrode and the lower (adaptor) electrode. The salt water solution shall be a solution of sodium chloride in chemically pure water [$\rho(\text{NaCl}) = 450\text{ g/l}$].

Measure the current with an instrument having a sensitivity of at least $1\ \mu\text{A}$ ($= 1 \times 10^{-6}\text{ A}$).

6.4 Visual and dimensional inspection

Hose assemblies shall be inspected using the normal tools and procedures.

6.5 Determination of elongation or contraction

6.5.1 Principle

This test is intended to check that the proper reinforcing braid angle was used to minimize axial motion due to pressurization.

6.5.2 Procedure

Hold the unpressurized hose in a straight position, mark off on the hose a gauge length of 250 mm (10 in) and then subject the hose to the nominal pressure specified in the procurement specification. After at least 5 min and with the hose length still pressurized, measure the gauge length and calculate the change in length.

6.6 Volumetric expansion test

6.6.1 Principle

This test is intended to determine the increase in volume that occurs when a hose assembly is pressurized.

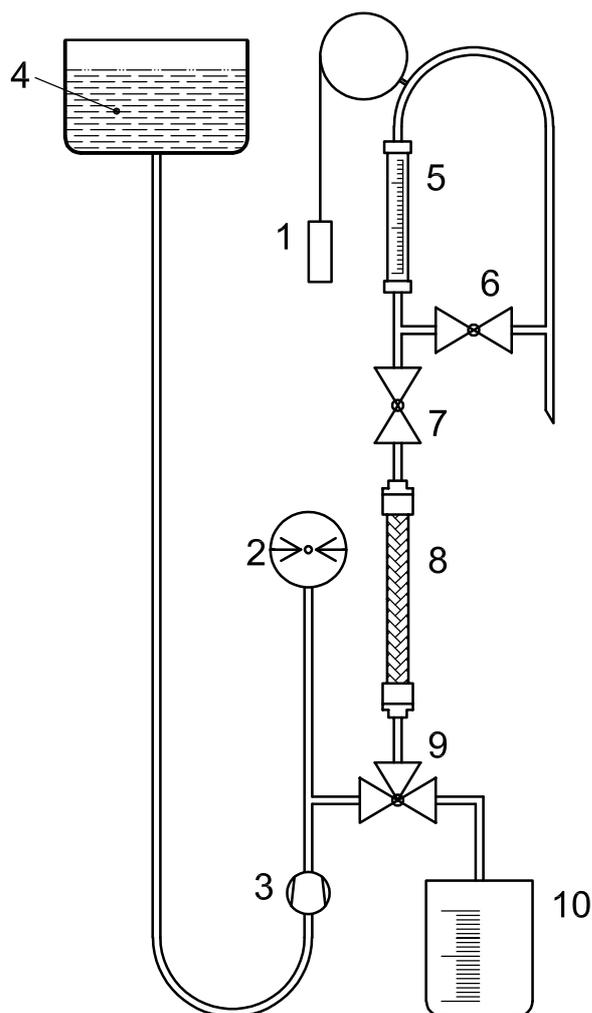
6.6.2 Apparatus

The test set-up, shown in Figure 5, shall be designed in such a way that air pockets cannot form. There shall be only one low point between the reservoir and the pump (see Figure 5). The internal passages shall not have constrictions or surface roughness that could allow air pockets. The hose end fittings and system tubes shall be both strong and rigid enough to allow only negligible expansion under test pressure. The test fluid shall be distilled water. The pump pressure shall be increased at a rate of $2\,000\text{ kPa/s}$ to $4\,000\text{ kPa/s}$ (290 psi/s to 580 psi/s).

Before installing the hose assembly, measure the volumetric expansion of the test set-up (see 6.6.3.9).

6.6.3 Procedure

6.6.3.1 Install the hose assembly to be tested in the test set-up as shown in Figure 5.



Key

- 1 counter-weight for that part of the installation which is located above the hose assembly
- 2 pressure gauge
- 3 pump
- 4 tank of distilled water
- 5 graduated glass tube
- 6 valve A
- 7 valve B
- 8 hose assembly under test
- 9 three-way valve
- 10 graduated glass container

Figure 5 — Test set-up for volumetric expansion test

6.6.3.2 Set the three-way valve to the position indicated in Figure 5.

6.6.3.3 Open valve B and close valve A.

6.6.3.4 Operate the pump until the water is visible in the graduated glass tube.

6.6.3.5 Close valve B. Subject the hose assembly to the appropriate proof pressure for 3 min and check the system for leakage.

6.6.3.6 Open valve B. Bring the water level in the graduated glass tube to zero, using the pump and valve A.

6.6.3.7 Close valve B. Raise the pressure in the system to the appropriate test pressure and hold there for 3 min to 6 min.

6.6.3.8 Close the three-way valve, and open valve B.

6.6.3.9 The increase in the volume of the hose assembly is indicated by the difference in level in the graduated tube. Subtract, from the value obtained, the value for the expansion of the rest of the test system which has been measured beforehand (see 6.6.2).

6.7 Leakage test

6.7.1 Principle

This test is intended to demonstrate that the hose will not leak or rupture at 70 % of the minimum required burst pressure.

6.7.2 Procedure

Pressurize the hose assemblies with water or system fluid to 70 % of the minimum burst pressure at the room temperature specified in the procurement specification, and hold for at least 5 min. Reduce the pressure to 0 kPa (0 psi); then raise the pressure again to 70 % of the minimum burst pressure at room temperature for a final check lasting 5 min.

6.8 Proof-pressure test

6.8.1 Principle

This test is intended to verify the structural integrity of a hose assembly prior to use.

6.8.2 Procedure

6.8.2.1 All hose assemblies

The test fluid may be either water or system fluid. Test all hose assemblies to the proof pressure specified in the procurement specification.

This proof pressure shall apply for at least 5 min when this minimum duration was used for qualification tests. A minimum of 2 min is sufficient for acceptance tests.

6.8.2.2 Hose assemblies having fire sleeves or covers

Proof pressure shall be applied without any sleeve or cover in the end fitting areas. If there is, it shall be pulled back or removed from the end fittings.

6.9 Burst-pressure tests

6.9.1 Principle

These tests are intended to establish failure mode under overpressure at room temperature and at high temperatures.

6.9.2 Test conditions

The hose assemblies shall be tested in the straight condition, the end opposite to the pressure source being left free. The assemblies shall be observed throughout the tests.

6.9.3 Burst-pressure test at room temperature

The test fluid shall be hydraulic fluid or water.

Fill the hose assemblies with the test fluid and increase the pressure at a rate of 150 000 kPa/min \pm 37 500 kPa/min (21 755 psi/min \pm 5 439 psi/min) until the assemblies burst. Record the type of failure and the pressure at which it occurred.

For hose assemblies for fluid systems, the burst pressure at room temperature shall be as specified in the procurement specification.

6.9.4 Burst-pressure test at high temperature

Fill the hose assemblies with a suitable test fluid.

Soak hose assemblies and maintain for at least 1 h at ambient and fluid at the maximum working temperature specified in the procurement specification. After 1 h, raise the pressure to the rated nominal pressure and hold there for at least 5 min. Increase the pressure at a rate of 150 000 kPa/min \pm 37 500 kPa/min (21 755 psi/min \pm 5 439 psi/min) until rupture or leakage occurs. Record the type of failure and the pressure at which it occurred.

The burst pressure at high temperature shall be as specified in the procurement specification.

6.10 Impulse test

6.10.1 Principle

This test is intended to verify the service life of a hose assembly when exposed to hydraulic pressure cycling and surging.

6.10.2 Preconditioning

Prior to testing, the hose assemblies shall be aged and/or exposed to a salt-solution soak test if this is specified in the procurement specification.

6.10.3 Procedure

6.10.3.1 Connect the hose assemblies to rigid supports in the test rig and bend through 180° to the appropriate minimum bend radius specified in the procurement specification.

6.10.3.2 Using system fluid or a high-temperature test fluid (test fluids No. 3, 5 or 6, or equivalent; see Annex A), subject hose assemblies made with a smooth-bore to impulse testing in accordance with ISO 6772. During the test, the fluid and ambient temperatures shall vary as specified in ISO 6772. The test shall be run in such a manner that the hose assemblies are submitted to at least two complete temperature cycles.

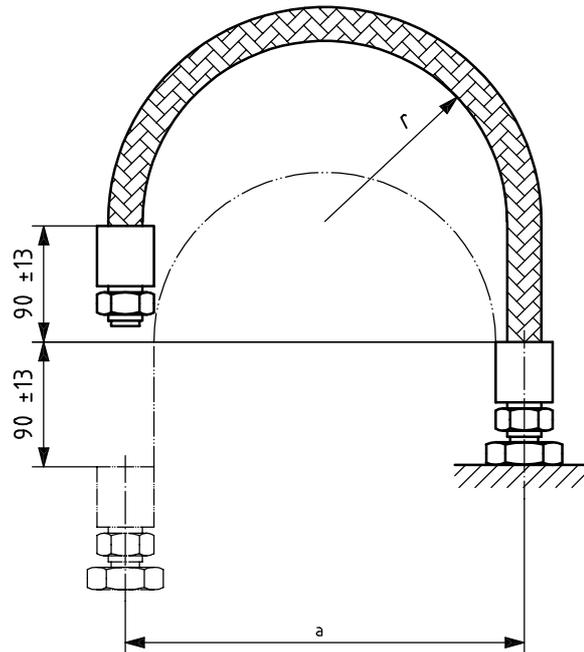
6.11 Flexure test

6.11.1 Principle

This test is intended to demonstrate the flexure fatigue performance of hose braids and fitting attachments.

6.11.2 Procedure

6.11.2.1 Fill the hose assemblies with system fluid (test fluids No. 5 or 6, or equivalent; see Annex A) and mount in the flexure test set-up shown in Figure 6.

**Key**

- r Minimum inside bend radius $\pm 10\%$.
- a Dimensions specified in the procurement specification.

Figure 6 — Test set-up for flexure test

6.11.2.2 Maintain the test assemblies, without pressure and without flexing, at a temperature of $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$) for at least 1 h.

6.11.2.3 Without flexing and with the temperature still maintained at $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$), pressurize the test assemblies to the specified proof pressure for at least 5 min; this shall be done for the first cycle only.

6.11.2.4 While the test assemblies are pressurized to the nominal pressure, with the temperature still maintained at $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$), begin flexing at a rate of (70 ± 10) cycles/min for at least 4 000 flexing cycles.

6.11.2.5 With the pressure reduced to 0 kPa and with the temperature still maintained at $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$), continue flexing at the same rate as specified in 6.11.2.4 for a further 1 000 flexing cycles.

6.11.2.6 Increase the temperature to the maximum working temperature specified in the procurement specification and flex the hose assemblies at the same rate as specified in 6.11.2.4 for a further 1 000 cycles with the pressure at 0 kPa (0 psi). With the high temperature maintained, increase the pressure to the specified nominal pressure. Continue flexing at the same rate at that pressure and temperature for an additional 74 000 cycles, until an accumulated total of 80 000 cycles is reached.

6.11.2.7 Repeat the procedure specified in 6.11.2.2 and 6.11.2.4 to 6.11.2.6 for a total of five test sequences (i.e. 400 000 flexing cycles).

6.11.2.8 After the procedure specified in 6.11.2.7 has been completed, without flexing and with the high temperature maintained, pressurize the test assemblies to the specified proof pressure for at least 5 min; this shall be done for the final cycle only.

6.12 Fuel resistance test

This test is intended to demonstrate the suitability of hydraulic hose for fuel system use.

6.12.1 Procedure

6.12.2.1 Fill the hose assemblies with degreasing fluid (test fluid No. 1; see Annex A) or fuel (test fluid No. 7; see Annex A) and place in an oven maintained at a temperature of $-125\text{ °C} \pm 5\text{ °C}$ ($-257\text{ °F} \pm 9\text{ °F}$) for a period of at least 48 h. Throughout the 48 h, apply to the hose assemblies the nominal pressure specified in the procurement specification.

Precautions shall be taken to ensure that the hose assemblies do not come into contact with parts of the oven that are at a higher temperature.

6.12.2.2 After 48 h, depressurize the hose assemblies, drain and allow to cool for 20 min at room temperature. Then fill the hose assemblies with appropriate test fluid (test fluid No. 8; see Annex A) and apply the rated nominal pressure and maintain at room temperature for at least 2 h.

6.13 Low-temperature flexure testing

6.13.1 Principle

This test is primarily intended to verify usability for fuel systems.

6.13.2 Procedure

6.13.2.1 Fill the hose assemblies with appropriate test fluid (test fluid No. 8; see Annex A) and place in a cold chamber maintained at a temperature of $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$) for at least 24 h.

6.13.2.2 After 24 h, and with the temperature maintained at $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$), bend the hose assemblies around a mandrel with a radius equal to the minimum bend radius specified in the procurement specification. Then bend in the reverse direction and return to the straight position. Repeat this cycle for a total of five times allowing a maximum of 10 s per cycle.

6.14 Pneumatic leakage test

6.14.1 Principle

This test is intended to verify usability of a hose assembly in areas where no pneumatic leakage is permissible.

6.14.2 Procedure

At room temperature, test the hose assemblies, submerged under water, with air or nitrogen gas (N_2) at nominal pressure for at least 5 min.

6.15 Vacuum test

6.15.1 Principle

This test is intended to verify hose assemblies for applications where negative pressures could occur.

6.15.2 Procedure

Empty the hose assemblies, bend to the minimum bend radius specified for the hose, and place in an oven, maintained at the maximum working temperature specified in the procurement specification. Then apply the specified negative pressure to the assemblies and maintain it. At the end of 4 h, remove the hose assemblies from the oven with the negative pressure maintained. When the samples have cooled to room temperature, release the pressure and inspect the hose assembly for collapse or defects.

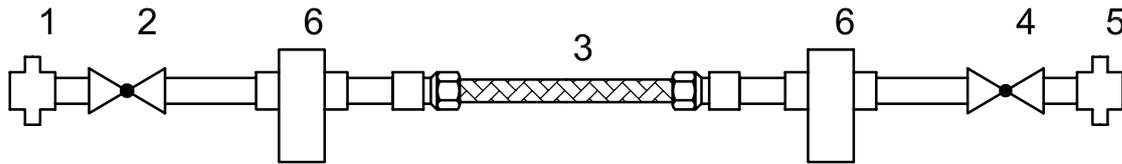
Then cut off one end of each hose assembly within 25 mm (1 in) of a fitting and roll a ball of the appropriate diameter as specified in the procurement specification through the length of the hose.

6.16 Pneumatic surge test

Install the hose assembly in a gas system (air or nitrogen) fitted with rapid-action valves as shown in Figure 7. The gas shall be clean and dry. The test, carried out at room temperature, shall comprise 16 times the following cycle:

- a) hold nominal pressure in the hose assembly for at least 25 min;
- b) then rapidly reduce to atmospheric pressure and hold there for at least 5 min.

After this test, subject the hose assembly to proof-pressure testing and visually examine internally and externally.



Key

- 1 air or nitrogen gas source
- 2 inlet valve
- 3 hose assembly under test
- 4 outlet valve
- 5 exhaust
- 6 filter (optional)

Figure 7 — Test set-up for pneumatic surge test

6.17 Thermal shock test

6.17.1 Preconditioning

Hose assemblies shall be air-aged or unaged as specified in the procurement specification. The assemblies shall be subjected to the specified proof pressure for at least 5 min.

6.17.2 Procedure

6.17.2.1 Proof-pressure phase

Mount the empty hose assemblies in a high-temperature test fixture, as shown in ISO 6773, and reduce the ambient temperature to $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$) for at least 2 h. At the end of this period and with the temperature maintained at $-55\text{ °C} \pm 1\text{ °C}$ ($-67\text{ °F} \pm 1,8\text{ °F}$), suddenly introduce a high-temperature test fluid at the maximum working temperature specified in the procurement specification at a minimum pressure of 350 kPa (50,8 psi). Immediately after the high-temperature test fluid has filled the assembly, raise the pressure to the specified proof pressure for at least 5 min. Not more than 15 s shall elapse between the introduction of the high-temperature test fluid at 350 kPa (50,8 psi) and the raising of the pressure to proof pressure.

6.17.2.2 Burst-pressure phase

Fill the hose assemblies with a suitable high-temperature test fluid at a pressure of $525\text{ kPa} \pm 175\text{ kPa}$ ($76,1\text{ psi} \pm 25,4\text{ psi}$) and maintain the test chamber and fluid at the maximum working temperature specified in the procurement specification for 1 h. At the end of this period, pressurize the hose assemblies to the specified proof pressure for at least 5 min. Then release pressure and, with the high temperature maintained at the maximum working temperature given in the procurement specification, increase the pressure at a rate of $150\ 000\text{ kPa/min} \pm 37\ 500\text{ kPa/min}$ ($21\ 755\text{ psi/min} \pm 5\ 439\text{ psi/min}$) until failure occurs. Throughout the test, observe the hose assemblies continuously, and record the type of failure and the pressure at which the failure occurred.

6.18 Light-radiation aging

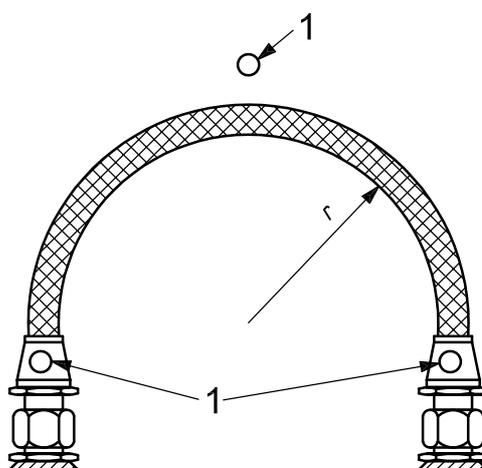
6.18.1 Principle

This aging is intended to verify hose assemblies for applications where light exposure could occur.

6.18.2 Apparatus

The test chamber contains a series of lamps which allow the insulation conditions of this test to be respected.

The hose assembly shall be bent to its minimum bending diameter specified in the procurement specification, as shown in Figure 8. The bending plane shall be parallel to and centered under the plane of the lamps, at a minimum distance of 800 mm (31,5 in) from the plane of the lamps and of 300 mm (11,8 in) from the wall of the test chamber.



Key

- 1 measurement devices
- r* Minimum inside bend radius $\pm 10\%$. Dimension specified in the procurement specification.

Figure 8 — Test set-up for light-radiation-aging test

The light shall have the following wavelength and irradiance level and tolerances:

280 nm to 320 nm:	$5 \text{ W/m}^2 \pm 35 \%$
320 nm to 400 nm:	$63 \text{ W/m}^2 \pm 25 \%$
400 nm to 780 nm:	$560 \text{ W/m}^2 \pm 10 \%$
780 nm to 3 000 nm:	$492 \text{ W/m}^2 \pm 20 \%$

Most radiation sources have a limited lifetime, after which the intensity of their rays decreases. A replacement for the lamps, their rotation and a repositioning of test samples may be necessary, so that the whole sample(s) may be uniformly exposed to light rays and to temperature. The manufacturer's recommendations shall be followed for the replacement and the rotation of the lamps.

The temperature and the humidity in the chamber shall be regulated to $50 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$ ($122 \text{ }^\circ\text{F} \pm 2,4 \text{ }^\circ\text{F}$) and to (30 to 40) % of relative humidity. The air speed around the hose assembly shall be regulated to $1 \text{ m/s} \pm 0,2 \text{ m/s}$ ($3,28 \text{ ft/s} \pm 0,66 \text{ ft/s}$). The temperature in the hose assembly shall be regulated to $70 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$ ($158 \text{ }^\circ\text{F} \pm 5,3 \text{ }^\circ\text{F}$), and the pressure to the nominal pressure specified in the procurement specification.

All measurements shall be made at least at the beginning and at the end of each cycle. Temperature and irradiance measurements shall be made on the irradiated face of each fitting, and not at about 25 mm (1 in) from the bend center (see Figure 8).

6.18.3 Preconditioning

Prior to testing, the hose assemblies shall be aged and/or exposed to a salt-solution soak test, if so specified in the procurement specification.

6.18.4 Procedure

6.18.4.1 Place the test device in the chamber and expose it to the effects of the source of radiation, temperature humidity and pressure during 20 h. This duration shall be decreased or increased in order to have $22\,400 \text{ W/m}^2$ of total irradiance during this period.

6.18.4.2 After a rest time of at least 3 h, the above exposure shall be repeated:

- Class A = 10 cycles
- Class B = 56 cycles

Class B applies when the hose assembly should be exposed for more than 24 h to sunlight radiation during its life time.

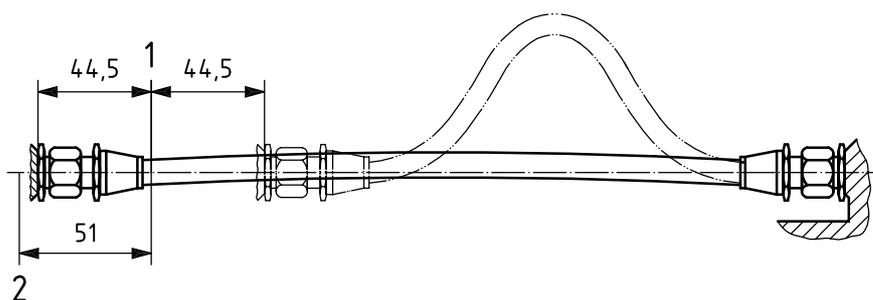
6.19 Push-pull test

6.19.1 Fill the hose assemblies with hydraulic fluid. Throughout the test, the nominal pressure and room temperature shall be maintained.

6.19.2 Compress, on 51 mm, the hose assemblies along their centerline (see Figure 9). This is the neutral position for running the test.

6.19.3 The hose assemblies shall be continuously pushed and pulled along the centerline on 44,5 mm, on each side of the neutral position.

Dimensions in millimetres

**Key**

- 1 neutral position
- 2 straight position

Figure 9 — Test set-up for push-pull test**6.20 Fire test**

Hose assemblies having fire-protective elements, such as fire covers, or fire sleeves, shall be tested in accordance with the hose assembly test specified in ISO 2685.

Annex A (informative)

Test fluids

As yet, International Standards giving specifications for appropriate test fluids to be used when testing hose assemblies in aircraft fluid systems are not available. For the time being, test fluids as specified in some national standards are given in Table A.1. Test fluids of equivalent properties and characteristics, as specified in other national standards, may be used. However, it should be borne in mind, when selecting test fluids, that non-equivalent test fluids 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.

Table A.1 — Equivalent test fluids

Test fluid No.	Equivalent test fluids					
	France		United Kingdom		USA	
	National standard applicable	Description	National standard applicable	Description	National standard applicable	Description
1	NF M 15-006	White spirit	BS 245	White spirit	P-D-680	Dry clean solvent
2	AIR 3660	2-Propanol (isopropyl alcohol)	BS 1595	2-Propanol (isopropyl alcohol)	TT-I-735	2-Propanol (isopropyl alcohol)
3	AIR 3514	Synthetic oil, aviation	Same as for USA		MIL-L-7808	Lubricating oil; aircraft turbine engine, synthetic base
4	AIR 3520	Hydraulic fluid	DEF STAN 91-48 Grade OM-18	Hydraulic fluid, petroleum, normal	MIL-H-5606	Hydraulic fluid, petroleum base; aircraft missile and ordnance
5	—	—	Same as for USA		MIL-H-8446	Hydraulic fluid, petroleum base; aircraft
6	—	—			MIL-H-83282	Hydraulic fluid, fire resistant, synthetic hydrocarbon base; aircraft
7	AIR 3407	Turbine fuel, aviation	DERD 2454	Turbine fuel; aviation	MIL-T-5624	Turbine fuel, aviation; Grade JP4
8	—	—	Same as for USA		TT-S-735	Standard test fluid, hydrocarbon, type III

Bibliography

- [1] AIR 3407, *Carburant type "large coupe" pour turbomachines d'aviation (symbole otan f-40)*
- [2] AIR 3514, *Huile synthétique type 3 centistokes à 98,9 °C, pour turbomachines d'aviation (symbole otan o-150)*
- [3] AIR 3520, *Liquide mineral pour transmissions hydrauliques (symbole otan h-515)*
- [4] AIR 3660, *Alcool isopropylique denature (2 propanol) (symbole otan s-737)*
- [5] BS 245, *Mineral solvents (white spirit and related hydrocarbon solvents) for paints and other purposes*
- [6] BS 1595, *Propan-2-ol (isopropyl alcohol) for industrial use. Specification*
- [7] DEF STAN 91-48, *Hydraulic fluid, petroleum, normal*
- [8] DERD 2454, *Aviation — Turbine fuel*
- [9] MIL-H-5606, *Hydraulic fluid, petroleum base; Aircraft missile and ordnance*
- [10] MIL-H-8446, *Hydraulic fluid, petroleum base; Aircraft*
- [11] MIL-D-83282, *Hydraulic fluid, fire resistant, synthetic hydrocarbon base, metric*
- [12] MIL-L-7808, *Lubricating oil; Aircraft turbine engine, synthetic base*
- [13] MIL-T-5624, *Turbine fuel, aviation; Grades JP-4, JP-5 and JP-5/JP-8 ST*
- [14] NF M 15-006, *Combustibles minéraux liquides — Caractéristiques du white spirit*
- [15] P-D-680, *Dry clean solvent*
- [16] TT-I-735, *2-propanol (isopropyl alcohol)*
- [17] TT-S-735, *Standard test fluid, hydrocarbon, type III*

