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Aerospace — Polytetrafluoroethylene (PTFE) hose assemblies — Test methods

Aéronautique et espace — Tuyauteries flexibles en polytétrafluoréthylène (PTFE) — Méthodes d'essai

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8829 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

Annex A of this International Standard is for information only.

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Introduction

This International Standard 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.

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Aerospace — Polytetrafluoroethylene (PTFE) hose assemblies — Test methods

1 Scope

This International Standard specifies test methods for flexible polytetrafluoroethylene (PTFE) hose and hose assemblies used in aircraft fluid systems in the pressure and temperature ranges covered by pressure classes B, D and E, and temperature types I, II and III as specified in ISO 6771.

This International Standard applies to the hose and the hose coupling. The tests and assembly requirements for the connecting end fittings are covered in the procurement specification.

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

ISO/TR 2685 : 1984, *Aircraft — Environmental conditions and test procedures for airborne equipment — Resistance to fire in designated fire zones.*

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

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

ISO 6773 : 1982, *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.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 room temperature: Temperature in the test laboratory between 15 °C and 32 °C.

3.2 fire sleeve: Flame- and heat-retardant element, normally tubular, slipped over the hose assembly and fastened to the hose fitting.

3.3 fire-cuff: Flame- and fire-retardant element, normally (silicone) rubber, moulded over the hose and hose fittings.

4 Tests on PTFE inner tubes

4.1 Density and relative density

4.1.1 Principle

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

4.1.2 Test methods

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

4.2 Tensile tests

4.2.1 Principle

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

4.2.2 Preconditioning

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

4.2.3 Apparatus

4.2.3.1 Testing machine

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 and which has a suitable dynamometer and a device for measuring the force applied within ± 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 ± 2 %, and the smallest tensile force measured shall be accurate to within ± 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 that the force applied is 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 %.

4.2.3.2 Micrometer

The micrometer used for measuring flat test specimen thickness shall be capable of exerting a pressure of 22 kPa ± 5 kPa on the test specimens and of measuring the thickness to within ± 0,025 mm.

NOTE — Dial micrometers exerting either a force of 0,8 N ± 0,15 N on a circular foot 6,35 mm in diameter or a force of 0,1 N ± 0,04 N on a circular foot 3,2 mm 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.

4.2.4 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 daily at regular intervals.

4.2.5 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 jeweller'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

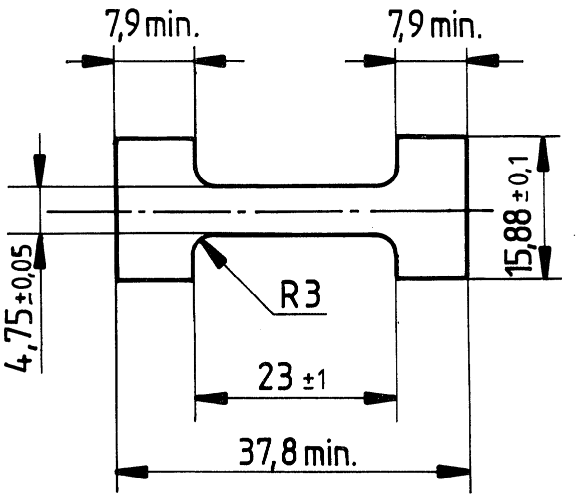

Figure 1 — Test specimen for tensile test

4.2.6 Determination of tensile strength and elongation

4.2.6.1 Procedure

Place the test specimens (see 4.2.5) in the jaws of the testing machine (4.2.3.1), 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.

4.2.6.2 Expression of results

Calculate the tensile strength, R_m, in newtons per square millimetre[1], using the following equation:

$$R_m = F/S$$

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.

1) 1 N/mm² = 1 MPa

4.3 Rolling and proof pressure tests

4.3.1 Principle

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

4.3.2 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 ± 2° 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°

Table 2 — Roller gap dimensions

Dimensions in millimetres

Hose size	Flattening gap max.		Rounding gap max.	
	Class B (10 500 kPa) hose	Classes D and E (21 000 kPa and 28 000 kPa) hose	Class B (10 500 kPa) hose	Classes D and E (21 000 kPa and 28 000 kPa) hose
DN 05	5,2	—	5,5	—
DN 06	5,5	7,1	5,5	6,4
DN 08	5,5	—	6,4	—
DN 10	5,5	7,1	7,9	8,3
DN 12	5,9	8,3	9,5	11,9
DN 16	6,4	8,3	12,7	14,7
DN 20	6,4	8,3	12,7	17,5
DN 25	6,4	8,3	19,1	21
DN 32	7,9	11,1	22,2	25,4
DN 40	9,5	—	31,8	—

4.3.3 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 pressures

Pressures in kilopascals

Hose size	Proof pressures	
	Class B (10 500 kPa) hose	Classes D and E (21 000 kPa and 28 000 kPa) hose
DN 05	2 690	—
DN 06	2 480	2 620
DN 08	2 000	—
DN 10	1 590	1 930
DN 12	1 240	1 520
DN 16	1 170	1 170
DN 20	965	890
DN 25	621	660
DN 32	448	660
DN 40	310	—

4.4 Electrical conductivity test

4.4.1 Preconditioning

The test specimen shall be a 350 mm length of PTFE hose tube, with braid removed. The inner surface of the tube shall be washed first with solvent (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.

4.4.2 Procedure

Arrange the test specimen vertically as shown in figure 2. The relative humidity shall be kept below 70 %. Apply 1 000 V d.c. between the upper and lower electrodes (salt water solution or mercury). 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 µA ($= 1 \times 10^{-6}$ A).

5 Tests on hoses and hose assemblies

5.1 Stress degradation test

5.1.1 Principle

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

5.1.2 Classes E and D (21 000 kPa and 28 000 kPa) hose — Procedure

5.1.2.1 Fill the hose assemblies with a high-temperature test fluid (test fluid No. 3; see annex A) and place in an oven

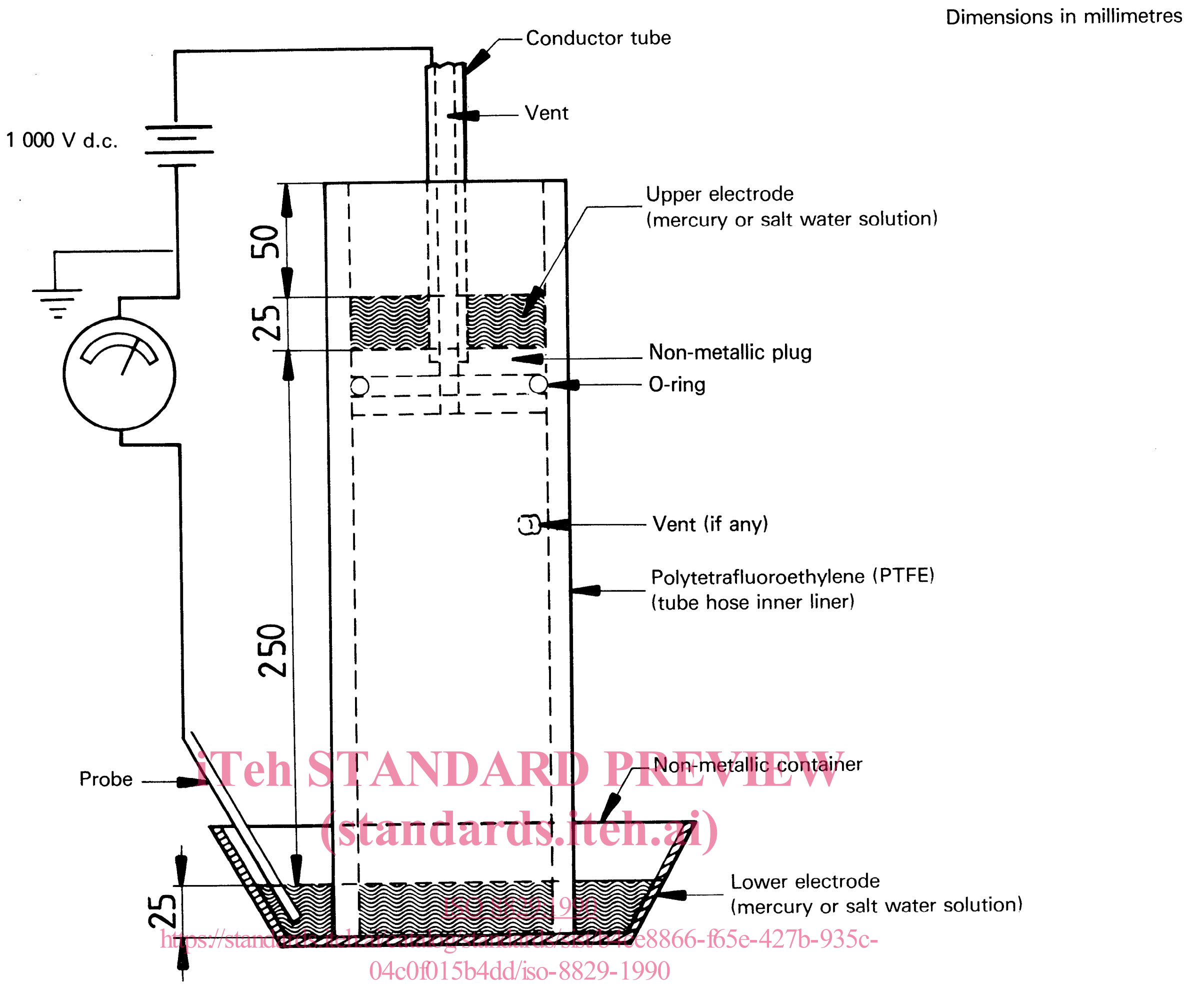

Figure 2 — Test set-up for electrical conductivity test on inner tubes

maintained at 204 °C ± 5 °C. Apply to the hose assemblies the nominal working 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.

5.1.2.2 After at least 20 h at 204 °C, 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.

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

5.1.2.4 Repeat the procedure specified in 5.1.2.1 to 5.1.2.3 a total of three times.

5.1.2.5 Within 4 h after the final pressurization period of 2 h, drain the hose assemblies, flush with trichloroethylene (test fluid No. 5; see annex A) and place in an oven for 1 h at a temperature of 70 °C ± 5 °C.

5.1.2.6 Within 8 h after the drying process has been completed, remove the hose assemblies from the oven, cool to room temperature, and then subject 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.

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

5.1.2.8 Hold the pressure for a further period of 5 min, during which time collect the gas escaping from the test specimen, including the juncture of the hose and the fitting, but not including the fitting nut. 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.

5.1.3 Class B (10 500 kPa) hose — Procedure

The hose assemblies shall be tested in the same manner as specified in 5.1.2 except that the test temperature shall be 232 °C (instead of 204 °C).

5.2 Pneumatic effusion test

5.2.1 Principle

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

5.2.2 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.

5.3 Electrical conductivity test

5.3.1 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.

5.3.2 Preconditioning

The test specimen shall be a length of hose (with braid and one end fitting) as shown in figure 4. The inner surface of the tube shall be washed first with solvent (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 4 to prevent contact with the end of the PTFE hose. One steel adaptator of appropriate size shall be fitted as shown in figure 4.

5.3.3 Procedure

Arrange the test specimen vertically as shown in figure 4. The relative humidity shall be kept below 70 %. Apply 1 000 V d.c. between the upper (salt water solution or mercury) electrode and the lower (adaptor) electrode. 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 µA (= 1 × 10^{-6} A).

5.4 Visual and dimensional inspection

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

5.5 Determination of elongation or contraction

5.5.1 Principle

This test is intended to check that the proper reinforcing angle was used.

5.5.2 Procedure

Hold the unpressurized hose in a straight position, mark off on the hose a gauge length of 250 mm and then subject the hose to the nominal operating 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.

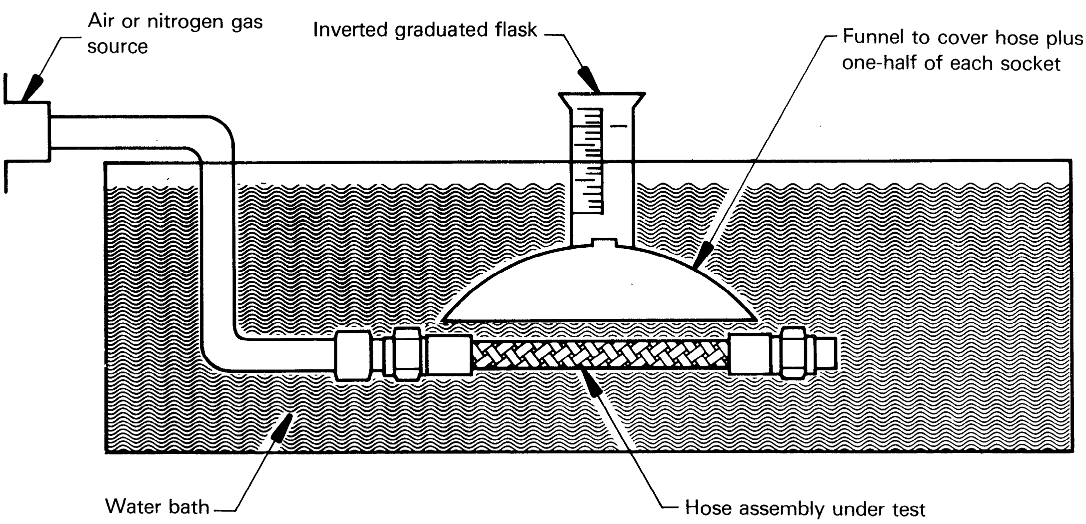

Figure 3 — Test set-up for pneumatic effusion tests