INTERNATIONAL STANDARD

**ISO 1825**

Third edition
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# Rubber hoses and hose assemblies for aircraft ground fuelling and defuelling — Specification

*Tuyaux et flexibles en caoutchouc pour le ravitaillement carburant et la vidange des avions au sol — Spécifications*

Reference number
ISO 1825:2010(E)





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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 1825 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

This third edition cancels and replaces the second edition (ISO 1825:1996), which has been technically revised (for details, see the Introduction).

# Introduction

This specification has been updated to bring it into line with the two most common specifications used for this product in the field, EN 1361:2004 and API 1529, 6th edition. As the 1996 edition of ISO 1825 was closer to EN 1361, EN 1361 was used as the basis for redrafting. Where possible, an attempt has been made to align all three specifications. As a result of this, the following changes have been made to the specification:

a) type A (hoses without any special electrical properties) has been eliminated;

b) type D (hoses with a conductive cover but without a low-extraction tube compound) has been eliminated;

c) there are now four hose types (all with a low-extraction tube);

d) a hose flammability test has been introduced;

e) a cyclic kinking test has been introduced;

f) a flex test at −30 °C has been introduced;

g) the flexibility at room temperature test is carried out at 20 °C as opposed to 23 °C originally.

# Rubber hoses and hose assemblies for aircraft ground fuelling and defuelling — Specification

## 1 Scope

This International Standard specifies the dimensions and construction of, and requirements for, four types of hose and hose assembly for use in all operations associated with the ground fuelling and defuelling of aircraft.

All four types are designed for

a) use with petroleum fuels having an aromatic-hydrocarbon content not exceeding 30 % by volume;

b) operation within the temperature range of −30 °C to +65 °C and such that they will be undamaged by climatic conditions of −40 °C to +70 °C when stored in static conditions;

c) operation at up to 2,0 MPa (20 bar) maximum working pressure, including surges of pressure which the hose can be subjected to in service.

NOTE 1 Type C hoses are intended for general pressure applications on all vehicles used for plane fuelling. They can also be used for vehicle/rail car loading and discharge where excessive vacuum does not occur.

NOTE 2 Type F hoses can be used for plane delivery applications on vehicles that are also used for defuelling at high flow rates where type C hoses are not suitable.

NOTE 3 Type E and F hoses can also be used for vehicle/rail car loading and discharge, for trailer to fueller transfer and for elevation platform supply (riser) to provide greater kink resistance.

## 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 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 1382, *Rubber — Vocabulary*

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 1817:2005, *Rubber, vulcanized — Determination of the effect of liquids*

ISO 2230, *Rubber products — Guidelines for storage*

ISO 4649:2002, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*

ISO 4671, *Rubber and plastics hoses and hose assemblies — Methods of measurement of the dimensions of hoses and the lengths of hose assemblies*

ISO 4672:1997, *Rubber and plastics hoses — Sub-ambient temperature flexibility tests*[1)]

ISO 6246, *Petroleum products — Gum content of light and middle distillate fuels — Jet evaporation method*

ISO 7326, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 7989-1, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 1: General principles*

ISO 7989-2, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 2: Zinc or zinc-alloy coating*

ISO 8031, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity*

ISO 8033, *Rubber and plastics hoses — Determination of adhesion between components*

ISO 8330*, Rubber and plastics hoses and hose assemblies — Vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1382 and ISO 8330 and the following apply.

**3.1**
**hose assembly**
hose with either permanent or reusable end fittings attached

**3.2**
**electrically bonded hose/hose assembly**
hose/hose assembly that uses a metallic wire connection to conduct static electricity

**3.3**
**electrically conductive hose/hose assembly**
hose/hose assembly that is capable of conducting static electrical charges, using a conductive rubber layer, without the use of a metallic wire

1) Under revision as ISO 10619-2.

## 4 Classification

Hoses for this application are classified into four types and two grades according to their construction and electrical properties.

| Type | Grade | Construction |
|---|---|---|
| B | M | Electrically bonded, incorporating at least two low-resistance electrically conductive wires and a conductive cover compound. |
| C | Ω | Electrically conductive, incorporating a conductive cover compound. |
| E | M | Electrically bonded, incorporating at least one metallic wire helix, at least two low-resistance electrically conductive wires and a conductive cover compound. Has an enhanced defuelling capability. |
| F | Ω | Electrically conductive, incorporating at least one non-electrically conductive non-metallic helix and a conductive cover compound. |

## 5 Service reeling diameter

Hoses shall be designed for operation on equipment fitted with hose reels of the diameters given in Table 1.

NOTE These hoses remain substantially circular in cross-section when reeled on drums and should not be confused with hoses of the collapsible type that are intended to be reeled flat.

**Table 1 — Service reeling diameters**

| Nominal internal diameter of hose | Minimum external diameter of reeling drum used in service<br>mm |
|---|---|
| 19,0 | 225 |
| 25,0 | 300 |
| 31,5 | 375 |
| 38,0 | 450 |
| 50,0 | 550 |
| 63,0 | 600 |
| 76,0 | 600 |
| 100,0 | 900 |
| 101,5 | 900 |

## 6 Materials and construction

### 6.1 Hoses

If the hose is mandrel-built and vulcanized on a mandrel, particulate-type release agents shall not be used. The hose shall be uniform in quality and be free from porosity, air holes, foreign inclusions and other defects when inspected visually.

The hose shall comprise the following components:

— a lining of synthetic rubber resistant to petroleum fuel;

— a reinforcement consisting of layers of woven, braided or spirally wound textile material;

— an outer cover made of synthetic rubber which shall be conductive and resistant to abrasion, outdoor exposure and petroleum fuel.

For type E and F hoses only, an embedded helix reinforcement shall be included in the construction. For type E hoses, the wire reinforcement used shall be a hard steel and shall have a galvanized finish in accordance with ISO 7989-1 and ISO 7989-2.

Types B and E shall also incorporate low-resistance electrically conductive wires to ensure that the hoses are electrically conductive.

The cover may have a shallow cloth-marked finish.

### 6.2 Hose assemblies

In order to produce the required electrical properties, the method of attachment of the couplings shall be in accordance with Clause 9.

## 7 Dimensions and tolerances

### 7.1 Internal diameter

When measured in accordance with the most appropriate method in ISO 4671, the internal diameter shall lie within the tolerance limits specified in Table 2.

**Table 2 — Internal diameters and tolerances**

| Internal diameter<br>mm | Tolerance limits<br>mm |
|---|---|
| 19,0 | ± 0,8 |
| 25,0 | ± 0,8 |
| 31,5 | ± 0,8 |
| 38,0 | ± 0,8 |
| 50,0 | ± 1,2 |
| 63,0 | ± 1,2 |
| 76,0 | ± 1,2 |
| 100,0 | ± 1,6 |
| 101,5 | ± 1,6 |

### 7.2 Thickness

When measured in accordance with the most appropriate method in ISO 4671, the thickness of the lining shall be not less than 1,6 mm.

When measured in accordance with the most appropriate method in ISO 4671, the thickness of the cover shall be not less than 1,6 mm for hoses of nominal bore less than 50 and not less than 2,0 mm for hoses of nominal bore 50 and greater.

### 7.3 Concentricity

When determined in accordance with the most appropriate method in ISO 4671, the concentricity, based on a total indicator reading between the bore and the outside surface of the cover, shall be no greater than 1,0 mm.

### 7.4 Tolerances on length

The tolerances on the measured length shall be ± 1 % of the specified length.

### 7.5 Mass per unit length of hose

The maximum mass per unit length shall be as given in Table 3.

**Table 3 — Mass per unit length of hose**

| Nominal internal diameter | Maximum mass per unit length of hose | |
|---|---|---|
| | Types B and C<br>kg/m | Types E and F<br>kg/m |
| 19,0 | 0,9 | 1,1 |
| 25,0 | 1,1 | 1,5 |
| 31,5 | 1,4 | 1,9 |
| 38,0 | 1,7 | 2,2 |
| 50,0 | 2,7 | 3,0 |
| 63,0 | 3,5 | 4,0 |
| 76,0 | 4,0 | 4,7 |
| 100,0 | 6,5 | 7,5 |
| 101,5 | 6,5 | 7,5 |

## 8 Physical properties

### 8.1 Rubber compounds

The physical properties of the rubber compounds used for the lining and cover shall comply with the values given in Table 4, when tested by the methods listed in Table 4. Tests shall be carried out on test pieces or test samples taken either from the hose or from separately vulcanized sheets, except for the cold embrittlement and abrasion resistance tests which shall be carried out on moulded test pieces vulcanized to the same state as the hose. The tests which shall be carried out for type testing and routine testing are given in Annex M. The tests recommended for production acceptance testing are given in Annex N.

**Table 4 — Requirements for rubber compounds**

| Property | Unit | Requirement | | Method of test |
|---|---|---|---|---|
| | | Lining | Cover | |
| Tensile strength, min. | MPa | 7,0 | 7,0 | ISO 37 (dumb-bell test pieces) |
| Elongation at break, min. | % | 250 | 300 | ISO 37 (dumb-bell test pieces) |
| Change in volume (swelling) in fuel, max. | % | 50 | 75 | 7.3 of ISO 1817:2005 (48 h at 40 °C in liquid B) |
| Fuel-soluble matter, max. | % | 4,0 | Not applicable | Annex A |
| Cold embrittlement | | No cracking | No cracking | Annex B |
| Abrasion resistance, max. | $mm^3$ | Not applicable | 140 | Method A of ISO 4649:2002 |
| Ageing | | | | ISO 188 (7 days at 70 °C) (air-oven method) |
| Tensile strength change, max. | % | ± 30 | ± 30 | ISO 37 (see above) |
| Elongation at break change, max. | % | ± 30 | ± 30 | ISO 37 (see above) |

## 8.2 Finished hoses and hose assemblies

Finished hoses and hose assemblies shall meet the requirements specified in Table 5.

**Table 5 — Requirements for finished hoses and hose assemblies**

| Property | Requirement | Method of test |
|---|---|---|
| **Hose dimensions** | | |
| Internal diameter | See Table 2 | ISO 4671 |
| Lining thickness, min. | 1,6 mm | ISO 4671 |
| Cover thickness, min. | 1,6 mm (nominal bore < 50)<br>2,0 mm (nominal bore 50 and greater) | ISO 4671 |
| Concentricity, max. | 1,0 mm | ISO 4671 |
| Length tolerances | ± 1 % | ISO 4671 |
| Mass per unit length, max. | See Table 3 | |
| **Hose tests** | | |
| Adhesion between components (dry), min.<br>After contact with fuel, min. | 3,0 N/mm<br>2,0 N/mm | Annex C |
| Fuel contamination, $R_e$, max. | 10 mg/100 ml | Annex D |
| Ozone resistance | No cracking observed under ×2 magnification | ISO 7326 (40 °C) |
| Flexibility at ambient and low temperature | No permanent deformation or visible structural damage, no increase in electrical resistance outside the specified limits, no impairment of electrical continuity and shall comply with the proof-pressure requirements in Annex J at (20 ± 5) °C. | Annex E (20 °C)<br>Annex F (30 °C) |
| Crush recovery (type F only) | | Annex G |
| After 1 min | Regains 90 % of original diameter | |
| After 10 min | Regains 95 % of original diameter | |
| | Shall comply with the proof-pressure requirement in Annex J at (20 ± 5) °C | |

**Table 5** (*continued*)

| Property | Requirement | Method of test |
|---|---|---|
| Cyclic kinking (types B and C only) | No leakage at proof pressure at (20 ± 5) °C<br>No increase in electrical resistance or impairment of electrical continuity<br>Any adhesion between components to be less than 2,0 N/mm | Annex H |
| Flammability | Hose shall cease burning immediately on removal of flame and there shall be no glowing visible after 2 min | Annex I |
| Change in length at working pressure, max. | Types B and C: 0 to +7 %<br>Types E and F: 0 to +12 % | Annex J |
| Proof pressure | At 4,0 MPa (40 bar):<br>No leakage or damage<br>No increase in electrical continuity or resistance beyond the specified limits | Annex J |
| Burst pressure, min. | 8,0 MPa (80 bar) | Annex J |
| Vacuum test | Types B and C at 15 kPa (0,15 bar) absolute: no visible structural damage<br>Types B and C at 85 kPa (0,85 bar) absolute: loss of circularity not to exceed 20 % of internal diameter<br>Type E at 15 kPa (0,15 bar) absolute: ball shall pass and no visible structural damage<br>Type F at 35 kPa (0,35 bar) absolute: ball shall pass and no visible structural damage | Annex K |
| Electrical properties | The electrical properties of the hose shall be such that the electrical requirement for the hose assemblies is met. | 9.1, 9.2 |
| **Hose assembly tests** | | |
| Proof pressure | At 4,0 MPa (40 bar):<br>No leakage or damage<br>No increase in electrical continuity or resistance outside the specified limits | Annex J |
| Security of couplings | No leakage or movement of the couplings out of the hose at the specified pressures | Annex L |
| Electrical properties | Types B and E: resistance 100 Ω max.<br>Types C and F: resistance $10^3$ to $10^6$ Ω | 9.1<br>9.2 |

# 9 Electrical properties

## 9.1 Type B and type E (electrically bonded)

No fewer than two low-resistance electrical bonding wires shall be provided between, or incorporated in, the reinforcement plies and arranged in such a manner that electrical continuity is maintained along the length of the hose in service. Each bonding wire shall have not less than nine strands. The metal used shall have high resistance to fatigue.

When attaching couplings to type B and type E hoses, the protruding length of bonding wire shall be folded into the hose bore, positioned between the lining and the fitting tail and extending along approximately half the length of the fitting tail. If the hose is supplied without couplings, the bonding wires shall protrude approximately 150 mm at each end of the hose. When tested in accordance with ISO 8031, the electrical resistance of each assembly shall be no greater than 100 Ω.

NOTE When confirming electrical continuity on production hose assembly tests, a suitable and quick method is by the use of a 4,5 V battery and a 3,5 V, 0,3 A test bulb. A dimly lighted bulb is sufficient to indicate satisfactory continuity.

### 9.2 Type C and type F (electrically conductive incorporating a semi-conductive cover compound)

For assemblies, it is necessary to create a connection between the hose cover and the coupling. When tested in accordance with ISO 8031, the electrical resistance of each assembly shall be between $10^3$ Ω and $10^6$ Ω.

## 10 Frequency of testing

Type testing is carried out in order to confirm that all the material, construction and test requirements of this International Standard are met by the method of manufacture and hose design. Type tests shall be repeated at least every five years or whenever a change in method of manufacture or materials occurs.

Routine tests are those tests that shall be carried out on all hoses and hose assemblies prior to dispatch.

Production acceptance tests are those tests which should preferably be carried out by the manufacturer to control the quality of its products.

Type tests and routine tests are specified in Annex M.

Production acceptance tests are given in Annex N. The frequencies specified in Annex N are given as a guide only.

## 11 Marking

### 11.1 Hoses

The hose shall be legibly and durably marked on the outer cover, at intervals of not more than 1 m, with the following information:

a) the manufacturer's name or identification, e.g. MAN;

b) the manufacturer's product identification, e.g. No. 123;

c) the number and year of publication of this International Standard, i.e. ISO 1825:2010;

d) the type/grade, e.g. C/Ω;

e) the nominal bore, e.g. 63;

f) the maximum working pressure, in MPa or bars, e.g. 2,0 MPa;

g) the quarter and the last two digits of the year of manufacture, e.g. 2Q10;

h) a unique serial number.

EXAMPLE MAN/No. 123/ISO 1825:2010/C/Ω/63/2,0 MPa/2Q10/0001.

### 11.2 Hose assemblies

The couplings of hose assemblies shall be permanently marked with the following information:

a) the name or identification of the assembler;

b) a serial number corresponding to a hydrostatic test report (this serial number shall be recorded on the test inspection document by the hose assembly manufacturer at the time of factory testing).

It is recommended that hoses be supplied to the end user complete with couplings, i.e. as a hose assembly.

## 12 Test certificate/report

When requested, a test certificate or test report shall be provided with each length of hose or hose assembly, containing the following, as appropriate:

a) the hose manufacturer's name;

b) the coupling manufacturer's name;

c) the assembler's name;

d) the hose type/grade;

e) the length and nominal bore of the hose or assembly;

f) the serial or reference number of the hose;

g) the serial or reference number of the assembly;

h) the quarter and year of hose manufacture;

i) the month and year of assembly manufacture;

j) the hydrostatic proof pressure;

k) the electrical resistance;

l) the date(s) of testing.

## 13 Cleanliness

The hose bore shall be cleaned, flushed and dried to remove any substances used in manufacture.

NOTE A recommended practice for flushing and handling hoses is given in Annex O.

## 14 Protection for dispatch and storage

To protect the couplings and to prevent damage to the lining, corrosion-resistant protective end caps shall be fitted to all hoses and hose assemblies at the manufacturer's factory after testing is completed.

# Annex A
(normative)

# Method for determination of fuel-soluble matter

## A.1 Procedure

**A.1.1** Take a sample large enough to be able to obtain a 5 g test portion from the lining of the hose and remove any extraneous fibres. Cut the sample into pieces approximately 3 mm square and extract (5 ± 0,01) g of the comminuted sample with 100 ml of liquid B, as specified in ISO 1817, in a glass flask for 96 h at (40 ± 1) °C. Take suitable precautions to prevent loss of liquid by evaporation.

**A.1.2** While still hot, decant the liquid in the flask through a filter into a pre-weighed hemispherical glass dish of suitable size. Wash both the residue in the flask and the filter with a small quantity of liquid B.

**A.1.3** Evaporate the contents of the dish on a boiling water bath and heat the residue in a ventilated air oven for 2 h at (150 ± 3) °C. Determine the residual mass by weighing to the nearest 0,01 g.

Take great care to avoid overheating of the residue, as any degradation of polymeric material due to overheating cannot be estimated and could give a false result.

## A.2 Expression of results

Calculate the mass of residual fuel-soluble matter as a percentage of the original mass of the test portion.

# Annex B
(normative)

# Method of test for cold embrittlement

## B.1 Apparatus

The apparatus is shown in Figure B.1.

## B.2 Procedure

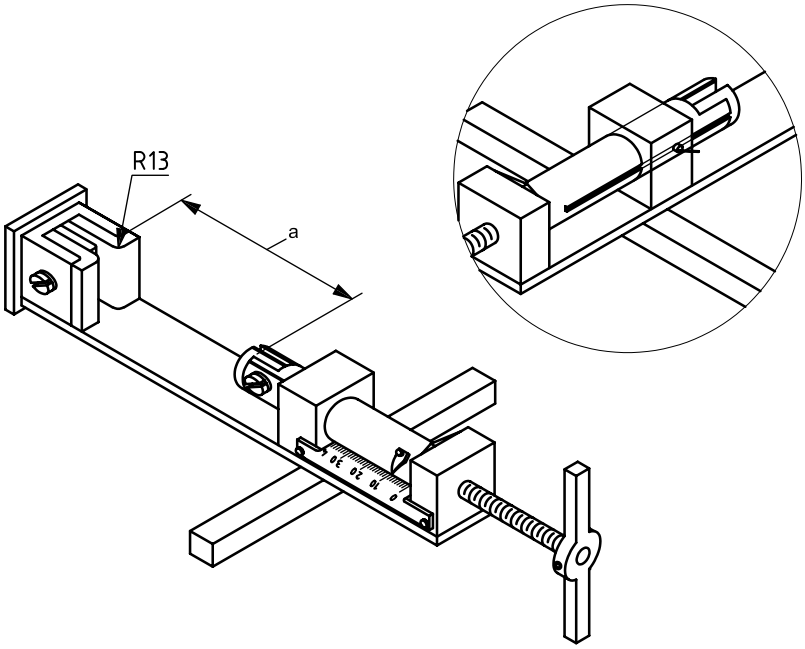
Fix a test piece measuring 150 mm × 25 mm × 2 mm in two grips so that it lies in one plane with 127 mm exposed between the grips and then reduce the distance between the grips by 1 mm. If the test piece is taken from a piece of hose, it shall be free of any adhering reinforcement fabric.

Place the clamped test piece in a Dewar vessel containing a coolant so that the test piece is completely immersed. Maintain the temperature at (−40 ± 1) °C for 30 min and then reduce the distance between the grips by 25 mm in 20 s by moving one grip directly towards the other in the same plane.

Examine the test piece for cracks.

NOTE A temperature of −40 °C can be attained by using methanol or ethanol with crushed dry ice (solid carbon dioxide) and maintained by carefully adding further pieces of dry ice.

Dimensions in millimetres




[a] Length between grips.

**Figure B.1 — Apparatus for cold embrittlement test**

# Annex C
(normative)

# Method for determination of adhesion between components

## C.1 Dry adhesion

Cut out samples of type E and type F hoses parallel to the helix. Subject the hose to the adhesion test described in ISO 8033 and determine the minimum value (in newtons per millimetre) for adhesion:

a) between lining and reinforcement;

b) between reinforcement and cover;

c) between reinforcement layers.

## C.2 Adhesion after contact with fuel

Cut out a sample approximately 300 mm in length of the hose to be tested and seal one end. Fill the hose with liquid B as specified in ISO 1817, and lightly cap the top. Condition the liquid-filled hose at $(20 \pm 5)$ °C for $168 \,^{+2}_{0}$ h. Then empty the hose and determine the minimum adhesion between components as described in Clause C.1.

# Annex D
(normative)

# Method for determination of resistance to fuel contamination

## D.1 Principle

The fuel contamination is judged by determination of the substances which are dissolved from the hose by a simulator liquid after pre-treatment. The result is given in terms of a hose with a nominal bore of 76.

## D.2 Procedure

Take a suitable length of hose, not less than 300 mm, and stopper one end with a glass plug. Fill the hose with liquid B as specified in ISO 1817, and allow to stand at room temperature for 3 days. Remove the liquid and visually examine it for contamination.

For a further 4 days, at daily intervals, refill the hose with liquid B, allow to stand at room temperature, remove the liquid and visually examine it for contamination.

Refill the hose with liquid B and allow to stand for 3 days at (20 ± 5) °C. Remove the liquid and determine the residue on evaporation in accordance with ISO 6246.

Also determine the residue on evaporation of a blank (liquid B) test sample in accordance with ISO 6246.

Report the value $R$, which is the mass of the residue obtained on evaporation of the liquid from the hose less the mass obtained from the blank, as milligrams of residue per 100 ml of test liquid.

## D.3 Expression of results

When testing hoses having a nominal bore other than 76, adjust the value obtained to give the final result in terms of a nominal bore of 76, using the following equation:

$$R_{\mathrm{e}} = \frac{RB}{76}$$

where

$R_{\mathrm{e}}$ is the equivalent residue, in milligrams per 100 ml of test liquid, for a hose of nominal bore 76;

$R$ is the mass of the residue, in milligrams per 100 ml of test liquid, corrected for the mass obtained in the blank run;

$B$ is the nominal bore of the hose tested.

This adjustment compensates for the fact that the hose surface area/liquid volume ratio varies with the nominal bore of the hose.

# Annex E
(normative)

# Method of test for flexibility at 20 °C

Coil an empty hose at (20 ± 5) °C around a test drum of external diameter given in Table E.1. Uncoil and check for visible structural damage and permanent deformation.

For type B and type E hoses, check that the electrical continuity is maintained (see 9.1) and, for type C and type F hoses, measure the electrical resistance (see 9.2).

**Table E.1 — External diameter of test drum for flexibility test at 20 °C**

| Nominal bore | External diameter of test drum<br>mm |
|---|---|
| 19 | 180 |
| 25 | 230 |
| 32 | 280 |
| 38 | 360 |
| 50 | 430 |
| 63 | 460 |
| 75 | 460 |
| 76 | 460 |
| 100 | 690 |
| 101 | 690 |

# Annex F
(normative)

# Method of test for flexibility at –30 °C

Use method B of ISO 4672:1997 with the following additions:

a) Test temperature: (–30 ± 2) °C.

b) Diameter of test drum: 10 times the nominal bore of the hose.

c) Bend hoses of nominal bore 19 to 63, inclusive, through 180° and hoses of nominal bore 75 to 101, inclusive, through 90°.

d) Examine the hose at ambient temperature and then pressure-test it to 4,0 MPa (40 bar) in accordance with ISO 1402.

   Hoses of nominal bore 100 or 101 may be tested outside the cold chamber, but it is essential that they be tested within 30 s of removal from the cold chamber.

e) Fill the test piece with aviation kerosene and allow to soak for 24 h at ambient temperature before placing it in the cold chamber for 24 h.

f) Carry out the test on the filled test piece.

g) For type B and type E hoses, check the electrical continuity (see 9.1) and, for type C and type F hoses, measure the electrical resistance (see 9.2).

# Annex G
(normative)

# Method of test for crush recovery

**IMPORTANT — This test applies only to type F hoses, which might be subjected to crushing forces in service.**

## G.1 Apparatus

### G.1.1 Apparatus 1

**G.1.1.1** **Compression-testing machine**, capable of a rate of traverse of (50 ± 5) mm/min and with a capacity adequate for the level of crushing force specified.

**G.1.1.2** **Two metal plates**, each 80 mm wide and capable of withstanding the applied forces without deformation. The edges of the plates shall be rounded (approximately 1,5 mm radius) to avoid cutting the hose during the test.

### G.1.2 Apparatus 2

**G.1.2.1** **Tensile-testing machine**, with a rate of traverse of (50 ± 5) mm/min and with a capacity adequate for the level of crushing force that may be specified.

**G.1.2.2** **Compression cage**.

**G.1.2.3** **Two metal plates**, as described in G.1.1.2.

## G.2 Test piece

Take a sample of hose of minimum length 500 mm.

## G.3 Conditioning of test piece

No test shall be carried out within 24 h of manufacture of the hose. Condition the test piece at a temperature of (20 ± 5) °C for at least 3 h before testing; this may be part of the 24 h after manufacture.

## G.4 Procedure

Measure the outside diameter of the test piece in accordance with the most appropriate method in ISO 4671. Place the test piece between the two parallel plates (G.1.1.2) mounted in the test machine (G.1.1.1 or G.1.2.1) so that the central 80 mm of the test piece will be crushed.

Compress the hose so that the outside diameter is reduced by 50 % and retain it in the compressed condition for (60 ± 10) s. Release the compressive force at a rate of (50 ± 5) mm/min.

Remeasure the outside diameter, at the narrowest point, 1 min and 10 min after releasing the compressive force. Then subject the test piece to a proof-pressure test (see J.1.2).

# Annex H
(normative)

# Method for determination of cyclic kinking resistance

Use the following procedures to test type B and type C hoses for kink resistance:

a) Prepare the test hose by filling it with liquid B as specified in ISO 1817, leaving it to soak for 168 h.

b) Empty the hose and lightly cap both ends.

c) Bend the empty hose at (20 ± 5) °C to form a kink with an included angle of 60°.

d) Release the hose and allow it to recover for 2 min to 4 min.

e) Repeat steps c) and d) for 1 000 continuous cycles and visually examine the hose for permanent deformation and structural damage. Measure the electrical continuity and electrical resistance while empty to ensure the limits of 9.1 and 9.2 are met as appropriate.

f) Proof-test the hose to 4,0 MPa (40 bar) (see J.1.2).

g) Cut a section of the hose at the location of the kink and carry out lining/reinforcement/cover adhesion tests.

h) Report all findings.

# Annex I
(normative)

# Flammability test

## I.1 Procedure

Bend a hose assembly test piece into a U-shape of radius as indicated in Figure I.1. Fill the test piece with liquid F as specified in ISO 1817 (water may be used as the test liquid in place of liquid F if the use of liquid F is deemed to be a safety risk).

Expose the test piece to a naked flame from a Bunsen burner of 10 mm pipe diameter for a period of 3 min, with the air flow to the burner shut off. The distance between the burner and test piece shall be as indicated in Figure I.1.

## I.2 Assessment

The test piece is deemed to be non-flammable if

a) it ceases to burn immediately on removal of the burner flame;

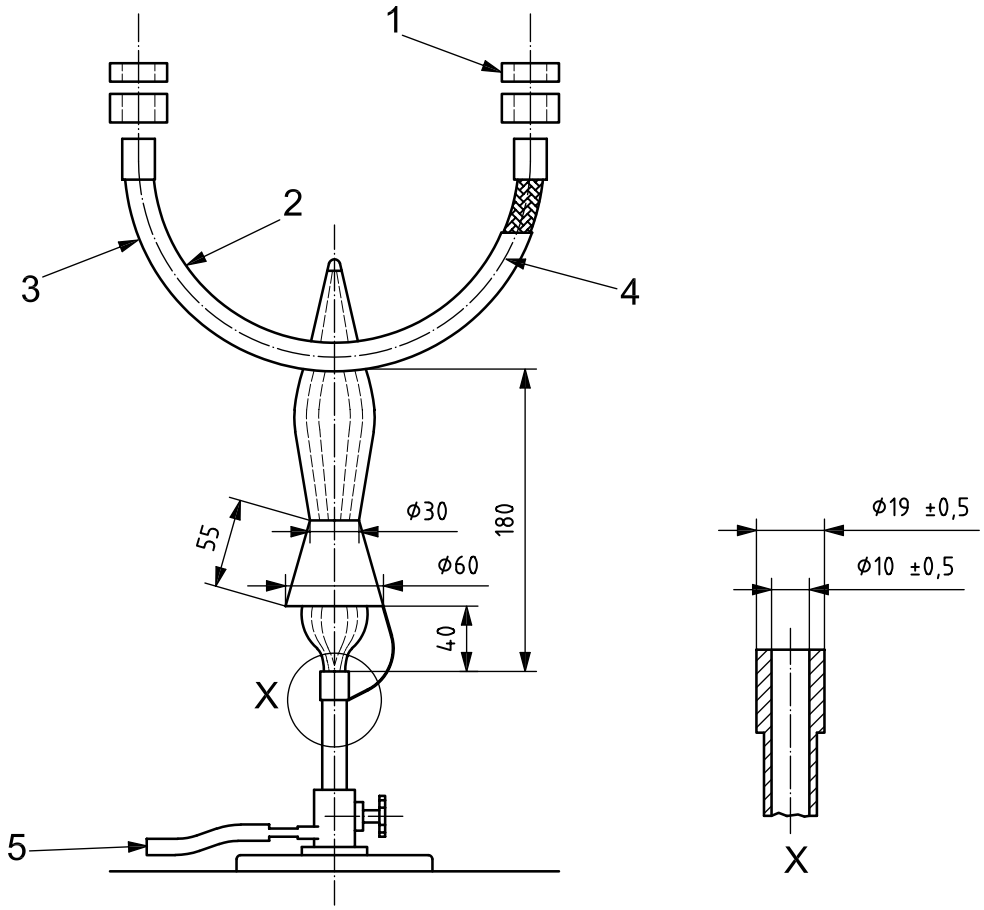
or

b) there is no glowing visible 2 min after removal of the burner flame.

On completion of the test, the hose test piece shall be impervious to liquids, as judged by visual examination.

The test may be carried out on a reference nominal bore hose, preferably 19 mm or 25 mm. The result is applicable to the reference size and larger diameters, provided the construction materials are the same for all of the sizes.

Dimensions in millimetres




**Key**

1 cap
2 bending radius = 10 to 15 times the outer hose diameter
3 hose assembly
4 hose filled with liquid F (or water)
5 propane (LPG) at approximately 50 kPa

**Figure I.1 — Arrangement for flammability test**

# Annex J
(normative)

# Hydrostatic tests

## J.1 Pressure tests on hose lengths and/or hose assemblies

### J.1.1 Working-pressure test

Raise the pressure in a test piece to 2,0 MPa (20 bar) at a rate of (0,04 ± 0,025) MPa/s [(0,4 ± 0,25) bar/s] and measure the variation in length when compared with the length at 0,07 MPa (0,7 bar) after maintaining the pressure for 5 min minimum.

### J.1.2 Proof-pressure test

Fill the hose with a test medium of either clean kerosene or clean water. The test medium shall be agreed between the purchaser and the manufacturer.

Subject a length of hose or a hose assembly to an internal proof pressure of 4,0 MPa (40 bar) built up at a rate of (0,04 ± 0,025) MPa/s [(0,4 ± 0,25) bar/s]. Maintain the proof pressure for 5 min, then reduce the pressure at the same rate to 0,3 MPa (3 bar), maintaining this pressure for a further 2 min. Remove the test medium completely from the hose.

For type B and type E hoses, test for electrical continuity as specified in 9.1.

For type C and type F hoses, determine the electrical resistance as specified in 9.2.

## J.2 Burst-pressure test on hose lengths

Cut a test piece approximately 1 m long from a hose and fit it in a suitable test rig so that the free length is at least 625 mm. Using water as the test medium, increase the hydrostatic pressure at a rate of (0,12 ± 0,05) MPa/s [(1,2 ± 0,5) bar/s] until the hose bursts. Record the pressure at burst.

# Annex K
(normative)

# Method of test for vacuum resistance

## K.1 General

The hose length as supplied shall be tested at (20 ± 5) °C no earlier than 24 h after manufacture.

## K.2 Types B and C only (all bore sizes)

Apply a vacuum equivalent to an absolute pressure of 50 kPa (0,5 bar) for 10 min. Examine the hose for structural damage. This test applies to all bore sizes.

## K.3 Types B and C only (bore sizes 19 to 63)

For bore sizes 19 to 63, inclusive, apply a vacuum equivalent to an absolute pressure of 85 kPa (0,85 bar) for 10 min. Measure the outside diameter before and during the test by means of a calliper gauge and calculate the loss in circularity.

## K.4 Type E only

Apply a vacuum equivalent to an absolute pressure of 15 kPa (0,15 bar) for 10 min and then pass a metal ball, of a diameter as specified in Table K.1, through the hose bore while maintaining the vacuum. Report whether the ball passes freely and examine the hose for visible structural damage.

## K.5 Type F only

Apply a vacuum equivalent to an absolute pressure of 35 kPa (0,35 bar) for 10 min. Continue the test as specified in Clause K.4.

**Table K.1 — Ball diameter for resistance to vacuum test**
(type E and type F only)

| Nominal bore | Ball diameter<br>mm |
|---|---|
| 19 | 15,00 |
| 25 | 21,60 |
| 32 | 25,00 |
| 38 | 31,75 |
| 50 | 41,27 |
| 63 | 50,00 |
| 75 | 63,50 |
| 76 | 63,50 |
| 100 | 88,90 |
| 101 | 88,90 |

# Annex L
(normative)

# Method of test for security of attachment of couplings

## L.1 Test piece

Use a test assembly, 1 m in length, consisting of hose and end couplings.

## L.2 Leakage check

Using water as the test medium, raise the internal pressure to 4,0 MPa (40 bar) and hold for 2 min.

Reduce the applied pressure to zero. Then increase the pressure to 1,0 MPa (10 bar), hold for 2 min and examine the test assembly for leakage. Reduce the applied pressure to zero.

Increase the pressure to 4,0 MPa (40 bar), hold for 2 min and examine the test assembly for leakage. Reduce the applied pressure to zero.

## L.3 Coupling attachment check

Raise the internal pressure to 8,0 MPa (80 bar) and hold for 5 min. The hose couplings shall remain attached to the hose under this pressure. Minor leakage or distortion is permitted.

# Annex M
(normative)

# Type testing and routine testing

Table M.1 gives the tests to be carried out for type testing and routine testing as defined in Clause 10.

**Table M.1 — Type tests and routine tests**

| Dimension/property under test | Type testing | Routine testing |
|---|---|---|
| **Compound tests** | | |
| Tensile strength and elongation at break | X | N.A. |
| Swelling in fuel | X | N.A. |
| Fuel-soluble matter | X | N.A. |
| Cold embrittlement | X | N.A. |
| Abrasion resistance | X | N.A. |
| Tensile strength and elongation after ageing | X | N.A. |
| **Hose tests** | | |
| Adhesion (dry) | X | N.A. |
| Adhesion (after contact with fuel) | X | N.A. |
| Fuel contamination | X | N.A. |
| Ozone resistance | X | N.A. |
| Flexibility (at 20 °C and –30 °C) | X | N.A. |
| Crush recovery (type F only) | X | N.A. |
| Cyclic kinking (types B and C only) | X | N.A. |
| Measurement of internal diameter | X | X |
| Measurement of thickness of lining and cover | X | X |
| Measurement of concentricity | X | X |
| Measurement of hose length | X | X |
| Measurement of mass per unit length | X | N.A. |
| Resistance to vacuum | X | X |
| Flammability | X | N.A. |
| Electrical properties | X | X |
| Change in length at maximum working pressure | X | N.A. |
| Proof pressure | X | X |
| Burst pressure | X | N.A. |
| **Hose assembly tests** | | |
| Security of attachment of couplings | X | N.A. |
| Electrical properties | X | X |
| Proof pressure | X | X |
| X = test carried out;<br>N.A. = not applicable. | | |

# Annex N
(informative)

# Recommended tests for production acceptance testing

Production acceptance tests are those tests carried out per batch or per 10 batches as indicated in Table N.1. A batch is defined as either 500 m of hose or 500 kg of lining and/or cover compound.

**Table N.1 — Recommended tests**

| Dimension/property under test | Production acceptance testing | |
|---|---|---|
| | Per batch | Per 10 batches |
| **Compound tests** | | |
| Tensile strength and elongation at break | X | N.A. |
| Swelling in fuel | X | N.A. |
| Fuel-soluble matter | X | N.A. |
| Cold embrittlement | N.A. | X |
| Abrasion resistance | N.A. | X |
| Tensile strength and elongation after ageing | N.A. | X |
| **Hose tests** | | |
| Adhesion (dry) | X | N.A. |
| Adhesion (after contact with fuel) | X | N.A. |
| Fuel contamination | N.A. | N.A. |
| Ozone resistance | N.A. | X |
| Flexibility (at 20 °C and −30 °C) | N.A. | X |
| Crush recovery (type F only) | N.A. | X |
| Cyclic kinking (types B and C only) | N.A. | X |
| Measurement of internal diameter | X | X |
| Measurement of thickness of lining and cover | X | X |
| Measurement of concentricity | N.A. | N.A. |
| Measurement of hose length | N.A. | N.A. |
| Measurement of mass per unit length | N.A. | X |
| Resistance to vacuum | X | X. |
| Flammability | N.A. | N.A. |
| Electrical properties | N.A. | N.A. |
| Change in length at maximum working pressure | N.A. | X |
| Proof pressure | N.A. | N.A. |
| Burst pressure | N.A. | X |
| **Hose assembly tests** | | |
| Security of attachment of couplings | N.A. | X |
| Electrical properties | N.A. | N.A. |
| Proof pressure | N.A. | N.A. |
| X = test carried out;<br>N.A. = not applicable | | |

# Annex O
(informative)

# Recommended practice for hose flushing and handling

## O.1 Flushing

Users should establish and perform an initial soak/flush procedure for each new hose assembly. Such a procedure typically entails circulating a minimum of 2,000 l of fuel through the hose assembly after allowing the fuel to stand in the hose for a minimum of 8 h at a minimum temperature of 15 °C.

The user should monitor local operating conditions and conduct a further flushing procedure if fuel left standing in the hose becomes discoloured.

## O.2 Handling

Aviation fuelling hose users should establish guidelines for hose handling that include the following precautions:

a) Ensure that the hose does not become snagged or wedged under equipment. The hose needs to be free to move when pressurized.

b) Keep the hose and the coupling outside surfaces free of oil.

c) Avoid excessive strain on the hose couplings. When manipulating the hose, pull on the hose, not on the coupling.

d) Avoid sharply bending or kinking the hose.

e) To minimize abrasion, carry the nozzle back to the fuelling vehicle before rewinding the hose on to the reel.

f) Maintain the reel in good operating condition.

g) Guide the hose on to the reel when rewinding.

## O.3 Inspection

Aviation fuelling hoses should be inspected as follows:

a) Visually inspect the hose daily during fuelling operations.

b) At least monthly, pull the hose out to full length in a clean and dry area. Pressurize the hose to normal operating pressure and then conduct an inspection. Pay particular attention to each hose/coupling interface. At zero pressure, determine if there are any “soft” spots which could indicate delamination. Examine couplings for signs of movement or slippage and tighten any fastenings if necessary.

c) Hydrostatically test the hose every 6 months to the maximum working pressure of 2,0 MPa (20 bar). Reduce the pressure to zero, then repressurize to 0,35 MPa (3,5 bar). Check the couplings as in b) above.

## O.4 Replacement

Fuelling hoses should be taken out of service when any of the following conditions are observed:

a) soft spots, bulges or blisters in the hose;

b) excessive abrasion, exposing the reinforcement;

c) cuts or cracks in the hose which expose the reinforcement.

NOTE The physical and chemical properties of the hose might gradually deteriorate, depending on storage and service conditions. Accordingly, a good practice is to specify a maximum hose life from the date of manufacture, for example 10 to 15 years.

## O.5 Recommended hose recoupling practice

Recoupling of hoses which have been used for aviation fuelling is allowed; however, all new aviation fuelling hoses should be coupled by the original manufacturer or a qualified distributor. When hoses are recoupled, the following should be observed:

a) the recoupling should be done by a qualified hose distributor or by a user company with a recoupling training programme;

b) the coupling should be marked with a durable label stating the coupler's name and the date of coupling, or otherwise be properly identified and documented;

c) the hose assembly should be tested at proof pressure [4,0 MPa (40 bar)] unless a lower pressure is specified by the user, in which case the maximum working pressure of 2,0 MPa (20 bar) is recommended as the minimum;

d) user companies should use a test fluid identical to or wholly compatible with that normally carried by the hose.

## O.6 Storage of hoses and hose assemblies

Hoses and hose assemblies should be stored in accordance with the guidelines given in ISO 2230.

# Bibliography

[1] EN 1361:2004, *Rubber hoses and hose assemblies for aviation fuel handling — Specification*

[2] API 1529, 6th edition (2005), *Aviation Fuelling Hose and Hose Assemblies*

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