INTERNATIONAL STANDARD

ISO 1825

Second 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 en carburant et la vidange des avions au sol — Spécifications

Reference number
ISO 1825:1996(E)

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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

This second edition cancels and replaces the first edition (ISO 1825:1975), which has been technically revised.

Annexes A to K form an integral part of this International Standard. Annexes L and M are for information only.

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

1 Scope

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

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 37:1994, *Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties.*

ISO 188:—[1], *Rubber, vulcanized - Accelerated ageing and heat-resistance tests.*

ISO 1382:1996, *Rubber - Vocabulary.*

ISO 1402:1994, *Rubber and plastics hoses and hose assemblies - Hydrostatic testing.*

ISO 1817:1985, *Rubber, vulcanized - Determination of the effect of liquids.*

ISO 2230:1973, *Vulcanized rubber - Guide to storage.*

ISO 4649:1985, *Rubber - Determination of abrasion resistance using a rotating cylindrical drum device.*

ISO 4671:1984, *Rubber and plastics hose and hose assemblies - Methods of measurement of dimensions.*

ISO 4672:—[2], *Rubber and plastics hoses - Subambient-temperature flexibility tests.*

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1) To be published. (Revision of ISO 188:1982)

2) To be published. (Revision of ISO 4672:1988)

ISO 6246:1995, *Petroleum products - Gum content of light and middle distillate fuels - Jet evaporation method.*

ISO 7326:1991, *Rubber and plastics hoses - Assessment of ozone resistance under static conditions.*

ISO 7989:1988, *Zinc coatings for steel wire.*

ISO 8031:1993, *Rubber and plastics hoses and hose assemblies - Determination of electrical resistance.*

ISO 8033:1991, *Rubber and plastics hose - Determination of adhesion between components.*

3 Definitions

For the purposes of this International Standard the definitions given in ISO 1382 apply, together with the following.

3.1 hose assembly: A hose with either permanent or reusable end fittings attached.

4 Types

4.1 Hoses shall be of one of the following six types:

a) type A, non-electrically bonded;

b) type B, electrically bonded;

c) type C, non-electrically bonded but incorporating an antistatic cover compound;

d) type D, non-electrically bonded but incorporating an antistatic cover compound and a low fuel contaminating inner lining;

e) type E, with enhanced defuelling capability (electrically conducting and incorporating a wire helix reinforcement);

f) type F, with enhanced defuelling capability (non-electrically conducting and incorporating a non-metallic helix reinforcement and an antistatic cover).

4.2 All six types of hose shall be designed for:

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

b) operation within the temperature range - 25 °C to + 55 °C and to be undamaged by climatic conditions of - 40 °C to + 70 °C;

c) operating at the pressures given in table 4.

NOTE 1 Hoses of types A, B, C and D are primarily intended for use as fuel delivery hose to aircraft and also for the bottom loading and off-loading of fuellers and tank trucks used in aviation product service where low hydrant pressures are encountered. They remain substantially circular in cross section when reeled on drums (see table 1), and should not be confused with hoses of the collapsible type, which are intended to be reeled flat.

NOTE 2 Hoses of types E and F contain an embedded helix reinforcement and are intended for normal fuelling duties but have an enhanced defuelling capability enabling high speed defuelling operations to be performed.

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

Table 1 - Service reeling diameters

Nominal internal diameter of hose	Minimum external diameter of reeling drum used in service
mm	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

5 Construction

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 contain a lining of rubber resistant to petroleum fuel of minimum thickness 1,6 mm at any point.

The hose shall contain a reinforcement of woven, braided or spirally wound textile material. The reinforcement layers shall be treated with a compound resistant to petroleum fuel.

The hose shall contain an outer cover with a minimum thickness at any point of 1,6 mm for hoses with internal diameters between 19 mm and 31,5 mm, and 2,0 mm for hoses with internal diameters of 38,0 mm and larger. This rubber cover shall be resistant to abrasion, outdoor exposure and petroleum fuel.

For types 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 to ISO 7989.

NOTE 3 The cover may have a shallow cloth marked finish.

NOTE 4 For type F hoses a non-metallic helix reinforcement of nylon 6 or nylon 6.6 monofilament has been found to be suitable.

6 Physical properties

The physical properties of the compounds used for the lining and cover shall be as given in table 2 when tested by the methods given therein.

The physical properties of the finished hose shall be as given in table 3 when tested by the methods given therein.

No test shall be carried out within 24 h of manufacture of the hose. Test pieces shall be conditioned at a temperature of 23 °C +- 5 °C, for at least 3 h before testing; this may be part of the 24 h after manufacture.

Table 2 - Requirements for rubber compounds

Property	Requirement		Method of test
	Lining	Cover	
Minimum tensile strength (in MPa)	7,0	7,0	ISO 37 (dumb-bell test pieces)
Minimum percentage elongation at break	250	300	ISO 37 (dumb-bell test pieces)
Maximum percentage swelling in fuel	50	75	ISO 1817 (48 h at 40 °C in liquid B)
Maximum percentage fuel-soluble matter	3,0	Not applicable	Annex A
Cold embrittlement	No cracking	No cracking	Annex B
*Abrasion resistance	Not applicable	140 mm^3	Method A of ISO 4649
Resistance to ageing	Change in tensile strength and elongation at break of lining and cover shall be not greater than +- 30 % of the original value		ISO 188 (7 days at 70 °C)

* Tests shall be carried out either on test pieces taken from the hose or from separately vulcanized sheets of rubber taken from production batches.

The recommended minimum frequency of testing is given in annex M.

Table 3 - Requirements for the finished hose

Property	Requirement	Method of test
Adhesion between components dry after contact with fuel	 2,0 N/mm width (min) 1,5 N/mm width (min)	Annex C
Resistance to fuel contamination (types A, B, C, E and F) (type D)	 10 mg (max) 2 mg (max)	Annex D
Ozone resistance at 40 °C +- 2 °C	No cracking observed under x 2 magnification	ISO 7326
Flexibility at 23 °C +- 5 °C	No permanent deformation or visible structural damage, no increase in electrical resistance and shall comply with the proof pressure requirements given in table 4 when measured at 23 °C +- 5 °C	Annex E
Flexibility at - 25 °C +- 3 °C	As for flexibility at 23 °C +- 5 °C	ISO 4672 Method B
Crush recovery (type F only) after 1 min after 10 min	 Regain 90 % of original diameter Regain 95 % of original diameter	Annex F
Kink resistance	A kinked hose is unacceptable	Annex G

7 Pressure requirements

When tested in accordance with annex H the maximum working pressure, proof pressure and minimum bursting pressure of the hoses shall be as given in table 4.

Table 4 - Pressure rating

Maximum working pressure*	Proof pressure	Minimum bursting pressure
MPa	MPa	MPa
2,0	4,0	8,0

* It is essential that the maximum pressure, including surge pressure to which the hose is subjected in service does not exceed the permissible maximum working pressure specified.

8 Dimensions and tolerances

8.1 Internal diameters and tolerances

When measured in accordance with ISO 4671 the internal diameters and tolerances shall be as given in table 5.

Table 5 - Diameters and tolerances

Internal diameter	Tolerance
mm	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

* This size has been included to cover metric mandrel sizes fully.

8.2 Thickness

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

8.3 Concentricity

The concentricity, based on a total indicator reading between the bore and the outside surface of the cover, determined in accordance with ISO 4671, shall be not more than 1,0 mm.

8.4 Tolerance on length

The tolerance on the measured length shall be +- 1 % of the specified length.

8.5 Mass per unit length of hose

The maximum mass per unit length shall be as given in table 6.

Table 6 - Mass per unit length of hose

Nominal internal diameter	Maximum mass per unit length of hose	
	A, B, C and D	E and F
mm	kg/m	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	-
101,5	6,5	-

9 Resistance to vacuum

9.1 The hose length, as supplied, shall be tested at 23 °C +- 5 °C no earlier than 24 h after manufacture.

9.2 All sizes of hose types A, B, C and D shall be capable of withstanding a vacuum of 0,015 MPa absolute for 10 min without suffering visible structural damage.

Hoses of sizes 19 mm to 63 mm inclusive shall also withstand a vacuum of 0,085 MPa absolute without loss of circularity exceeding 20 % of the internal diameter.

9.3 Hoses of type E shall withstand a vacuum of 0,015 MPa absolute for 10 min and hoses of type F a vacuum of 0,035 MPa absolute for 10 min. When tested in accordance with annex J both types of hose shall show no visible signs of structural damage.

10 Hose assemblies

10.1 Couplings

The dimensions of the couplings shall be compatible with the dimensions of the hose. The method of attachment of the couplings shall be such that the hose assembly complies with 10.2.

10.2 Test for security of coupling attachment

Hose assemblies shall withstand, without leakage or movement of the coupling out of the hose, the test described in annex K. There shall be no visible cuts or other damage to the hose lining.

11 Electrical bonding

11.1 General

During and after subjection to the hydrostatic pressure tests described in annex H, electrical continuity of each hose shall be maintained from end to end and electrical continuity of each hose assembly shall be maintained from one coupling to the other. In addition, the hose shall show no signs of leakage or other damage, including breakdown in electrical continuity of types B and E (see 11.2) or increase in electrical resistance above the specified limits of types C, D and F (see 11.3).

11.2 Types B and 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 types B and E hoses, the protruding length of bonding wire shall be folded into the hose bore, positioned between lining and fitting tail and extend along approximately half the length of the fitting

tail. If the hose is supplied without couplings, bonding wires shall protrude approximately 150 mm at each end of the hose.

NOTE 5 A suitable method of confirming electrical continuity is by 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.

11.3 Types C, D and F (non-electrically bonded incorporating an antistatic cover compound)

When tested in accordance with ISO 8031, the electrical resistance shall be between the following limits:

1×10^3 Ω/m to 1×10^6 Ω/m.

NOTE 6 For these hoses it is necessary to create a bond between the cover and the coupling.

NOTE 7 The conditioning parameters should be agreed between the manufacturer and the purchaser.

12 Cleanliness

The hose bore shall be thoroughly cleansed, flushed and dried before despatch.

13 Protection for despatch

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 works after testing is completed.

Recommendations for storage are given in annex L.

14 Marking

Each length of hose shall be legibly and permanently marked, at intervals of not more than 2 m on the outer cover, with the following information:

a) the number of this International Standard, and the hose type as suffix;

b) the manufacturer's name or identification;

c) the nominal bore of the hose;

d) the month and year of manufacture;

e) the maximum working pressure.

An example of the marking is as follows:

MN/ISO xxxx - C/63/04/-89/20.

Annex A (Normative) Method for determination of fuel-soluble matter

Take a sample from the lining of the hose and remove any extraneous fibres. Cut the sample into pieces approximately 3 mm square and extract 5 g +- 0,01 g of the comminuted sample with 100 cm^3 of liquid B, as specified in ISO 1817, in a glass flask for 96 h +- 2 h at 40 °C +- 1 °C. Take suitable precautions to prevent loss by evaporation.

While still hot, filter the contents into a pre-weighed hemispherical glass dish of suitable size. Wash both the residue in the flask and the filter with a further known quantity of the solvent mixture.

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 °C +- 3 °C.

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

NOTE 8 Precautions to avoid overheating during preparation of the sample are essential as any degradation of the polymer due to overheating is not estimable and could give a falsely high result.

Annex B (Normative) Method of test for cold embrittlement

The apparatus is shown in figure 1.

Place the test piece, 150 mm x 25 mm x 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.

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 °C +- 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 9 A temperature of -40 °C may be attained by using methanol or ethanol with crushed dry ice (solid carbon dioxide) and maintained by carefully adding further pieces of dry ice.

NOTE 10 If this determination is made on a sample of lining or cover taken from the hose, remove any adhering reinforcement fabric.

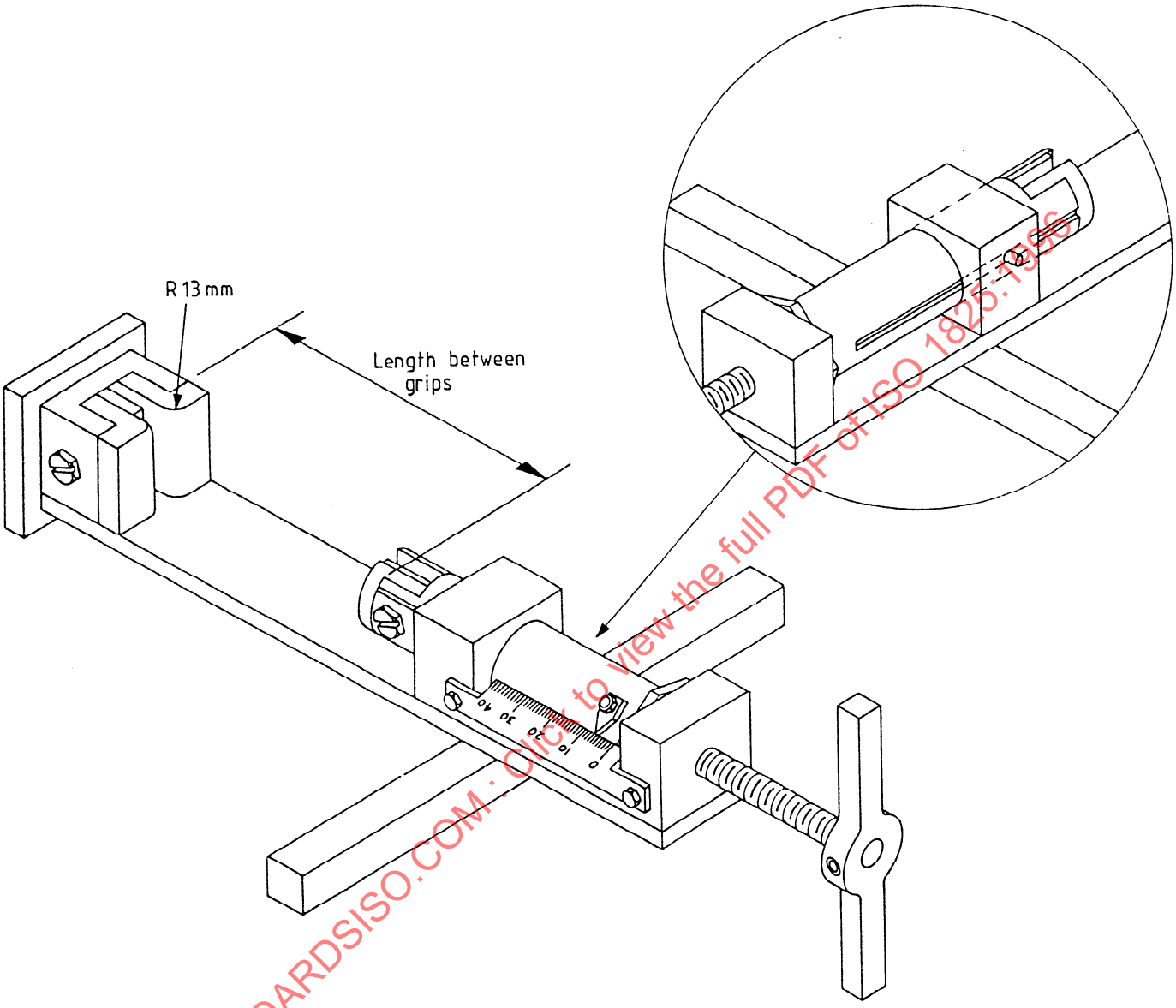

Figure 1 - Apparatus for cold embrittlement test

Annex C (Normative) Adhesion between components

C.1 Dry adhesion

Subject the hose to the adhesion test as described in ISO 8033 and determine the minimum value for adhesion:

a) between lining and reinforcement;

b) between reinforcement and cover; and

c) between reinforcement layers.

Samples for types E and F shall be cut parallel with the helix.

C.2 Adhesion after contact with fuel

Cut the sample of the hose to be tested approximately 300 mm in length and seal one end.

Fill the hose with liquid B as described in ISO 1817 and lightly cap the top.

Condition the sample at 23 °C +- 5 °C for 168 h +2,-0 h.

Determine the minimum adhesion between components as described in C.1.

Annex D (Normative) Fuel contamination test

D.1 Procedure

Take a suitable length of hose, not less than 300 mm, and stopper one end with a glass or metal plug. For types A, B, C, E and F hoses the bore shall be 76 mm. For type D hoses the bore shall be 31,5 mm. 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 examine in accordance with D.2, then refill the hose with fresh liquid. Repeat this procedure at daily intervals for a further 4 days. Refill the hose again and allow to stand for 3 days at 23 °C +- 5 °C. Visually examine the liquid taken from the hose after the final day in accordance with D.2 and test in accordance with D.3.

D.2 Visual examination

On removal from the hose the test liquid should appear clear, bright and free from suspended matter after each flushing. Note any change in colour of the test liquid. Carry out a "blank" determination of the residue on evaporation on a sample of the liquid B mixture, in accordance with D.3.

D.3 Fuel contamination (increase in residue on evaporation)

First determine the residue on evaporation of the "test" and "blank" samples in accordance with ISO 6246.

Report the increase in residue on evaporation from that of the blank sample as milligrams of residue per 100 cm^3 of test liquid, using a hose of bore 76 mm in the case of types A, B, C, E and F and a hose of bore 31,5 mm for type D.

When testing hoses having bores other than the reference bores quoted above, adjust the values obtained to give the final result in terms of the relevant reference bore. This is to compensate for the fact that the hose surface area/liquid volume ratio is different and allowance for this factor has to be made.

Calculate R_e, the 76 mm equivalent increase in residue (in mg/100 cm^3), from the equation:

$$R_e = RB \div 76$$

where

R is the measured increase in residue (in mg/100 cm^3);

B is the bore of the hose.

Annex E (Normative) Flexibility test at 23 °C

Coil an empty hose at 23 °C +- 5 °C around a test drum of external diameter given in table 7. Uncoil and check for visible structural damage and permanent deformation.

For types B and E measure the electrical continuity (see 11.2) and for types C, D and F measure the electrical resistance (see 11.3).

Table 7 - External diameter of drum for flexibility test at 23 °C

Nominal internal diameter of hose	Nominal external diameter of test drum
mm	mm
19,0	180
25,0	230
31,5	280
38,0	360
50,0	430
63,0	460
76,0	460
100,0	690
101,5	690

Annex F (Normative) Crush recovery test

F.1 General

This test is applicable to hoses that may be subjected to crushing forces in service.

F.2 Apparatus

F.2.1 General

The apparatus shall be as described in either F.2.2 or F.2.3.

F.2.2 Apparatus 1

F.2.2.1 *Compression testing machine*, capable of a rate of traverse of (50 +- 5) mm/min with a capacity adequate for the level of crushing force that may be specified.

F.2.2.2 *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.

F.2.3 Apparatus 2

F.2.3.1 *Tensile machine*, with a rate of traverse of (50 +- 5) mm/min with a capacity adequate for the level of crushing force that may be specified.

F.2.3.2 *Compression cage*.

F.2.3.3 *Two metal plates*, as described in F.2.2.2.

F.3 Test pieces

The test piece shall be a sample of hose of minimum length 500 mm

F.4 Conditioning of test pieces

No test shall be carried out within 24 h of manufacture of the hose. Test pieces shall be conditioned at a temperature of 23 °C +- 5 °C, for at least 3 h before testing; this may be part of the 24 h after manufacture.

F.5 Procedure

Measure the outside diameter of the test piece in accordance with the method described in ISO 4671.

Place the test piece between the two parallel plates (F.2.2.2) mounted in the test machine (either F.2.2.1 or F.2.3.1) 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 s +- 10 s.

Release the compressive force at a rate of (50 +- 5) mm/min.

Remeasure the minimum outside diameter at 1 min and at 10 min after the release of the compressive force.

Then subject the hose sample to the proof pressure test (see H.1)

Annex G (Normative) Kink resistance

Bend an empty hose at 23 °C +- 5 °C until an obvious kink is just formed.

Release the hose and allow to recover for 10 min +2 -0 min.

Visually examine the hose for permanent deformation or kinking.

Discard any kinked hose.

Annex H (Normative) Hydrostatic test

H.1 Pressure tests on hose lengths and/or hose assemblies

H.1.1 Working pressure test

Raise the pressure to the maximum working pressure as given in table 4 at a rate within the range 0,015 MPa/s to 0,065 MPa/s and measure the variation in length when compared with the length at 0,07 MPa. The maximum variation in length under test shall be 7 % of the original length for types A, B, C and D and 12 % for types E and F.

H.1.2 Proof pressure test

Subject each manufactured length of hose or hose assembly to an internal proof pressure as given in table 4, built up at a rate within the range 0,015 MPa/s to 0,065 MPa/s.

Maintain the proof pressure for 5 min, then reduce at the same rate to 0,3 MPa and maintain for a further 2 min.

The test medium shall be either clean kerosene or clean water. The test medium shall be completely removed from the hose after testing; in the case of types B and E the electrical continuity shall be retested (see 11.2) and in the case of types C, D and F the resistance shall be retested (see 11.3).

NOTE 11 The test medium should be agreed between the purchaser and the manufacturer.

H.1.3 Burst test

When tested in accordance with ISO 1402, a sample of hose shall meet the requirements specified in table 4.

Annex J (Normative) Vacuum resistance test

Insert into the hose a metal ball of the appropriate size given in table 8. Reduce the internal pressure of the hose to the test vacuum specified in 9.3. While the vacuum is maintained the metal ball shall pass freely from end to end through the hose. Examine the hose for any visible structural damage.

Table 8 - Ball diameter for resistance to vacuum test (types E and F only)

Hose bore	Ball diameter
mm	mm
19,0	15,00
25,0	21,60
31,5	25,00
38,0	31,75
50,0	41,27
63,0	50,00
76,0	63,50
100,0	88,90
101,5	88,90

Annex K (Normative) Security of coupling attachment test

K.1 Apparatus

K.1.1 *Test assembly*, consisting of hose and end couplings of 1 m in length.

K.2 Procedure

Using water as the test medium, raise the test pressure to stage 1 pressure as given in table 9 and hold for 2 min. Reduce the applied pressure to zero. Increase the pressure to stage 2 pressure as given in table 9, hold for 2 min and examine for leakage. Reduce the applied pressure to zero.

Increase the pressure to stage 3 pressure as given in table 9, hold for 2 min and examine for leakage. Reduce the applied pressure to zero.

Table 9 - Test pressures for security of coupling attachment test

Test pressure		
Stage 1	Stage 2	Stage 3
MPa	MPa	MPa
4,0	1,0	4,0