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BSI Standards Publication

Rubber and plastics hoses and hose assemblies — Non-bonded fluoroplastic lined (e.g. PTFE) hoses and hose assemblies for liquid and gaseous chemicals — Specification

bsi.

National foreword

This British Standard is the UK implementation of EN 16643:2016.

The UK participation in its preparation was entrusted to Technical Committee PRI/66, Rubber and plastics tubing, hoses and hose assemblies.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Rubber and plastics hoses and hose assemblies - Non-bonded fluoroplastic lined (e.g. PTFE) hoses and hose assemblies for liquid and gaseous chemicals - Specification

Tuyaux et flexibles en caoutchouc et en matières plastiques - Tuyaux non-liés revêtus de fluoroplastique (par exemple PTFE) pour substances chimiques liquides ou gazeuses - Spécifications

Gummi- und Kunststoffschläuche und -schlauchleitungen - Fluorkunststoffbeschichtete (z. B. PTFE) Nicht-Verbundschläuche und -schlauchleitungen für flüssige und gasförmige Chemikalien - Anforderungen

This European Standard was approved by CEN on 15 June 2016.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

Tables

Figures

European foreword

This document (EN 16643:2016) has been prepared by Technical Committee CEN/TC 218 “Rubber and plastics hoses and hose assemblies”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2017, and conflicting national standards shall be withdrawn at the latest by February 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Annexes A, C, E, F, I and J are normative. Annexes B, D, G, H and K are informative.

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Introduction

This document has been prepared to provide minimum acceptable requirements for the satisfactory performance of non-bonded flexible fluoroplastic lined hoses and hose assemblies with various types of reinforcement, for each chemical substance conveyed.

1 Scope

This European Standard specifies requirements for three types of non-bonded fluoroplastic lined hoses and hose assemblies with convoluted or smooth linings designed to convey liquid or gaseous chemical substances, hereinafter termed the "chemicals conveyed". These hoses and hose assemblies can be used for pharmaceutical, biotechnology and industrial applications as detailed in Clause 5.

The hose assemblies are intended for use with chemicals conveyed in the temperature range of −70°C to +260°C and for a working pressure up to 205 bar[1)].

NOTE 1 This standard sets out requirements for these hoses and hose assemblies to ensure that users are not exposed to danger from fire or explosion and that the environment is protected against contamination or damage.

NOTE 2 Other working pressures than those given above can be agreed with the manufacturer provided the physical properties of the hose assembly materials conform to Clause 8, the hose and hose assembly performance requirements conform to Clause 9 and the hose assembly electrical properties conform to Clause 10.

NOTE 3 Other diameters than those given in this standard can be agreed with the manufacturer provided the physical properties of the hose assembly materials conform to Clause 8, the hose and hose assembly performance requirements conform to Clause 9 and the hose assembly electrical properties conform to Clause 10.

NOTE 4 This standard also provides guidance on the storage of hose assemblies (Clause 15).

NOTE 5 The attention of users is drawn to Annex G concerning the working temperature range which can be affected by the chemical(s) to be conveyed in the hoses and hose assemblies.

NOTE 6 The attention of users is drawn to Annex G concerning the selection of materials for lining, helix wire (if applicable), electrical bonding wire (if applicable), braid reinforcement and cover (if applicable) related to the chemical(s) to be conveyed by the hoses and hose assemblies.

2 Normative References

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10088-3:2014, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

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

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

EN ISO 7233, *Rubber and plastics hoses and hose assemblies — Determination of resistance to vacuum (ISO 7233)*

EN ISO 8031:2009, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity (ISO 8031:2009)*

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

1) 1 bar = 0,1 MPa.

EN ISO 10619-1, *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness — Part 1: Bending tests at ambient temperature (ISO 10619-1)*

EN ISO 12086-2, *Plastics — Fluoropolymer dispersions and moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties (ISO 12086-2)*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

3 Terms and definitions

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

NOTE In this document the word "fitting" has been used; this is, in some cases, interchangeable with the word "coupling".

3.1
non-bonded
hose construction where different layers in the hose wall (e.g. lining, braid reinforcement and cover) are not chemically bonded together

3.2
Grade I
hose assembly constructed so that it is electrically insulating e.g. $>10^8$ Ω per assembly between end fittings, AND $>10^8$ Ω between lining and end fittings AND $>10^8$ Ω between cover and end fittings

4 Classification

Hoses and hose assemblies for this application shall be divided into three types according to how the hose fluoroplastic lining is constructed/formed:

— Type SE smoothbore (externally smooth): the hose lining is internally and externally smooth (parallel) in this document referred to as Smoothbore (externally smooth).

— Type SC smoothbore (externally convoluted): the hose lining is internally smooth and externally convoluted in this document referred to as Smoothbore (externally convoluted).

— Type C convoluted or corrugated: hose lining is internally and externally convoluted with the convolution running helically to the lining axis.

Hoses and hose assemblies for this application shall be divided into eight grades:

— Grade I: electrically insulated (no electrical bonding AND no static-dissipative layers),

— Grade M: electrically bonded without static-dissipative lining or cover,

— Grade Ω-L: static-dissipative lining without electrical bonding,

— Grade Ω-C: static-dissipative cover without electrical bonding,

— Grade Ω-CL: static-dissipative cover and lining without electrical bonding,

— Grade M/Ω-L: electrically bonded and static-dissipative lining,

— Grade M/Ω-C: electrically bonded and static-dissipative cover,

— Grade M/Ω-CL: electrically bonded and static-dissipative cover and lining.

5 Hose assembly designs

Hose assemblies are designed as follows:

— design A Conformity to the demands of pharmaceutical and biotechnological industry of all hose assembly components,

— design B Conformity to the demands of pharmaceutical and biotechnological industry of all parts of the hose assembly in contact with the product,

— design C for industrial purposes only.

6 Materials and construction

6.1 General

All types of hoses covered by this standard shall consist of a fluoroplastic (e.g. PTFE) lining with an over-braided reinforcement. Optionally a helix wire may be incorporated between the lining and braid reinforcement if the lining construction permits e.g. linings with external convolutions. Where electrical bonding is required between metallic end fittings in conjunction with no helix wire and plastic braid reinforcement, separate electrical bonding wires may be used situated between the lining and braid reinforcement. Optionally a cover or some other type of outer layer may be added to protect the over-braided reinforcement.

6.2 Lining

The lining shall be uniform in quality and form and shall be free from porosity, holes, foreign inclusions and other defects which would impair the expected use.

In circumstances where a hose lining can become electro-statically charged, a static-dissipative lining shall be used.

6.3 Helix wire (optional)

Any helix wire (if applicable) shall be wrapped around the outside of the fluoroplastic lining to prevent contact with the medium conveyed within the hose.

6.4 Electrical bonding wires (optional)

Any electrical bonding wires (if applicable) shall be wrapped around the outside of the fluoroplastic lining to prevent contact with the medium conveyed within the hose. See 10.2 b.

6.5 Braid reinforcement

The reinforcement shall consist of an over-braid of suitable metallic or non-metallic materials. Multiple layers of reinforcement may be used including combinations of separate metallic and non-metallic layers.

NOTE In low pressure applications Tube Only (TO) assemblies could be used. Consult assembly manufacturer for details.

6.6 Cover (optional)

The cover (if applicable) can be a solid flexible outer layer (pricked or non-pricked) or spirally wrapped wire or spirally wrapped plastic strip and shall be designed to withstand mechanical damage. For

resistance to environmental effects due to weather and short-term external chemical exposure a solid flexible outer cover should be used.

In circumstances where a hose cover can become electro-statically charged, a static-dissipative cover shall be used.

7 Dimensions and tolerances

7.1 Diameters, thickness, bend radii, resistance to vacuum and lowest permitted maximum working pressure requirements

The inside and minimum outside diameters of hoses, minimum thickness of lining, minimum thickness of cover (where applicable), minimum bend radius and resistance to vacuum (capability to withstand an internal vacuum without damage as specified in Table 9) shall conform to the values given in Table 1, Table 3, Table 5 or Table 6 (depending on lining type). Minimum bend radius shall be equal to or less than the values given in Table 1, Table 3, Table 5 or Table 6 (depending on lining type). Maximum working pressures (MWP's) shall be equal to or greater than the values given in Table 2, Table 4 or Table 7 (depending on lining type).

Type C hoses may exhibit differences in flow rate and flexibility for a given nominal bore size and these differences are primarily influenced by inside diameter and shape of the convolutions. To provide scope for manufacturers to tailor flexibility and flow rates for a given nominal bore size Tables for two forms of Type C hose are provided in Tables 5 and 6, which are referred to as manufacturing methods 1 and 2 respectively. These manufacturing methods could be proprietary and therefore are not described or specified within this standard. To obtain specific flow rate and flexibility data the hose manufacturer should be consulted.

Table 1 — Dimension requirements, Type SE lining hoses without and with cover

Nominal bore	Inside diameter mm	Tolerance mm	Outer Layer	Minimum thickness mm		Outside[a] diameter mm min.	Bend radius mm min.	Resistance[b] to vacuum bar
				lining	cover			
3,2	3,1	±0,1	Braid	0,6	-	5,3	40	−0,9
			Cover		0,4	6,1		
5	4,7	±0,2	Braid	0,6	-	7	60	
			Cover		0,4	7,8		
6,3	6,3	±0,4	Braid	0,6	-	8,4	80	
			Cover		0,5	9,4		
8	8	±0,6	Braid	0,6	-	10	100	
			Cover		0,5	11		
10	10	±0,9	Braid	0,6	-	11,7	130	
			Cover		0,6	12,9		
13	13	±1,1	Braid	0,7	-	14,8	170	
			Cover		0,6	16		
16	16	±1,1	Braid	0,7	-	18	200	
			Cover		0,8	19,6		
19	19	±1,2	Braid	0,7	-	21,1	230	
			Cover		0,8	22,7		
25	25	±1,2	Braid	0,9	-	27,6	320	
			Cover		0,8	29,2		

[a] Minimum outside diameter assumes one layer of stainless steel braid reinforcement and minimum lining thickness shown, with and without cover. For other braid reinforcement materials and/or multiple braid reinforcement layers and/or thicker lining consult hose manufacturer for outside diameter and tolerances.

[b] Ability to withstand the internal vacuum specified and shall conform to the requirements specified in Table 9. For resistance to vacuum at higher temperatures consult hose manufacturer.

Table 2 — Maximum working pressure requirements, Type SE lining hoses without and with cover for two typical braid reinforcements

Nominal bore	Maximum working pressure[a]	
	Stainless steel braid bar	Aramid braid bar
3,2	205	150
5	190	135
6,3	170	120
8	150	105
10	130	90
13	100	70
16	80	55
19	60	40
25	35	25

[a] Assumes one layer of braid reinforcement. For other braid reinforcement materials or multiple braid reinforcement layers consult hose manufacturer for maximum working pressure.

Table 3 — Dimension requirements, Type SC lining hoses without and with cover

Nominal bore	Inside diameter mm	Tolerance mm	Outer Layer	Minimum thickness mm		Outside[b] diameter mm min.	Bend radius mm min.	Resistance[c] to vacuum bar
				lining[a]	cover			
6,3	6,6	±0,4	Braid	0,9	-	9,1	19	−0,9
			Cover		0,7	10,5		
8	7,8		Braid	0,9	-	10,2	19	
			Cover		0,7	11,6		
10	9,7	±0,5	Braid	1,0	-	12,6	25	
			Cover		1,1	14,8		
13	13,1	±0,7	Braid	1,2	-	16,4	60	
			Cover		1,1	18,6		
16	16,2		Braid	1,6	-	20,3	60	
			Cover		1,4	23,1		
19	19,3		Braid	1,6	-	23,8	60	
			Cover		1,4	26,2		
22	22,1		Braid	1,7	-	27,5	60	
			Cover		1,6	30,7		
25	25,7		Braid	1,7	-	30,8	100	
			Cover		1,6	34,0		
32	32,2		Braid	2,2	-	38,0	135	
			Cover		1,6	41,2		
35	34,8		Braid	2,4	-	42,3	135	
			Cover		2,0	46,3		
38	38,5	±0,8	Braid	2,6	-	46,2	170	
			Cover		2,0	50,2		
48	47,4		Braid	3,1	-	56,4	190	
			Cover		2,0	60,4		
50	51,1	±0,9	Braid	3,3	-	60,3	210	
			Cover		2,0	64,3		

[a] Lining thickness is measured from inside smooth bore of lining to outside diameter of convolutions. Lining thickness between external convolutions will be less than that shown above.

[b] Minimum outside diameter assumes one layer of stainless steel braid reinforcement and minimum lining thickness shown, with and without cover. For other braid reinforcement materials and/or multiple braid reinforcement layers and/or thicker lining consult hose manufacturer for outside diameter and tolerances.

[c] Ability to withstand the internal vacuum specified and shall conform to the requirements specified in Table 9. For resistance to vacuum at higher temperatures consult hose manufacturer.

Table 4 — Maximum working pressure requirements, Type SC lining hoses without and with cover for three typical braid reinforcements

Nominal bore	Maximum working pressure[a]		
	Stainless steel braid bar	Polypropylene braid bar	Aramid braid bar
6,3	63	31	50
8	58	29	45
10	54	27	40
13	48	24	35
16	44	22	35
19	41	20	30
22	39	19	30
25	37	18	25
32	34	17	25
35	33	16	23
38	32	16	20
48	29	14	16
50	28	14	16

[a] Assumes one layer of braid reinforcement. For other braid reinforcement materials or multiple braid reinforcement layers consult hose manufacturer for maximum working pressure.

Table 5 — Dimension requirements for manufacturing method 1, Type C lining hoses without and with cover

Nominal bore	Inside[a] diameter mm	Tolerance mm	Outer Layer	Minimum thickness mm		Outside[b] diameter mm min.	Bend radius mm min.	Resistance[c] to vacuum bar
				Lining	cover			
6,3	6,5	±2	Braid	0,6	-	10,9	20	
			Cover		0,7	12,4	30	
10	9,7		Braid	0,6	-	11,7	25	
			Cover		1,1	13,9	40	
12	12,1		Braid	0,6	-	14,9	40	
			Cover		1,1	17,1	60	
15	15,1	±2,6	Braid	0,7	-	19,6	50	
			Cover		1,4	22,4	70	
19	18,3		Braid	0,7	-	21,9	55	
			Cover		1,4	24,7	80	
21	21,3		Braid	0,7	-	26,0	65	
			Cover		1,6	29,2	95	
25	24,3		Braid	0,9	-	30,0	70	
			Cover		1,6	33,2	105	
30	29,8		Braid	0,9	-	34,6	85	
			Cover		1,6	38,0	125	
32	32,1		Braid	0,9	-	36,8	85	−0,9
			Cover		1,6	40,0	125	
34	34,0		Braid	1,1	-	41,5	115	
		±3	Cover		1,8	45,5	150	
38	38,0		Braid	1,1	-	43,5	120	
			Cover		2,0	47,5	160	
45	44,5		Braid	1,1	-	53,3	140	
			Cover		2,0	57,3	210	
50	50,0		Braid	1,2	-	57,5	140	
			Cover		2,0	61,5	210	
54	53,5		Braid	1,2	-	63,0	180	
			Cover		2,0	67,0	270	
63	63,0		Braid	1,5	-	73,0	230	
			Cover		2,2	77,4	345	
75	75,0	±3,5	Braid	1,6	-	86,0	260	
			Cover		2,4	90,8	350	
98	98,0		Braid	1,8	-	117,0	400	
			Cover		2,4	121,8	500	

130	130,0		Braid	2,2	-	150,0	600	
			Cover		2,4	154,8	900	
150	150,0		Braid	2,5	-	170,0	600	
			Cover		2,4	174,8	900	

a Bore inside convolutions.

b Minimum outside diameter assumes one layer of stainless steel braid reinforcement and minimum lining thickness shown, with and without cover. For other braid reinforcement materials and/or multiple braid reinforcement layers and/or thicker lining consult hose manufacturer for outside diameter and tolerances.

c Ability to withstand the internal vacuum specified and shall conform to the requirements specified in Table 9. For resistance to vacuum at higher temperatures consult hose manufacturer.

Table 6 — Dimension requirements for manufacturing method 2, Type C lining hoses without and with cover

Nominal bore	Inside[a] diameter mm	Tolerance mm	Outer Layer	Minimum thickness mm		Outside[b] diameter mm min.	Bend radius mm min.	Resistance[c] to vacuum bar
				Lining	cover			
10	6,3	±2	Braid	0,6	-	11,5	25	−0,9
			Cover		0,7	12,9	40	
12	9,5		Braid	0,6	-	15,0	40	
			Cover		1,1	17,2	60	
15	11,2		Braid	0,7	-	17,5	50	
			Cover		1,4	20,3	70	
19	15,0		Braid	0,7	-	21,0	55	
			Cover		1,4	23,8	80	
20	15,7	±2,6	Braid	0,7	-	21,9	55	
			Cover		1,4	24,7	80	
25	21,5	±3	Braid	0,9	-	28,8	70	
			Cover		1,6	32,0	105	
32	27,5		Braid	0,9	-	36,0	85	
			Cover		1,6	39,2	125	
38	30,0		Braid	1,1	-	41,5	120	
			Cover		1,6	44,7	160	
40	31,8		Braid	1,1	-	43,5	120	
			Cover		2,0	47,5	160	
50	43,0		Braid	1,2	-	55,0	140	
			Cover		2,0	59,0	210	
63	51,8	±3,5	Braid	1,5	-	69,0	230	
			Cover		2,2	73,4	345	
65	53,8		Braid	1,5	-	71,0	230	
			Cover		2,2	75,4	345	
75	59,0		Braid	1,6	-	82,0	260	

			Cover		2,4	86,8	350	
80	64,0		Braid	1,6	-	85,0	260	
			Cover		2,4	89,4	350	
100	98,0		Braid	1,8	-	108,0	400	
			Cover		2,4	112,4	500	
130	110,0		Braid	2,2	-	128,0	600	
			Cover		2,4	132,8	900	
150	130,0		Braid	2,5	-	148,5	600	
			Cover		2,4	153,3	900	

[a] Bore inside convolutions.

[b] Minimum outside diameter assumes one layer of stainless steel braid reinforcement and minimum lining thickness shown, with and without cover. For other braid reinforcement materials and/or multiple braid reinforcement layers and/or thicker lining consult hose manufacturer for outside diameter and tolerances.

[c] Ability to withstand the internal vacuum specified and shall conform to the requirements specified in Table 9. For resistance to vacuum at higher temperatures consult hose manufacturer.

Table 7 — Maximum working pressure requirements, Type C lining hoses without and with cover for three typical braid reinforcements

Nominal bore	Maximum working pressure[a]		
	Stainless steel braid bar	Polypropylene braid bar	Aramid braid bar
6,3	58	29	50
10	57	28	45
12	45	22	40
15	37	18	35
19	32	16	32
20	32	16	32
21	28	14	24
25	25	12	20
30	21	10	16
32	21	10	16
34	18	9	16
38	18	9	16
40	17	8	15
45	14	7	10

50	14	7	10
54	11	5	10
63	9	4	8
65	9	4	8
75	9	4	8
80	9	4	8
98	7	3	6
100	7	3	6
130	5	2	-
150	5	2	-

a Assumes one layer of braid reinforcement. For other braid reinforcement materials or multiple braid reinforcement layers consult hose manufacturer for maximum working pressure.

7.2 Concentricity

When determined in accordance with EN ISO 4671, the concentricity, based on a total indicator reading between the internal diameter and the outside surface of the various layers (e.g. lining, braid reinforcement, cover) or complete hose, shall be ≤ 10 % of average wall thickness.

7.3 Length of hose assemblies

7.3.1 General

The length of the hose assembly shall be the intended installed length measured from sealing surfaces of the end fittings.

NOTE Unlike rubber hose assemblies, fluoropolymer hose assemblies can be difficult to stretch if shorter than the intended installed length.

7.3.2 Type SE and Type SC hose assemblies

For all hose assembly lengths the tolerance shall be "(+2/-0)%"

If closer tolerances are required consult with hose assembly manufacturer.

7.3.3 Type C hose assemblies

For all hose assembly lengths the tolerance shall be "(+5/-0)%"

If closer tolerances are required, consult with hose assembly manufacturer.

8 Physical properties of materials used for hoses and hose assemblies

8.1 General

The physical properties of the fluoroplastic lining shall conform to the values given in Table 8, when tested in accordance with the methods listed in Table 8. For Type SE linings, tests shall be carried out on

samples taken from the finished hose lining. For convoluted linings, tests can be carried out on samples taken from lining tube prior to forming convolutions providing the convoluting process does not substantially change the lining materials physical properties. For fluoroplastic linings with a nominal bore too small to cut a suitable microtensile test specimen, a parallel sided test specimen may be used to measure tensile yield stress in the longitudinal and circumferential directions.

Table 8 — Physical properties of fluoroplastic lining

Property	Unit	Requirement	Direction	Test Method
Tensile yield stress min.	MPa	12,0	Longitudinal[a]	EN ISO 12086-2 (microtensile test pieces)
		9,0	Circumferential[b]	
Tensile strength min.	MPa	28	Longitudinal[a]	EN ISO 12086-2 (microtensile test pieces)
		20	Circumferential[b]	
Elongation at break min.	%	200	Longitudinal[a]	EN ISO 12086-2 (microtensile test pieces)
		325	Circumferential[b]	

[a] Microtensile longitudinal test pieces cannot be cut from fluoroplastic linings with a nominal bore < 5 mm

[b] Microtensile circumferential test pieces cannot be cut from fluoroplastic linings with a nominal bore < 12,5 mm

8.2 Materials used for the lining

The lining shall be made from the following materials capable of use at temperatures up to 260 °C:

— PTFE, PFA, FEP

NOTE The nature of some chemicals could limit the maximum temperature of use to less than 260 °C.

When a static-dissipative lining is required, high purity carbon black shall be incorporated into either an inner co-extruded layer of the lining or in the whole lining. The amount of high purity carbon black added shall be less than 2,5 % (EC Directive 2007/19/EC) and shall be carefully distributed within the lining ensuring no carbon agglomerates, lumps, blisters or other defects are formed which would impair the expected use.

8.3 Materials used for the helix wire

The helix shall consist of stainless steel wire, in accordance with EN 10088-3:2014 steel numbers X2CrNi19-11, X5CrNiMo17-12-2, X2CrNiMo17-12-2 or X3CrNiMo17-13-3.

8.4 Materials used for the electrical bonding wires

The electrical bonding wires shall consist of NiCu30 or a similar low electrical resistance, corrosion resistant material.

8.5 Materials used for the over-braid reinforcement

Metallic over-braid reinforcement shall consist of stainless steel wire, in accordance with EN 10088-3:2014, steel numbers X2CrNi19-11, X5CrNiMo17-12-2, X2CrNiMo17-12-2 or X3CrNiMo17-13-3.

Plastic over-braid reinforcement shall consist of Polypropylene, Polyvinylidene Fluoride or Aramid fibres. For other over-braid reinforcement plastic materials consult with the hose manufacturer.

NOTE The use of most plastic over-braid reinforcements will reduce the working temperature range of the hose. Consult with hose manufacturer for actual working temperature range of hose.

8.6 Materials used for the cover

Flexible plastic and elastomeric materials may be used as an outer cover including EPDM, CR, Silicone, PVC, Polyamides, Thermoplastic Polyester Elastomers and Thermoplastic Olefinic Elastomers. For other cover materials consult with the hose manufacturer. When required, the cover shall be flame resistant. The cover may be pricked providing the over-braid reinforcement and lining are not damaged.

Alternatively spiral wound wire or spiral wound flexible plastic strip hose protectors may, when required, be used in place of a solid flexible cover.

When a static-dissipative cover or static-dissipative plastic strip hose protector is required, carbon black shall be incorporated into the cover or plastic hose protector material.

NOTE The use of a flexible plastic or elastomeric cover will reduce the working temperature range of the hose. Consult with hose manufacturer for actual working temperature range of hose.

8.7 Materials used for end fittings and couplings

The material of end fittings and couplings, either metal or plastic, shall be chemically resistant to the chemicals conveyed. Wetted parts of metallic end fittings and couplings in contact with the transported products shall be protected by a fluoroplastic lining if required.

Parts in contact with the product shall not be made of cast material. Cast materials are allowed if appropriately protected from contact with media conveyed through the hose.

NOTE The use of plastic end fittings or couplings will reduce the working temperature range of the hose assembly. Some types of metallic and plastic end fitting or couplings will reduce the maximum working pressure of the hose assembly below that of the hose. Consult with hose manufacturer for actual working temperature range and actual maximum working pressure of hose assembly.

9 Performance requirements of hoses and hose assemblies

The physical properties of the finished hose and hose assemblies shall conform to the values given in Table 9, when tested in accordance with the appropriate methods given in Table 9. Testing is to be carried out at a standard laboratory temperature of 23°C (+2/-1)°C unless specified otherwise in the test method.

Table 9 — Performance requirements of hoses and hose assemblies

Property	Unit	Requirement	Test method
Yield orientation index (PTFE lining)	—	≤ 0,25 (standard sintering) ≤ 0,1 (high quality sintering)	Annex E
Weep pressure (PTFE lining)	%	≥ 60 (standard sintering) ≥ 70 (high quality sintering)	Annex F
Proof test pressure (Fluoroplastic lining)	—	No leakage or other signs of weakness at 75 % of theoretical burst pressure	Annex C
Burst pressure[a]	—	Minimum four times the maximum working pressure	EN ISO 1402
Proof test pressure (Hose assembly)	—	No leakage or other signs of weakness at 1,5 × the working pressure	EN ISO 1402
Change in length at proof test pressure at −0,9 bar vacuum	%	Maximum allowed All Types 0 to +10 All Types 0 to −10	EN ISO 1402
Twist at proof test pressure	°/m	Maximum allowed 8	EN ISO 1402
Resistance to vacuum, According to Tables 1, 3, 5 and 6 for 10 min	—	No failure and no collapse of hose or lining	EN ISO 7233
Flame resistance (Not applicable where plastic braid reinforcement forms the outer layer of the hose)	—	a) Burning with a naked flame to cease within 20 s of removal of the burner; b) no further glowing visible 2 min after removal of the burner; c) hose shall show no sign of leakage	Annex I
Electrical properties	Ω	> 10^8/assembly-I-grade < 10^2/assembly-M-grade 10^3 to 10^8[b] /assembly all Ω-grades	EN ISO 8031:2009 Clause 6 EN ISO 8031:2009 Clause 4 EN ISO 8031:2009 Clause 7
Bending test At minimum bend radius with atmospheric internal pressure, deformation of the external hose diameter (T/D)	%	< 10	EN ISO 10619-1 Method A1
Hose flexibility (Rolling U test)	cycles	≥ 100 000	Annex J

[a] Burst pressure is affected by the temperature of the chemical(s) conveyed for example at temperatures above 130 °C the burst pressure (and consequently the maximum working pressure) of PTFE lined hoses will reduce. Consult with hose manufacturer for changes to hose burst pressure and maximum working pressure at high temperatures.

[b] An upper limit of 10^8 Ω/assembly is acceptable in the majority of circumstances but should be avoided in the unusual circumstance of using a hose immediately downstream of a high charging device (such as a high throughput fine filter) that may generate a medium charging current of more than 10 µA and should also be avoided in the unlikely circumstance that a medium passing through the hose may generate a hose charging current of more than 10 µA. In either of these circumstances an upper limit of 10^6 Ω/assembly should be used. See IEC/TS 60079–32–1 for more information.

NOTE If an end user requires Type SC hose or hose assemblies to meet a permeation requirement see Annex H for test method and required average helium permeation rates as outlined in Table H.1.

10 Electrical properties

10.1 General

Because of the large number of combinations of metallic and non-metallic, conducting and non-conducting materials and optional layers that can be used to manufacture these hose types, electrical type testing shall be carried out with at least one end fitting or coupling attached to the hose under test. In some cases, e.g. testing of electrical bonding, end fittings or couplings will be required at both ends of the hose (a hose assembly).

10.2 Electrical bonding

Electrical bonding of hose assemblies shall be obtained by incorporating metallic materials with low electrical resistance in the hose construction e.g. metallic end fittings or couplings with at least one of the following:-

a) **Metallic helix wire** - When attaching end fittings or couplings to this type of hose a permanent electrical connection between the end fittings and helix wire shall be made.

b) **Electrical bonding wires** – These shall be used in the absence of a metallic helix wire and metallic over-braid reinforcement by incorporating two low resistance wires between the lining and non-metallic over-braid reinforcement. These wires shall be spirally applied in opposite directions and shall be positioned in such a way as to cross uniformly. When attaching end fittings or couplings to this type of hose a permanent electrical connection between the end fittings shall be made. See 8.4.

c) **Metallic over-braid reinforcement** - When attaching end fittings or couplings to this type of hose a permanent electrical connection between the end fittings or couplings and metallic over-braid reinforcement wire shall be made.

When electrical bonding is not required, a non-metallic over-braid reinforcement may be used and, if a helix wire is present, the helix wire ends shall be insulated from both end fittings or couplings providing this does not leave a section of the lining unsupported or leave sharp wire ends taped to the lining which could puncture the lining when in service.

10.3 Static-dissipative lining and/or static-dissipative cover

When attaching end fittings or couplings to this type of hose a permanent electrical connection between the end fittings or couplings, lining and/or cover shall be made.

11 Frequency of testing

The minimum frequency of testing shall conform to the schedule given in Annex A (normative).

Type tests are tests to verify that the hose or hose assembly conforms to all requirements of this European Standard.

Routine tests are tests carried out on each length of finished hose prior to warehousing or sale.

Production acceptance tests are those tests carried out per length of fluoroplastic lining, hose or hose assembly.

12 Type tests

Type tests shall be carried out in order to confirm that all the material, construction and test requirements of this European Standard have been met by the method of manufacture and hose design.

Type tests shall be repeated at a minimum of every five years or whenever there is a change in design, method of manufacture or materials.

Type tests shall be performed on the smallest, the middle and largest diameter of each design in the manufacturer's range for each type.

13 Test report

NOTE Attention is drawn to the Directive 97/23/EC of the European Parliament and of the Council of May 1997 on the approximation of the laws of the Member States concerning pressure equipment where applicable.

When requested, the manufacturer or supplier shall provide a test report with each length or batch of hoses or hose assemblies supplied to the purchaser.

In this report all hoses or hose assemblies shall be positively identified by batch or serial number and all test results shall be recorded.

14 Marking

14.1 Hoses

Unless agreed otherwise between hose manufacturer and hose assembler and where practical all hoses with a cover shall be continuously marked clearly, legibly and durably with at least the following information:

a) manufacturer's name or trade mark, e.g. xxx Ltd;

b) hose batch number;

c) number and year of this European Standard, EN 16643:2016;

d) hose type, e.g. Type SE, Type SC or Type C or manufacturer's hose designation;

e) hose I/D, e.g. 25 mm;

f) quarter and year of manufacture e.g. 3Q-14.

For hoses without a cover the hose manufacturer shall mark the same information with a durable label securely attached on each length.

14.2 Hose assemblies

Before they are supplied to the end user, hose assemblies in accordance with this European Standard shall be permanently marked by the hose assembler. This marking may be placed on one of the end fitting ferrules or a separate marker ring that cannot be removed over an end fitting or on a plate (conforming to the hose O.D.) or using an electronic tag permanently attached to the hose assembly. For hose assemblies incorporating a short, clear, flush streamline section of cover specifically for marking purposes the marking information can be placed under this clear section of cover. In all cases identification details shall be marked clearly, legibly and durably, for example by engraving. At least the following information shall be included:

a) hose assemblers name or trade mark, e.g. xxx Ltd;

b) hose assembly serial number;

c) number and year of this European Standard, EN 16643:2016;

d) hose I/D, e.g. 25 mm;

e) maximum working pressure of hose assembly, in bar, e.g. 10 bar;

f) test pressure, in bar, e.g. 15 bar;

g) symbol(s) to identify electrical properties, e.g. I, M, Ω-L, Ω-C, Ω-CL, M/Ω-L, M/Ω-C or M/Ω-CL;

h) quarter and year of manufacture e.g. 3Q-14;

i) temperature range, e.g. −70 °C to 260 °C.

NOTE The attention of users is drawn to Annex G concerning the maximum working pressure and the temperature range which can be affected by the chemical(s) to be conveyed in the hoses and hose assemblies.

It is the responsibility of the user to verify that the maximum permissible working pressure of the hose assembly is suitable for safe duty at the operating pressure in the user's system. The maximum working pressure of the hose assembly may be lower than the maximum working pressure of the hose alone.

15 Storage and admissible storage time

The recommendations for storing hoses and hose assemblies are given in EN ISO 8331.

Once hoses and hose assemblies have been stored for 2 years with effect from the date of manufacture or from the last test, they shall be subjected to further routine tests for hose assemblies in accordance with Table A.1 before use.

Annex A
(normative)

Test frequency for type tests and routine tests

The minimum frequency for type tests and routine tests shall be as specified in Table A.1.

Table A.1 — Test frequency for type tests and routine tests

Property	**Type tests** Frequency: at initial product qualification, in the event of product changes after initial qualification and after 5 years	**Routine tests** Performed on each length of lining, hose or each hose assembly
Lining tests		**Per length**[a]
Longitudinal and circumferential yield strength	X	X[b]
Longitudinal and circumferential tensile strength	X	N.A.
Longitudinal and circumferential elongation	X	N.A.
Yield orientation index	X	X[b]
Weep test	X	N.A.
Measurement of inside and outside diameters	X	X
Measurement of thickness	X	X
Measurement of concentricity	X	X
Proof pressure	N.A.	X
Electrical properties	X	X
Hose tests		**Per length**[a]
Measurement of inside and outside diameters	X	X
Measurement of thickness	X	X
Measurement of concentricity	X	X
Proof pressure	X	X
Burst pressure	X	N.A.
Vacuum resistance	X	N.A.
Bending test	X	N.A.
Electrical properties (all grades)	X	X
Rolling U test	X	N.A.
Flammability test	X	N.A.
Hose assembly tests		**Per assembly**
Proof pressure	X	X
Change in length and twist at proof pressure	X	N.A.
Resistance to vacuum	X	N.A.

Property	**Type tests** Frequency: at initial product qualification, in the event of product changes after initial qualification and after 5 years	**Routine tests** Performed on each length of lining, hose or each hose assembly
Burst pressure	X	N.A.
Electrical properties (all grades)	X	X
X = test to be carried out N.A. = test not applicable		
a A length is defined as a continuously extruded lining length up to a maximum of 200 m b Proprietary production acceptance tests can be used providing calibration to yield orientation and weep test results can clearly be demonstrated		

Annex B
(informative)

Production acceptance tests

The frequency of test for production acceptance tests should be as specified in Table B.1.

Table B.1 — Production acceptance tests

Property	**Production acceptance tests**[a] Performed on each length[b] of finished hose prior to warehouse or sale
Lining tests	
Yield orientation index	X

X = test to be carried out

[a] Proprietary production acceptance tests may be used providing calibration to yield orientation and weep test results can clearly be demonstrated.

[b] A length is defined as a continuously extruded lining length up to a maximum of 200 m.

Annex C
(normative)

Proof pressure test for fluoroplastic lining

Each continuously extruded length of fluoroplastic lining shall be subjected to a hydrostatic proof test pressure prior to the braid reinforcement being applied. The hydrostatic proof test pressure PP_L in bar shall be calculated as follows:

$$PP_L = \frac{253 \times t}{d}$$

where

t is the wall thickness in millimetres

d is the outside diameter in millimetres

This proof test pressure shall be applied for 10 min and on completion of the test, the fluoroplastic lining shall show no sign of leakage.

Annex D
(informative)

Couplings and fittings

D.1 General

Hoses can be fitted with the following end fitting or coupling types to form hose assemblies:

— swaged or crimped;

— reusable.

The end fittings or couplings can be of the following types:

— Quick release/quick acting;

— Screw thread;

— Flanged;

— Union;

— Special types (camlock, claw type etc).

D.2 Fluoroplastic lined end fittings

End fittings or couplings should be fluoroplastic lined when necessary. The fluoroplastic lining can be of the following types:

Integrally lined where the hose lining passes through the end fitting and is flared onto the end fitting sealing face without any reduction of internal diameter e.g. the end fitting bore is identical to the hose bore;

Encapsulated lining where a separate fluoroplastic lining is passed through the end fitting bore and then formed back onto the end fitting tail outside diameter in addition to being flared onto the end fitting sealing face. In this case the end fitting bore can be significantly less than the hose bore.

Integrally lined end fittings are recommended for significantly improved flow efficiencies and elimination of chemical entrapment.

Where encapsulated lining end fittings are used the lining shall be of the same type as the hose e.g. both hose and end fitting lining shall be natural fluoroplastic lined or both hose and end fitting lining shall be carbon filled fluoroplastic lined. This is to avoid confusion as to whether the hose has a static dissipating lining or not and to ensure if the hose has a static dissipating lining, that its static dissipating properties are not interfered with.

Annex E
(normative)

Yield orientation index

The yield orientation index provides a measure of tube quality for sintered PTFE tube. Based on tensile yield strength measured in both longitudinal and circumferential directions, the yield orientation index *YOI* is calculated as follows:

$$YOI = 1 - \frac{\sigma_{y,cd}}{\sigma_{y,ld}}$$

where

$\sigma_{y,cd}$ is the yield strength in circumferential orientation;

$\sigma_{y,ld}$ is the yield strength in longitudinal orientation.

Annex F
(normative)

Weep test

F.1General

The weep test provides a measure of tube quality for sintered PTFE tube based on the tubes ability to withstand a penetrating fluid at pressure.

F.2Test pieces

Tube only assembly e.g. smoothbore or convoluted lining only with suitable end fittings attached. The exposed lining length shall be at least 150 mm long.

F.3Apparatus

Test fluid (70 % isooctane, 30 % toluene and 0,5 % red dye);

Suitable system to increase pressure within tube only assembly at 0,35 bar every 5 min;

Valve to permit filling of tube only assembly and to hold pressure during test;

Stopwatch.

F.4Test method

The test piece shall be filled with the test fluid to exclude air and then pressurized to the initial pressure. An initial pressure p_1 in bar is calculated as follows:

$$p_1 = \frac{169 \times t}{d}$$

where

t is the wall thickness in millimetres;

d is the outside diameter in millimetres.

Pressure is then increased by 0,35 bar every five minutes.

The test piece is deemed to have failed when the test fluid is seen to seep (weep) through to the outer surface of the test piece.

Weep pressure p_w is calculated as a percentage of the theoretical burst pressure as follows:

$$p_w = \frac{p_f}{2 \times p_1} \times 100\%$$

where

p_f is the pressure recorded at failure;

p_1 is the initial pressure.

Annex G
(informative)

Resistance to chemicals conveyed

It is the responsibility of the user, in consultation with the manufacturer if required, to ensure that the hoses or hose assemblies are suitably resistant to the chemicals to be conveyed.

The outside of the hose and hose assembly (including end fittings) are not intended to be in contact with the chemical conveyed. Whenever such contact occurs the outside of the hose should be examined for harmful effects.

Annex H
(informative)

Permeability to gas

H.1 General

The construction of Type SC hose linings results in a lining of varying thickness. Assessment of the quality of this type of fluoroplastic lining should be made by measuring the permeation of helium through the lining wall.

H.2 Test pieces

For each nominal bore size to be tested;

Three tube only hose assemblies having a free length of 600 mm and consisting of a Type SC hose lining with suitable end fittings attached. See Figure H.1.

H.3 Apparatus

Test gas – helium;

Suitable system to purge the hose with helium and regulate the helium test pressure given in Table H.1;

Test tank to allow the hose to be tested under water;

Collector 500 mm long x 100 mm wide with a 60 ml measuring cylinder attached to collect helium permeating from hose. See Figure H.1;

Stopwatch.

H.4 Test method

Each test piece shall be placed under water in the test tank and purged with helium to exclude air and then pressurized to the test pressure given in Table H.1.

Wait three hours after which the helium permeation rate will have reached steady-state. Fill the collector/measuring cylinder with water and place over the hose assembly under test as shown in Figure H.1 ensuring helium is only collected from the hose and not the end fittings.

When a small measurable amount of helium has entered the collector measuring cylinder, start the stopwatch and record the initial helium level in the measuring cylinder.

When approximately 50 ml of helium has entered the measuring cylinder stop the stopwatch, record the final helium level in the measuring cylinder and time taken.

Calculate the helium permeation rate, HPR, in ml/m/h as follows:

$$HPR = \frac{2 \times \left(HL_{\mathrm{f}} - HL_{\mathrm{i}} \right)}{t}$$

where

HL_{f} is the final helium level in millilitres;

HL_{i} is the initial helium level in millilitres;

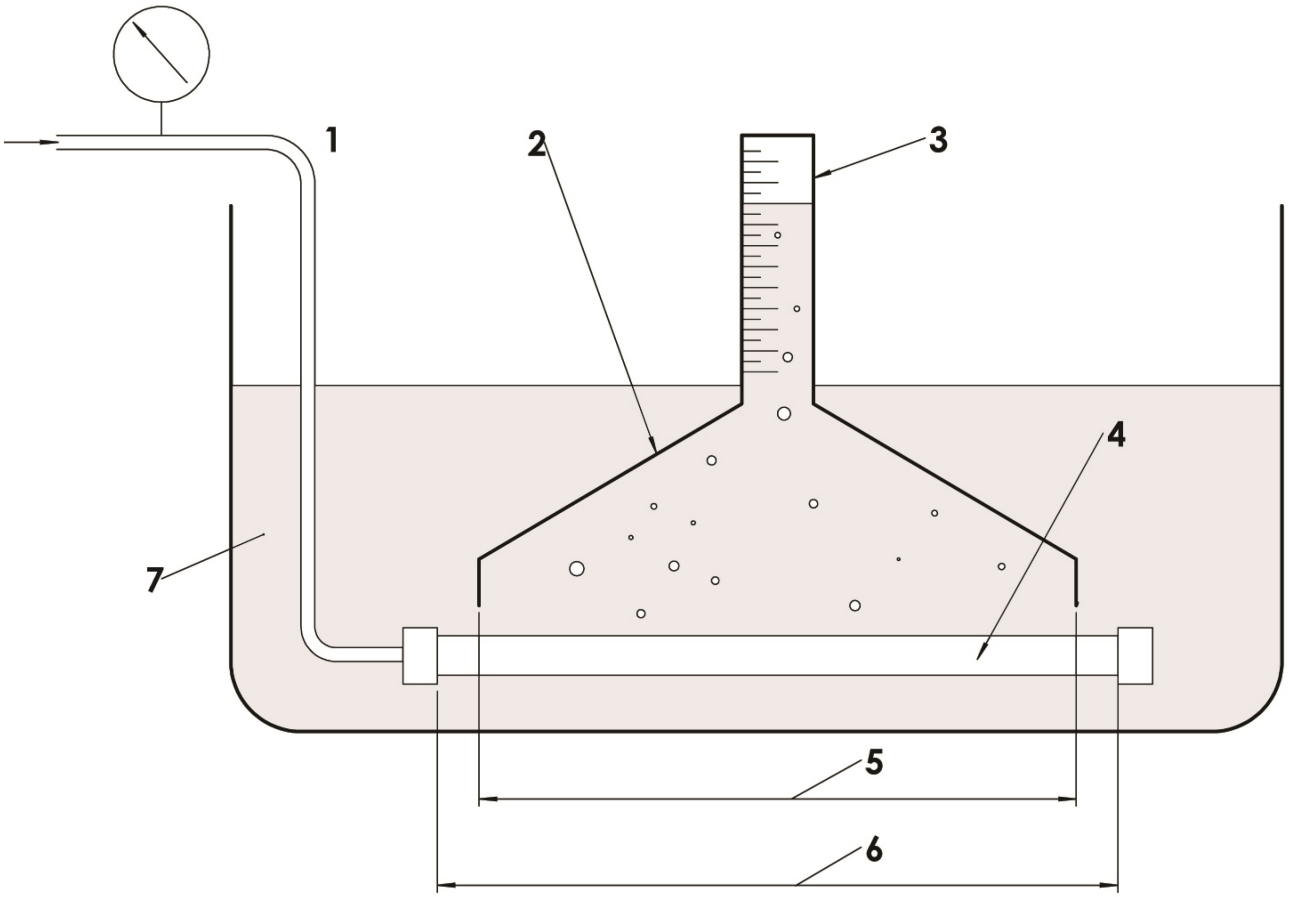
t is the time taken in hours.

All three test pieces are to be tested as above and testing of all three test pieces may be carried out in parallel using three separate collectors.

An average helium permeation rate is to be calculated from the individual helium permeation rates of these three test pieces for the Type SC hose lining and average helium permeation rates are given in Table H.1.

Table H.1 — Helium test pressures and average helium permeation rates for Type SC hose linings

Nominal bore	Inside diameter mm	Helium test pressure bar	Average helium permeation rate ml/m/h
6,3	6,6	10	41
8	7,8	8	38
10	9,7		41
12,5	13,1	6	37
16	16,2		35
19	19,3		42
22	22,1	5	36
25	25,7		40
31,5	31,7		41
35	34,8	4	34
38	38,5		35
48	47,4	3	27
51	51,1		28



Key

1 Helium gas supply
2 Collector
3 Measuring cylinder
4 Test piece
5 Collector length 500 mm (width 100 mm)
6 Free hose length 600 mm
7 Water bath

Figure H.1 — Arrangement for helium permeation test

Annex I
(normative)

Flame resistance test

I.1 Test pieces

Hose assembly with both ends capped

I.2 Apparatus

Bunsen burner;

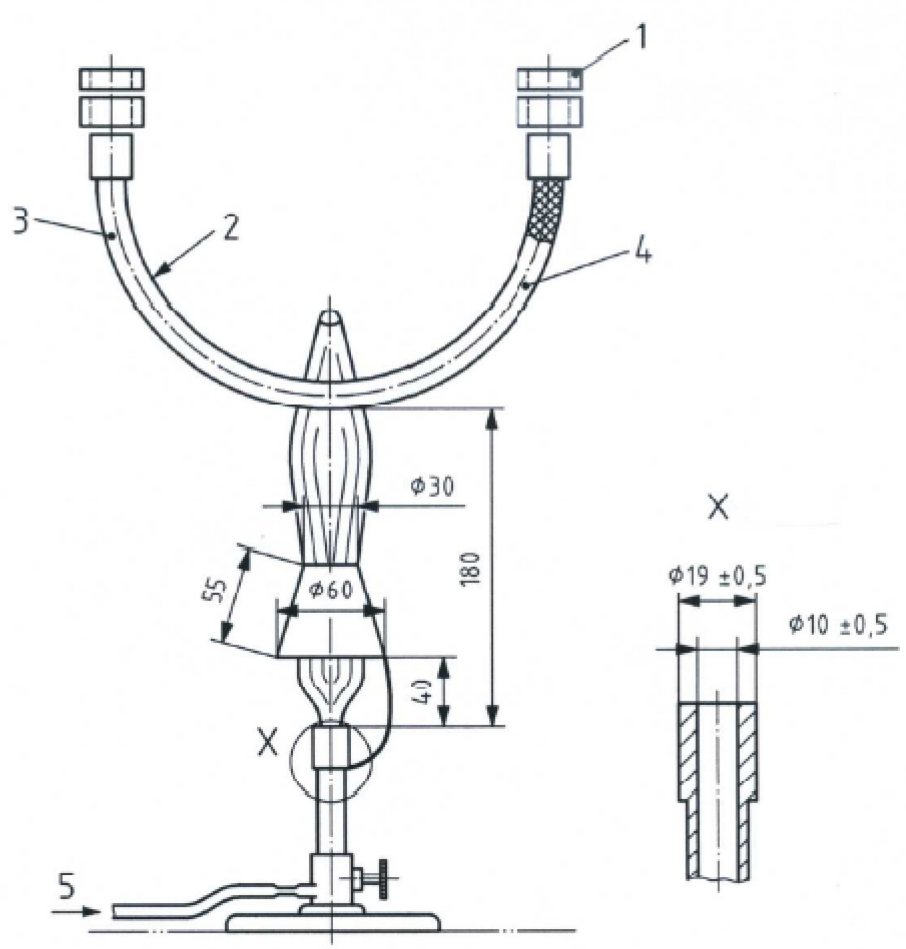
Stopwatch;

Suitable clamps to hold test assembly.

I.3 Test method

The hose test piece shall be bent into a U shape or radius according to Figure I.1. The test piece shall be filled with liquid according to ISO 1817. The test piece shall be exposed to a naked flame from a Bunsen burner of 10 mm pipe diameter for a period of 3 min, with the airflow to the burner shut off. The distance between burner and test piece shall be according to Figure I.1. The hose sample shall be deemed to be non-flammable if it ceases to burn with a naked flame within 20 s after removal of the burner, and there is no further glowing visible 2 min after removing the burner flame. On completion of the test, the hose test piece shall show no sign of leakage of the test fluid.

Dimensions in millimetres



Key

1 Cap

2 Bending radius = 10 to 15 times the outside diameter

3 Hose assembly

4 Liquid F in accordance with ISO 1817

5 Propane (LPG) approximately 50 mbar

Figure I.1 — Arrangement for flammability test

Annex J
(normative)

Hose flexibility - Rolling U test

J.1 General

The Rolling U test provides a measure of hose flexural fatigue performance while at minimum bend radius and maximum working pressure.

J.2 Test pieces

A hose assembly with suitable end fittings attached, sufficiently long to be bent in an inverted U at the hoses minimum bend radius and permit movement of ± M of one end fitting along its axis without straining the hose at the end fittings. See Figure J.1.

J.3 Apparatus

Test fluid - water;

Suitable system to fill the hose assembly and pressurize the hose assembly to its maximum working pressure and hold this pressure during the test;

Suitable system to provide a vertical reciprocating up and down movement to one end of the hose assembly of distance ± M at a rate of 60 cycles/min ± 10 cycles/min as shown in Figure J.2;

Counter to count the number of full cycles (movement from 0 mm to +M mm to -M mm to 0 mm corresponding to one full cycle).

J.4 Test method

The test piece shall be mounted in the test apparatus and filled with the water to exclude air and then pressurized to the test pressure.

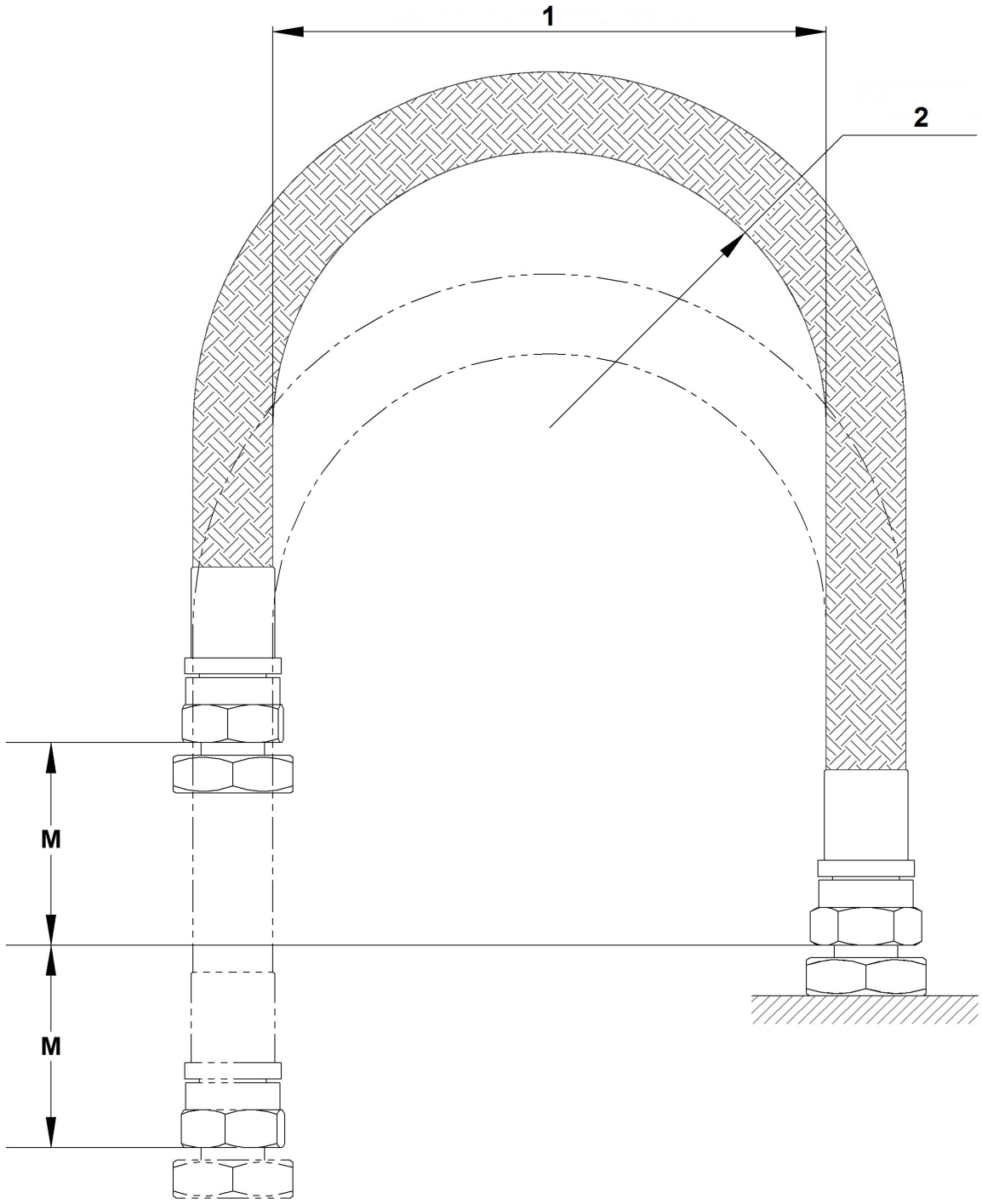
The test apparatus shall then be set in motion to begin the rolling U test while maintaining the test pressure.

The test piece is deemed to have failed when the test fluid is seen to leak from the test piece.

The test may be terminated if the hose assembly reaches the prescribed minimum number of Rolling U cycles without failure.

Table J.1 — Rolling U test movement

Nominal bore	**Movement, M** **mm**
≤ 51	150 ± 10
> 51	300 ± 10

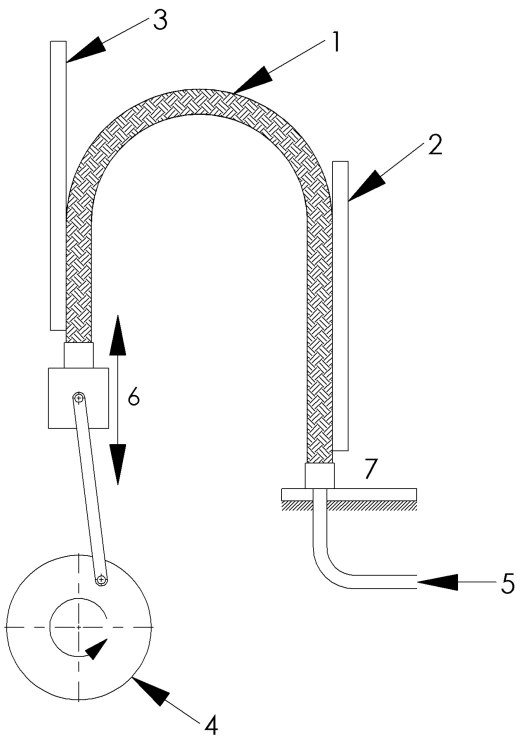


Key

1 2 x Minimum bend radius

2 Minimum bend radius ± 5 %

Figure J.1 — Rolling U test piece



Key

1 Test piece
2 Fixed guide
3 Moving guide
4 System to provide vertical reciprocating movement
5 Hydrostatic test pressure
6 Vertical movement
7 Fixed end

Figure J.2 — Typical arrangement of Rolling U test equipment

Annex K
(informative)

Environmental checklist

K.1 Materials should be selected to optimize product durability and lifetime and consideration should be made to avoiding the selection of rare or hazardous materials.

K.2 Packaging design should consider using recycled materials, and materials that need little energy for their manufacture, and should minimize waste.

K.3 The size and weight of packaging should be minimized while protecting the products to minimize waste through damage. Packaging should be designed to optimize capacity of transportation vehicles while facilitating safe loading and unloading.

K.4 Using hoses covered by this European standard, the end users handle chemicals up to 260°C. There is a risk to the environment from accidents if the materials are not handled in the recommended way.

Table K.1 — Environmental checklist

Environmental Issue	Stages of the life cycle										All stages
	Acquisition		Production		Use			End-of-Life			
	Raw materials and energy	Pre-manu-factured materials and components	Production	Packaging	Use	Maintenance and repair	Use of additional products	Reuse/ Material and Energy Recovery	Incineration without energy recovery	Final disposal	Transportation
Inputs											
Materials	K.1	K.1									
Water											
Energy				K.2							K.3
Land											
Outputs											
Emissions to air											
Discharges to water											
Discharges to soil											
Waste				K.2							K.3
Noise, vibration, radiation, heat											
Other relevant aspects											
Risk to the environ-ment from accidents or unintended use					K.4	K.4					
Customer information											

NOTE 1 The stage of packaging refers to the primary packaging of the manufactured product. Secondary or tertiary packaging for transportation, occurring at some or all stages of the life cycle, is included in the stage of transportation.

NOTE 2 Transportation can be dealt with as being a part of all stages (see checklist) or as separate sub-stage. To accommodate specific issues relating to product transportation and packaging, new columns can be included and/or comments can be added.

Bibliography

[1] IEC/TS 60079-32-1, *Explosive atmospheres — Part 32-1: Electrostatic hazards — Guidance*

[2] EN ISO 8331, *Rubber and plastics hoses and hose assemblies - Guidelines for selection, storage, use and maintenance (ISO 8331)*

[3] *Directive 97/23/EC of the European Parliament and of the Council of May 1997 on the approximation of the laws of the Member States*

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Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

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Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.