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Plastics hoses and hose assemblies — Textile-reinforced types for hydraulic applications — Specification

Tuyaux et flexibles en plastique — Types hydrauliques avec armature textile — Spécifications

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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 3949 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

This fourth edition cancels and replaces the third edition (ISO 3949:2004), which has been technically revised.

Plastics hoses and hose assemblies — Textile-reinforced types for hydraulic applications — Specification

1 Scope

This International Standard specifies requirements for three types of textile-reinforced thermoplastics hose and hose assembly of nominal size from 3,2 to 25. Each type is divided into two classes dependent on electrical conductivity requirements. They are suitable for use with water-based hydraulic fluids HFC, HFAE, HFAS and HFB as defined in ISO 6743-4 at temperatures ranging from 0 °C to +60 °C and oil-based hydraulic fluids HH, HL, HM, HR and HV as defined in ISO 6743-4 at temperatures ranging from –40 °C to +100 °C;

This International Standard does not include requirements for end fittings. It is limited to the performance of hoses and hose assemblies.

NOTE Operating temperatures in excess of 100 °C may materially reduce the life of the hose.

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

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

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*

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 6803, *Rubber or plastics hoses and hose assemblies — Hydraulic-pressure impulse test without flexing*

ISO 7326:2006, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

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

ISO 8331, *Rubber and plastics hoses and hose assemblies — Guidelines for selection, storage, use and maintenance*

3 Terms and definitions

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

4 Classification

Three types of hose are specified, distinguished by their maximum working pressure:

a) Type R7: hoses with one or more layers of reinforcement.

b) Type R8: hoses with one or more layers of reinforcement, for operation at higher working pressures.

c) Type R18: hoses with one or more layers of reinforcement, 21,0 MPa (210 bar) working pressure based.

Each type of hose is divided into two classes according to its electrical properties:

1) Class 1, no electrical requirements.

2) Class 2, “non-conductive” (see 7.8).

5 Materials and construction

5.1 Hoses

Hoses shall consist of a seamless thermoplastic lining resistant to hydraulic fluids, with suitable textile yarn reinforcement and a thermoplastic cover resistant to hydraulic fluids, water and the weather.

For class 2 hoses, the cover shall not be perforated. The cover shall be orange (colour code RAL 2004).

5.2 Hose assemblies

Hose assemblies shall only be manufactured with those hose fittings whose functionality confirms to the requirements of 7.1, 7.4, 7.5 and, for class 2 only, 7.8.

Follow the manufacturer's instructions for proper preparation and fabrication of hose assemblies.

6 Dimensions and tolerances

6.1 Diameters

When measured in accordance with ISO 4671, the diameters of the hoses shall conform to the values given in Table 1.

Table 1 — Dimensions of hoses

Nominal size	Inside diameter mm						Maximum outside diameter mm		
	Type R7		Type R8		Type R18		Type R7	Type R8	Type R18
	min.	max.	min.	max.	min.	max.			
3,2	3,4	4,0	3,4	4,0	3,4	4,0	9,5	10,5	9,5
5	4,6	5,4	4,6	5,4	4,6	5,4	11,4	14,6	10,8
6,3	6,2	7,0	6,2	7,0	6,2	7,0	13,7	16,8	13,5
8	7,7	8,5	—	—	7,7	8,5	15,6	18,6	16,6
10	9,3	10,3	9,3	10,3	9,3	10,3	18,4	20,3	18,4
12,5	12,3	13,5	12,3	13,5	12,3	13,5	22,5	24,6	22,8
16	15,6	16,7	15,6	16,7	15,5	16,8	25,8	29,8	27,2
19	18,6	19,8	18,6	19,8	18,6	19,8	28,6	33,0	31,5
25	25,0	26,4	25,0	26,4	25,0	26,4	34,7	38,6	40,4

6.2 Concentricity

When measured in accordance with ISO 4671, the concentricity of hoses shall conform to Table 2.

Table 2 — Concentricity of hoses

Nominal size	Maximum variation in wall thickness between inside diameter and outside diameter mm
Up to and including 6,3	0,8
Over 6,3 and including 19	1,0
Over 19	1,3

7 Physical properties

7.1 Hydrostatic requirements

When tested in accordance with ISO 1402 at the relevant proof pressure given in Table 3 and the relevant minimum burst pressure given in Table 4, the hoses and hose assemblies shall not leak.

Table 3 — Proof pressure

Nominal size	Type		
	R7	R8	R18
	MPa (bar)	MPa (bar)	MPa (bar)
3,2	42,0 (420)	84,0 (840)	42,0 (420)
5	42,0 (420)	70,0 (700)	42,0 (420)
6,3	38,5 (385)	70,0 (700)	42,0 (420)
8	35,0 (350)	—	42,0 (420)
10	31,5 (315)	56,0 (560)	42,0 (420)
12,5	28,0 (280)	49,0 (490)	42,0 (420)
16	21,0 (210)	38,5 (385)	42,0 (420)
19	17,5 (175)	31,5 (315)	42,0 (420)
25	14,0 (140)	28,0 (280)	42,0 (420)

Table 4 — Minimum burst pressure

Nominal size	Type		
	R7	R8	R18
	MPa (bar)	MPa (bar)	MPa (bar)
3,2	84,0 (840)	168,0 (1 680)	84,0 (840)
5	84,0 (840)	140,0 (1 400)	84,0 (840)
6,3	77,0 (770)	140,0 (1 400)	84,0 (840)
8	70,0 (700)	—	84,0 (840)
10	63,0 (630)	112,0 (1 120)	84,0 (840)
12,5	56,0 (560)	98,0 (980)	84,0 (840)
16	42,0 (420)	77,0 (770)	84,0 (840)
19	35,0 (350)	63,0 (630)	84,0 (840)
25	28,0 (280)	56,0 (560)	84,0 (840)

Table 5 — Maximum working pressure

Nominal size	Type		
	R7	R8	R18
	MPa (bar)	MPa (bar)	MPa (bar)
3,2	21,0 (210)	42,0 (420)	21,0 (210)
5	21,0 (210)	35,0 (350)	21,0 (210)
6,3	19,2 (192)	35,0 (350)	21,0 (210)
8	17,5 (175)	—	21,0 (210)
10	15,8 (158)	28,0 (280)	21,0 (210)
12,5	14,0 (140)	24,5 (245)	21,0 (210)
16	10,5 (105)	19,2 (192)	21,0 (210)
19	8,8 (88)	15,8 (158)	21,0 (210)
25	7,0 (70)	14,0 (140)	21,0 (210)

7.2 Change in length

When tested in accordance with ISO 1402, the change in length of hose at the maximum working pressure (see Table 5) shall not exceed ± 3 %.

7.3 Minimum bend radius

Use test pieces having a length at least 4 times the minimum bend radius. Measure the hose outside diameter with vernier callipers in the straight lay position before bending the hose. Bend the hose through 180° to the minimum bend radius and measure the flatness with the calliper.

When bent to the minimum bend radius in Table 6, measured on the inside of the bend, the flatness shall not exceed 10 % of the original outside diameter.

Table 6 — Minimum bend radius

Nominal size	Minimum bend radius mm	
	Type	
	R7 and R8	R18
3,2	25	25
5	90	30
6,3	100	45
8	115	50
10	125	75
12,5	180	90
16	205	125
19	240	165
25	300	250

7.4 Resistance to impulse

7.4.1 The impulse test shall be in accordance with ISO 6803. The test fluid temperature shall be 100 °C.

7.4.2 For type R7 hoses, when tested at an impulse pressure equal to 125 % of the maximum working pressure, the hose shall withstand a minimum of 150 000 impulse cycles.

For type R8 and R18 hoses, when tested at an impulse pressure equal to 133 % of the maximum working pressure, the hose shall withstand a minimum of 200 000 impulse cycles.

7.4.3 There shall be no leakage or other malfunction before reaching the specified number of cycles.

7.4.4 This test shall be considered a destructive test and the test pieces shall be destroyed.

7.5 Leakage of hose assemblies

When tested in accordance with ISO 1402, there shall be no leakage or evidence of failure. This test shall be considered a destructive test and the test piece shall be destroyed.

7.6 Cold flexibility

When tested in accordance with method B of ISO 4672:1997 at a temperature of −40 °C, there shall be no cracking of the lining or cover. The test piece shall not leak or crack when subjected to a proof pressure test in accordance with ISO 1402 after regaining ambient temperature.

7.7 Ozone resistance

When tested in accordance with method 1 or 2 of ISO 7326:2006, depending on the nominal bore of the hose, no cracking or deterioration of the cover shall be visible under × 2 magnification.

7.8 Electrical conductivity

This test applies to class 2 hoses only; it shall not be applied to hoses with a perforated cover.

When tested in accordance with Annex D, the current reading shall be no greater than 50 µA.

7.9 Fluid resistance

7.9.1 Test pieces

The fluid resistance tests specified in 7.9.2 to 7.9.4 shall be carried out on molded sheets of lining and cover material having a minimum thickness of 2 mm.

7.9.2 Oil resistance

When determined in accordance with ISO 1817 by immersion in IRM 903 oil for $72^{\ 0}_{-2}$ h at a temperature of 100 °C ± 3 °C, the percentage change in volume of the lining and cover shall be between −15 % and +35 %.

7.9.3 Water-based fluid resistance

When determined in accordance with ISO 1817 by immersion in a test fluid made up of equal volumes of 1,2-ethanediol and distilled water for $168^{\ 0}_{-2}$ h at a temperature of 70 °C ± 1 °C, the percentage change in volume of the lining and cover shall be between 0 % and +25 %.

7.9.4 Water resistance

When determined in accordance with ISO 1817 by immersion in distilled water for 168^{0}_{-2} h at a temperature of 70 °C ± 1 °C, the percentage change in volume of the lining and cover shall be between −10 % and +25 %.

7.10 Visual examination

Hoses shall be examined for visible defects in the outer cover and to verify that the hose identification is correct and has been properly marked. Hose assemblies shall, in addition, be inspected to verify that the correct fittings are fitted.

8 Frequency of testing

Type testing and routine testing shall be as specified in Annex A.

Type tests are those tests required to confirm that a particular hose or hose assembly design, manufactured by a particular method from particular materials, meets all the requirements of this International Standard. The tests shall be repeated at a maximum of five-year intervals, or whenever a change in the method of manufacture or materials used occurs. They shall be performed on all sizes and on all classes and types except those of the same size and construction.

Routine tests are those tests required to be carried out on each length of finished hose prior to dispatch.

Production tests are those tests, specified in Annex B, which should preferably be carried out to control the quality of manufacture. The frequencies specified in Annex B are given as a guide only.

9 Designation

Hoses shall be designated as in the following example for a Type R7 thermoplastics textile-reinforced hydraulic hose, class 1 with a nominal size of 10.

EXAMPLE ISO 3949-R7-1/10.

10 Marking

10.1 Hoses

Hoses shall be marked with at least the following information, and the marking shall be repeated at least once every 760 mm:

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

b) the number of this International Standard, i.e. ISO 3949;

c) the type and class, e.g. R7-1;

d) for class 2 hoses, the words “NON-CONDUCTIVE”;

e) the nominal size, e.g. 16;

f) the quarter and last two digits of the year of manufacture, e.g. 3Q04.

EXAMPLE 1 MAN/ISO 3949/R7-1/16/3Q04.

EXAMPLE 2 MAN/ISO 3949/R7-2/NON-CONDUCTIVE/16/3Q04.

10.2 Hose assemblies

Hose assemblies shall be marked with at least the following information:

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

b) the maximum working pressure of the assemblies[1)], in megapascals[2)], with the unit indicated, e.g. 7,0 MPa;

c) the last two digits of month and year of assembly, e.g. 01/08.

EXAMPLE MAN/7,0 MPa/01/08.

11 Recommendations for packaging and storage

These are given in ISO 8331.

12 Test certificate

When requested by the purchaser, the manufacture or supplier shall provide a test certificate with each length of hose or batch of hoses supplied to the purchaser.

1) The maximum working pressure of the assembly is the lowest maximum working pressure of any of its components.

2) 1 MPa = 10 bar.

Annex A
(normative)

Type and routine testing of hoses

Property	Type test Frequency (for each hose size and type): at initial product qualification, in the event of product changes after initial qualification and after 5 years	Routine test Performed on each length of finished hose prior to warehousing or sale
Hoses/hose assemblies (as appropriate)		
Visual examination (inside and outside)	X	X
Measurement of inside diameter	X	X
Measurement of outside diameter	X	X
Measurement of concentricity	X	X
Proof test	X	X
Burst test	X	X
Change-in-length test	X	X
Minimum bend radius	X	N/A
Impulse test	X	N/A
Leakage test	X	X
Cold bending test	X	N/A
Ozone resistance test	X	N/A
Electrical conductivity (class 2 only)	X	N/A
Resistance to fluids		
Oil resistance test for cover	X	N/A
Oil resistance test for lining	X	N/A
Water-based fluid resistance test for cover	X	N/A
Water-based fluid resistance test for lining	X	N/A
Water resistance test for cover	X	N/A
Water resistance test for lining	X	N/A
X = test to be carried out; N/A = not applicable		

Annex B
(informative)

Production testing

Property	Production test	
	Frequency: every 3 000 m produced of each type and hose size	Frequency: every 12 months of production for each type and hose size
Hoses/hose assemblies (as appropriate)		
Visual examination (inside and outside)	X	X
Measurement of inside diameter	X	X
Measurement of outside diameter	X	X
Measurement of concentricity	X	X
Proof test	X	X
Burst test	X	X
Change-in-length test	X	X
Minimum bend radius	X	X
Impulse test	N/A	N/A
Leakage test	X	X
Cold bending test	N/A	N/A
Ozone resistance test	N/A	N/A
Electrical conductivity (class 2 only)	N/A	N/A
Resistance to fluids		
Oil resistance test for cover	N/A	N/A
Oil resistance test for lining	N/A	N/A
Water-based fluid resistance test for cover	N/A	N/A
Water-based fluid resistance test for lining	N/A	N/A
Water resistance test for cover	N/A	N/A
Water resistance test for lining	N/A	N/A
X = test to be carried out; N/A = not applicable		

Annex C
(informative)

Recommendations for lengths of supplied hoses and tolerances on lengths of hose assemblies

C.1 Hoses

The hoses should be supplied in lengths as specified by the purchaser, subject to a tolerance on the specified lengths of ± 2 %.

When no specific hose lengths have been ordered, the percentages of different lengths in any given delivery should be as indicated in Table C.1.

Table C.1 — Hose lengths in delivery when no lengths specified

Length of hose	Percentage of total length
Greater than or equal to 1 m but less than or equal to 10 m	3 % max.
Greater than 10 m but less than or equal to 20 m	20 % max.
Greater than 20 m	80 % min.

No hose length should be less than 1 m.

C.2 Hose assemblies

The tolerances on the length of hose assemblies should conform to the values given in Table C.2.

Table C.2 — Tolerance of lengths of hose assemblies

Hose assembly length mm	Tolerance
Up to and including 630	$^{+7}_{-3}$ mm
Over 630 and up to and including 1 250	$^{+12}_{-4}$ mm
Over 1 250 and up to and including 2 500	$^{+20}_{-6}$ mm
Over 2 500 and up to and including 8 000	$^{+1,5}_{-0,5}$ %
Over 8 000	$^{+3}_{-1}$ %

Annex D
(normative)

Test method for electrical conductivity

WARNING — Care should be taken whilst carrying out this test in view of the high electrical voltage applied to the test assembly.

Take a hose assembly having a free length of 150 mm ± 10 mm, without fluid, and capped to prevent entry of moisture. Remove the surface moisture prior to testing by wiping with a dry cloth. Then condition the hose assembly at 23 °C ± 3 °C and at a minimum of 85 % relative humidity for a period of $168^{\ 0}_{-2}$ h .

Attach one end fitting of the conditioned assembly to the lead from a source of 50 Hz to 60 Hz sinusoidal 37,5 kV (r.m.s.) a.c. power source. Suspend this lead by dry fabric strings so that the hose hangs free at least 600 mm from any nearby objects. Connect the lower end of the hose to earth through a resistor of between $1 \times 10^3\ \Omega$ and $1 \times 10^6\ \Omega$, keeping the resistor near the end of the hose.

Connect a suitable a.c. voltmeter across the resistor, using a fully shielded cable with the shielding well earthed. Apply 37,5 kV ± 0,5 kV to the test piece for 5 min ± 15 s and measure the current.

Bibliography

[1] ISO 4397, *Fluid power systems and components — Connectors and associated components — Nominal outside diameters of tubes and nominal inside diameters of hoses*

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