INTERNATIONAL STANDARD

ISO 7628-2

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Road vehicles — Thermoplastics tubing for air braking systems —

Part 2:
Mounting on vehicle and test methods

Véhicules routiers — Tuyauteries thermoplastiques pour dispositifs de freinage pneumatique —

Partie 2: Conditions de montage sur le véhicule et méthodes d'essai

Reference number
ISO 7628-2:1998(E)

Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7628-2 was prepared by technical committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

This first edition cancels and replaces ISO/TR 7628-2:1986, which has been technically revised.

ISO 7628 consists of the following parts, under the general title *Road vehicles — Thermoplastics tubing for air braking systems*:

— *Part 1: Dimensions and marking*

— *Part 2: Mounting on vehicles and test methods*

Annexes A, B, C and D form an integral part of this part of ISO 7628. Annexes E and F are for information only.

Road vehicles — Thermoplastics tubing for air braking systems — Part 2: Mounting on vehicle and test methods

1 Scope

This part of ISO 7628 specifies the minimum requirements for tubing used in air braking systems, to allow its marking in accordance with ISO 7628-1. The conformity of production is the responsibility of the tubing manufacturer.

The marking of the tubing does not automatically imply that the tube assembly (i.e. tube with end-fittings) is appropriate to its use on a vehicle.

It is the responsibility of the tube assembler and/or the vehicle manufacturer to ensure that tests of annex D, relating to the tube assembly itself, are successfully performed.

The tubing defined in this part of ISO 7628 belongs to two possible categories:

— tubing for use up to a maximum working pressure of 1 000 kPa[1)];

— tubing for use up to a maximum working pressure of 1 250 kPa[1)];

and within a temperature range of – 40 °C[2)] to + 100 °C.

The requirements for coiled tube assemblies are specified in ISO 7375.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7628. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7628 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 179-1:—[3)], *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test.*

ISO 307:1994, *Plastics — Polyamides — Determination of viscosity number.*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Testing conditions for moulding and extrusion plastics.*

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1) 1 kPa = 10^{-2} bar

2) Reduction of the lower temperature limit will be considered during a future revision of this part of ISO 7628.

3) To be published. (Revision of ISO 179:1993).

ISO 1133:1997, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*.

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics*.

ISO 1874-1:1992, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 1: Designation*.

ISO 1874-2:1995, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*.

ISO 2719:1988, *Petroleum products and lubricants — Determination of flash point — Pensky-Martens closed cup method*.

ISO 2977:1997, *Petroleum products and hydrocarbon solvents — Determination of aniline point and mixed aniline point*.

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*.

ISO 3146:1985, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers*.

ISO 3795:1989, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*.

ISO 4080:1991, *Rubber and plastics hoses and hose assemblies — Determination of permeability to gas*.

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources*.

ISO 4892-4:1994, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*.

ISO 6427:1992, *Plastics — Determination of matter extractable by organic solvents (conventional methods)*.

ISO 7628-1:1998, *Road vehicles — Thermoplastic tubing for air braking systems — Part 1: Dimensions and marking*.

ISO 14910-1:1997, *Plastics — Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion — Part 1: Designation system and basis for specifications*.

ISO 14910-2:1997, *Plastics — Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion — Part 2: Preparation of test specimens and determination of properties*.

3 Definitions

For the purposes of this part of ISO 7628, the following definitions apply.

3.1
tube
tubing which has been cut to its appropriate length

3.2
tube assembly
tube which has been equipped with suitable end fittings

4 Materials

Thermoplastic tubing shall be extruded from 100 % virgin material (not regrind). If reinforcement is used, then the users must be satisfied that the reinforced tubing is suitable for the application. Depending on the material used for the tube, the complete list of tests to be carried out on the tube is given in clause 6.

5 Installation on the vehicle

5.1 Use of tube assemblies on the vehicle

The choice of appropriate fittings and tube shall be approved by the vehicle manufacturer.

In order to allow its mounting on the vehicle, the tube assembly shall have been tested according to annex D.

5.2 Installation precautions

When installed on a vehicle, the tube shall be routed and supported so as to eliminate chafing, abrasion, kinking or other mechanical damage to minimize fatigue conditions and to avoid excessive sag.

6 List of tests according to tube material

The list of appropriate tests to be performed on the tubing, depending on the material of the tube, is given in table 1. An "X" means the test shall apply to the corresponding material. For other materials, all the tests listed in table 1 (including additional tests to be defined by ISO/TC 22/SC 2) shall be successfully completed before the marking of the tube.

Table 1 — List of tests

Test	Subclause	PA11 type[1)]	PA12 type[1)]	TEEE type[1)]	Other material	Tube size to test
Surface appearance	7.1	X	X	X	X	Every
Burst at 23 °C	7.2	X	X	X	X	Every
Burst at 100 °C	7.2	X	X	X	X	Every
Deformation under pressure	7.3	—	—	—	X	Every
Cold impact	7.4	X	X	X	X	Every
Impact after ageing	7.5	X	X	X	X	Every
Moisture absorption	7.6	—	—	—	X	Any one
Low temp. flexural	7.7	X	X	X	X	Every
High temp. flexural	7.8	X	X	X	X	Every
Stress cracking	7.9	—	—	X	X	Every
Ethanol	7.10	—	—	X	X	Every
Battery acid	7.11	—	—	—	X	Every
Oil	7.12	—	—	—	X	6 mm × 1 mm or flat sample
Burning rate	7.13	X	X	X	X	12 mm × 1,5 mm
Artificial weathering	7.14	X	X	X	X	12 mm × 1,5 mm
Other tests[2)]		—	—	—	X	

[1)] PA11 types, PA12 types and TEEE types are defined in annex A.

[2)] Other tests, including a fatigue test, will be defined by ISO/TC 22/SC 2 upon request for a new tubing material.

7 Test procedure and requirements

For the purpose of these tests, the tube samples shall be at least two weeks (336 h) old. Unless otherwise stated, the tests are performed at an ambient temperature of (23 ± 2) °C, a relative humidity between 45 % and 75 %, and unpressurized. During the application of this part of ISO 7628 all burst tests shall be conducted using the same type of fitting.

7.1 Quality and surface appearance

The tube shall show no manufacturing faults, voids, scratches, cracks or lack of homogeneity which could affect service use. Additives shall be evenly distributed throughout the material.

7.2 Burst test

The burst test shall be carried out on five tube assemblies for each temperature. The tube length between the end fittings shall be approximately 150 mm.

7.2.1 Test procedure

The test procedure comprises the steps given in 7.2.1.1 and 7.2.1.2.

7.2.1.1 Burst at 23 °C

Soak the tube assemblies in water at 23 °C for 10 min to 15 min.

Before testing, keep the tube assemblies for the following times at 23 °C and (50 ± 5) % relative humidity:

a) 1 h minimum for tubes with a nominal wall thickness e of 0,5 mm ≤ e ≤ 1 mm;

b) 2 h minimum for tubes with a nominal wall thickness e of 1,25 mm ≤ e ≤ 2,5 mm.

Apply hydrostatic pressure at a constant rate by means of a hydraulic pump or accumulator system with a calibrated pressure gauge.

The pressure is applied so as to cause the tube to burst 15 s to 60 s after application of the pressure.

The burst pressure at 23 °C is the maximum pressure obtained during the test.

7.2.1.2 Burst at 100 °C

This test shall be performed with an inert internal pressurizing medium and air outside.

Place the assemblies in an oven at (100 ± 2) °C and allow to condition for 1 h.

Apply pressure at a constant rate by means of a pump or accumulator system with a calibrated pressure gauge.

The pressure is applied so as to cause the tube to burst 15 s to 60 s after application of the pressure.

The burst pressure at 100 °C is the maximum pressure obtained during the test.

7.2.2 Test requirements

The burst criteria is the burst of the tube itself.

7.2.2.1 Test requirements at 23 °C

All five samples shall have a burst pressure at 23 °C higher than:

4 MPa (40 bar) for 1 MPa (10 bar) tubes;

5 MPa (50 bar) for 1,25 MPa (12,5 bar) tubes.

7.2.2.2 Test requirements at 100 °C

All five samples shall have a burst pressure at 100 °C higher than:

2,5 MPa (25 bar) for 1 MPa (10 bar) tubes;

3,13 MPa (31,3 bar) for 1,25 MPa (12,5 bar) tubes.

7.3 Deformation under pressure

This test shall be carried out on three tube assemblies. The tube length shall be approximately 300 mm between the end fittings.

Condition the tube assemblies for 24 h at 23 °C.

Draw a datum line at approximately 50 mm from the end fittings. Then measure the initial outer diameter and the initial length between these datum lines.

Fix one end of each sample.

Expose the samples for 1 h at (100 ± 2) °C and, during the last 5 min, subject them to an internal pressure of 125 % of the maximum working pressure. The pressure shall be gradually increased so as to reach the specified value after 30 s to 60 s.

One hour after stabilizing at 23 °C, check that:

a) the length between the datum lines does not deviate by more than 3 % from the initial measured length;

b) the outer diameter does not deviate by more than 10 % from the mean value of the initial measured diameter.

7.4 Cold impact test

7.4.1 Test procedure

This test shall be carried out on five tube samples 150 mm minimum in length with a test apparatus in accordance with annex C.

Condition the tube samples for 2 h at (– 40 ± 2) °C.

Within 5 s of removal from the cold cabinet, subject the samples to a cold impact test at 23 °C.

7.4.2 Requirements

The five tube samples shall exhibit neither cracks nor breaks.

Samples that are only deformed are considered to have passed the test.

If only one sample exhibits cracks or breaks, a further ten samples shall be tested. If more than one of these ten samples exhibits failure, then the tube is considered to have failed the test.

7.5 Impact test after heat ageing

The impact test shall be carried out on three tube samples about 150 mm in length, with a test apparatus in accordance with annex C.

Expose the samples in a circulating air oven to a temperature of (150 ± 2) °C for 72 h, then cool them down to 23 °C over a period of 4 h at 23 °C.

Then subject each sample to an impact test at this temperature.

The samples shall show no evidence of cracks or breaks.

7.6 Moisture absorption

This test shall be carried out on three tube samples approximately 40 mm in length.

Expose the samples for 24 h in a circulating air oven at (100 ± 2) °C. Remove them from the oven, weigh immediately and expose for 100 h at 100 % relative humidity at 23 °C.

After 5 min, remove surface moisture from both the interior and exterior surfaces of the tube and reweigh.

The moisture absorption shall be measured (by mass variation).

NOTE — The actual requirement will be determined by ISO/TC 22/SC 2 depending on the material itself.

7.7 Low temperature flexural test

This test shall be carried out on three straight tube or tube assembly samples 300 mm minimum in length.

Condition the samples in a cold chamber for 2 h at (– 40 ± 2) °C. Include a metallic mandrel with a diameter ten times the outer diameter of the tubing. After conditioning and within 60 s, bend the samples 180° min around the mandrel.

The samples shall show no evidence of damage (e.g. cracks, crazing, kinking).

After a four hour stabilization period at an ambient temperature of 23 °C, subject each sample to the burst test at 23 °C described in 7.2.1.1. The length necessary for the burst test shall include the wound area.

7.8 High temperature flexural test

This test shall be carried out on three tube or tube assembly samples 300 mm minimum in length.

Bend each sample 180° min over a metallic mandrel with a diameter ten times the outer diameter of the tube.

Subject the sample on the mandrel to a temperature of (100 ± 2) °C for a period of 70 h in a circulating air oven.

After a four hour stabilization period of the samples on the mandrel, at an ambient temperature of 23 °C, straighten each sample and rebend 180° in the opposite direction over the mandrel.

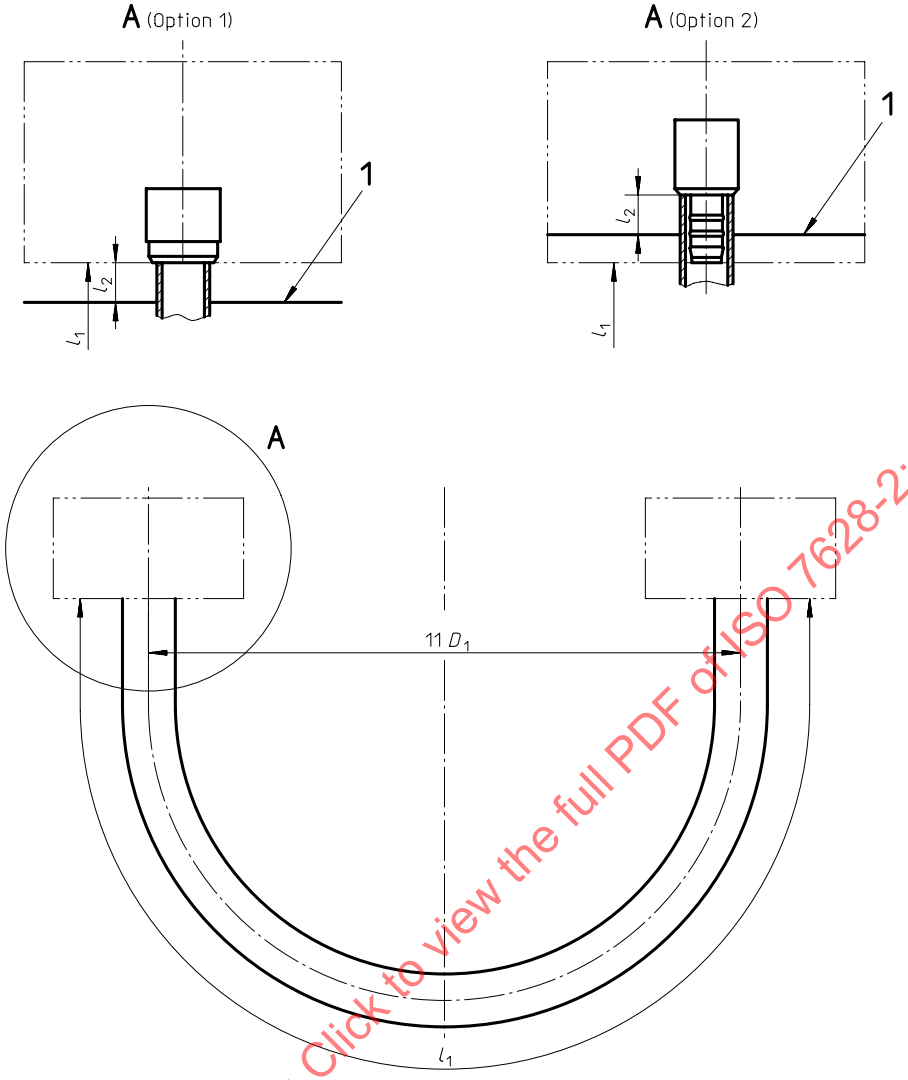
The samples shall show no evidence of damage (e.g. crack, crazing, kinking).

Subject each sample to a burst test at 23 °C (in accordance with 7.2.1.1); the length necessary for the burst test shall include the rewound area.

7.9 Stress cracking test

This test shall be carried out on six tube assemblies.

The tube assemblies shall be bent according to figure 1.



$$l_1 = \frac{11\pi D_1}{2} + 4\ D_1$$

$$l_2 = 5\ ^{+5}_{-0}\ \text{mm}$$

where

l_1 is the length of the free tube except the tube/fitting contact area;

l_2 is the distance between the tube and the solution surface;

D_1 is the outer diameter of the tube.

Key

1 Level of the solution

Figure 1

7.9.1 Test principle

The tube assembly samples shall be exposed for a certain period of time to a high level of humidity at 60 °C, with intermittent short immersions in a corrosive solution at ambient temperature.

7.9.2 Composition of the solution

The composition of the solution is as follows:

50 % water;

50 % mixture of:

30 % copper chloride,

20 % sodium chloride,

20 % potassium chloride,

30 % zinc chloride.

7.9.3 Test procedure

7.9.3.1 Immerse the samples into the bath at ambient temperature (avoiding contact between the fittings and the solution, see figure 1) for (5 ± 0,5) min. Place the tube assembly samples in a chamber at 60 °C with relative humidity greater than 85 % but avoiding condensation on the tube.

Repeat this immersion seven more times with an interval of 24 h between each immersion. One of the intervals may be of 72 h. Stop the test 24 h after the eight immersion. Inspect the tubes for cracks and breaks.

7.9.3.2 Carry out a burst test at 23 °C in accordance with 7.2.1.1.

7.9.4 Requirements

At the end of the procedure given in 7.9.3.1, the samples shall show no cracks or breaks.

After the procedure given in 7.9.3.2, the requirements of 7.2.2.1 shall be fulfilled, and the burst pressure shall be greater than 80 % of the reference value measured at 23 °C on samples from the same batch.

7.10 Resistance to ethanol

This test shall be carried out on three tube samples 300 mm minimum in length.

Bend each sample 180° minimum over a mandrel with a diameter ten times the outer diameter of the tubing.

Immerse the bent tube still on the mandrel, in 95 % ethanol for 200 h at an ambient temperature of 23 °C.

Remove the tube and straighten.

The samples shall show no evidence of cracking.

7.11 Resistance to battery acid

This test shall be carried out on three tube samples 300 mm minimum in length, sealed at each end.

Weigh the samples and measure their length, inner and outer diameter.

Bend each sample 180° minimum to a bend radius of five times the outer diameter of the tube and fix it.

Immerse the bent samples for 70 h in dilute sulphuric acid of mass per unit volume 1,275 g/cm^3 at a temperature of 23 °C.

Remove the samples from the test liquid, rinse and wipe them thoroughly.

Weigh and measure the samples again.

No dimensional change shall exceed ± 2 %.

Change in weight shall not exceed 2 %.

The tube shall show no evidence of cracking.

Then assemble end fittings onto the tube sample, and immediately perform the tensile test (see annex D). The samples shall withstand at least 80 % of the minimum applied tensile force given in table D.2

7.12 Resistance to oil

This test shall be carried out on either three 6 mm × 1 mm tube samples or three flat samples 25 mm wide, 1 mm thick and approximately 40 mm in length.

Determine the initial volume by the water displacement method according to ISO 1183, weighing to the nearest 1 mg. The water temperature shall be 23 °C.

Dry the test piece and place it in a container of oil with the following physical characteristics:

— aniline point: (69,5 ± 1) °C, measured according to ISO 2977;

— kinematic viscosity: (32 ± 2) × 10^{-6} m^2/s at 37,8 °C measured according to ISO 3104;

— minimum flash point: 165 °C measured according to ISO 2719.

The oil additives shall be chemically inactive with respect to the thermoplastic material.

Place the container in an oven at (70 ± 2) °C for 70 h. At the end of the soaking period, allow the sample to cool to ambient temperature in the test liquid, remove and wipe all traces of test liquid from all surfaces.

Determine the final volume by the same method as before immersion.

The average volume change shall not exceed 5 %.

7.13 Burning rate

This test shall be carried out on five tube samples approximately 350 mm in length, using the procedure specified in ISO 3795, replacing flat test specimen with tube samples of 12 mm × 1,5 mm.

The burning rate for each sample shall be less than 100 mm/min.

7.14 Artificial weathering test

Use a suitable radiation source with reproduceable spectrum and constant output as specified in ISO 4892-2. The preferred test device is a xenon arc test cabinet. Other cabinets using other types of light sources, for example an open-flame carbon arc, are acceptable, subject to agreement between the tube manufacturer and the end user.

Place three samples of one size of tube (12 mm × 1,5 mm) of about 150 mm length facing the lamp, ensuring that there is no movement of the samples during the test.

Expose samples to radiation according to method A of ISO 4892-2 or ISO 4892-4 with 550 W/m^2 irradiance:

a) for 750 h with the xenon arc lamp, at (55 ± 3) °C, or

b) for 400 h with an open-flame carbon arc lamp, at (65 ± 3) °C.

The test shall be carried out with water spray cycles, (18 ± 0,5) min spraying time and (102 ± 0,5) min dry interval, at a relative humidity of (65 ± 5) % for the dry interval.

Remove the samples from the cabinet and then assemble with end fittings. Subject the samples to a burst test at a temperature of 23 °C (in accordance with 7.2.1.1). All samples shall withstand 4 MPa (40 bar) for 1 MPa (10 bar) tubes [5 MPa (50 bar) for 1,25 MPa (12,5 bar) tubes] and at least 80 % of the burst pressure at 23 °C initially measured on samples from the same batch. The burst area shall be ductile. Brittle fractures shall be regarded as failures.

Annex A
(normative)

Characteristics of the appropriate PA11, PA12 and TEEE materials

This annex defines those PA11 types, PA12 types and TEEE types of materials which are currently used for tubing in air brake systems.

A.1 Specific characteristics

Table A.1 gives the characteristics of materials to be used for air brake systems.

Table A.1

Characteristic	Unit	PA11 types			PA12 types					TEEE type[2]
		PA11-P, EHL[1]		PA11-HIP, EHL[1]	PA12-P, EHL[1]	PA12-HIP,EHL[1]				TP4T/ PTMEG, EHL
		Type 1[11]	Type 2[11]			Type 1[11]	Type 2[11]	Type 3[11]	Type 4[11]	
Density[3]	—	1,04 to 1,06	1,04 to 1,06	1,03 to 1,05	1,02 to 1,04	1,01 to 1,04	1,01 to 1,04	1,02 to 1,04	1,01 to 1,03	1,22 to 1,26
Melting temperature[4]	°C	182 ± 5	182 ± 5	184 ± 5	172 ± 5	172 ± 5	172 ± 5	185 ± 5	174 ± 5	211 ± 5
Extractable content[5]	%	14 ± 2	10 ± 2	9 ± 2	14 ± 2	12 ± 2	8 ± 2	8 ± 2	9 ± 2	⩽ 3
Hoop strength at 23 °C[6]	MPa	⩾ 20	⩾ 22	⩾ 27	⩾ 20	⩾ 22	⩾ 25	⩾ 25	⩾ 27	⩾ 21
Tensile modulus[7]	MPa	350 to 450	350 to 450	450 to 600	350 to 450	350 to 450	400 to 500	350 to 450	450 to 600	290 to 450
Viscosity number[8]	ml/g	200 to 240	200 to 240	200 to 240	200 to 240	200 to 240	200 to 240	200 to 240	200 to 240	—[10]
Melt mass flow rate[9]	g/10 min	—[10]	—[10]	—[10]	—[10]	—[10]	—[10]	—[10]	—[10]	3,5 to 7

1) According to ISO 1874-1.
2) According to ISO 14910-1.
3) According to ISO 1183.
4) According to ISO 3146 method C.
5) According to ISO 6427.
6) According to clause A.2.
7) For PA11 and PA12 types, according to ISO 527-2 and ISO 1874-2. For TEEE types, according to ISO 527-2 and ISO 14910-2.
8) According to ISO 307.
9) According to ISO 1133 (load: 2,16 kg, temperature: 230 °C).
10) Not applicable.
11) Types 1, 2, 3 and 4 denote commonly available grades of material for air brake tubing.

A.2 Determination of the hoop strength at 23 °C

The hoop strength at 23 °C is calculated using the following formula:

$$\sigma_{23\,°C} = p_{B_{23\,°C}} \times \frac{D_1 - e}{2e}$$

where

$\sigma_{23\,°C}$ is the hoop strength at 23 °C, expressed in megapascals;

$p_{B_{23\,°C}}$ is the burst pressure at 23 °C, according to 7.2.1.1 and 7.2.2.2, expressed in megapascals;

D_1 is the maximum outer diameter measured on a sample to be burst, expressed in millimetres;

e is the minimum thickness measured on a sample to be burst, expressed in millimetres.

Annex B
(normative)

Alternative method for leak detection in leak-proof testing

B.1 Apparatus

See figures B.1 and B.2.

B.2 Procedure

Carry out the following operations to detect leaks in leak proof (or pressure resistance) testing (see annex D):

a) select test chamber to suit tube size;

b) remove test chamber end cap complete with glass sight tube;

c) remove gland nut and silicone sealing ring;

d) insert the tube sample to be tested with fitting already assembled into the test chamber;

e) slide silicone sealing ring and gland nut onto the tube;

f) position test fitting in chamber and tighten gland nut;

g) examine silicone sealing ring on test chamber head and replace head. Tighten;

h) connect test assembly to a high pressure line with a suitable adaptor;

i) fill test chamber with oil and continue to flush oil through until as much air as possible is forced from test chamber;

j) turn off oil discharge tap;

k) with sight glass vertical, allow air in the oil to collect at top of sight glass;

l) open vent valve at top of sight glass cove;

m) pump more oil through until all air is removed from top of sight glass;

n) close vent valve;

o) insert test chamber into hot or cold chamber;

p) carry out temperature test;

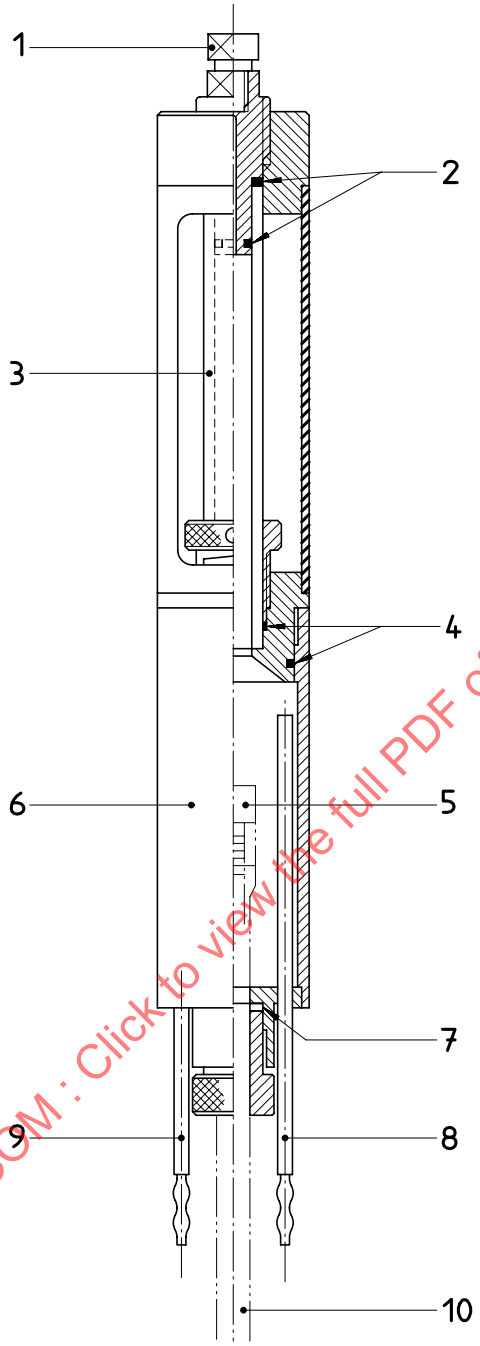
q) open oil discharge tap;

r) pressurize test tube to 150 % of the working pressure;

s) observe if air bubbles appear in glass sight tube;

t) fulfil test conditions as in clause D.4;

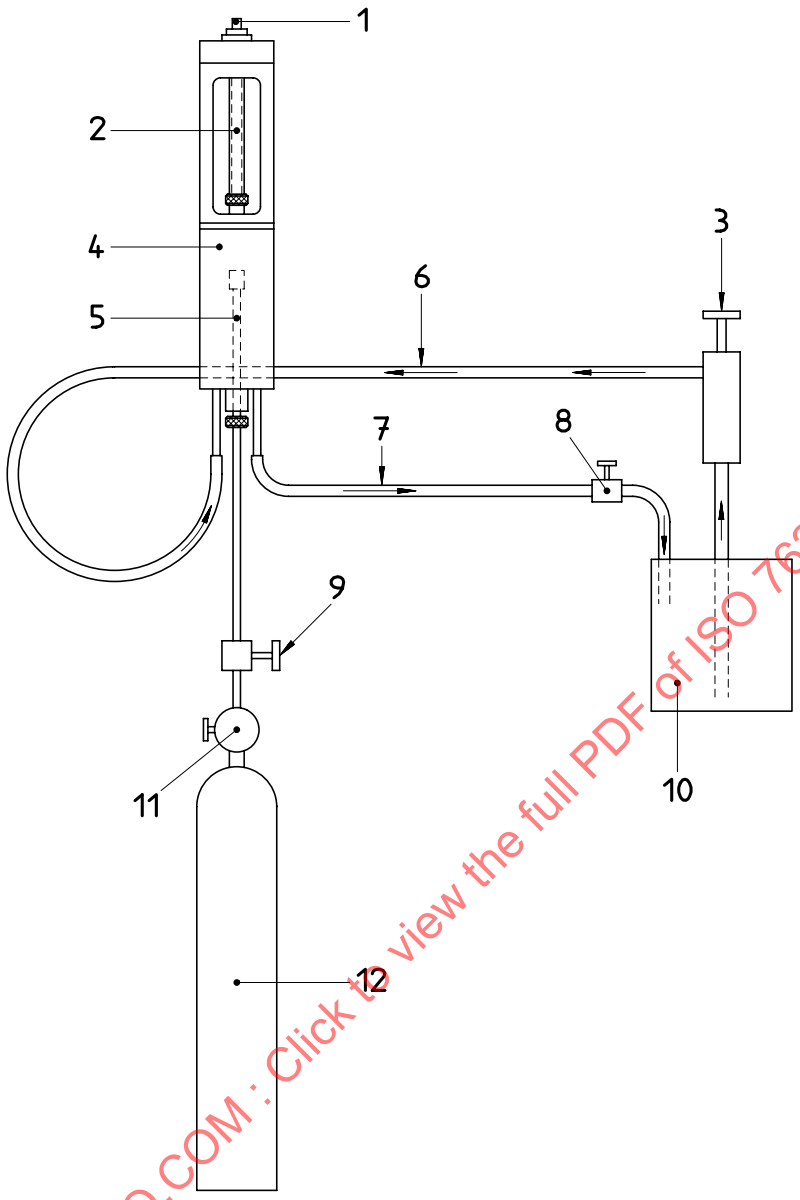
u) replace silicone sealing rings after 20 tests.



Key

1 Air bleed screw
2 Silicone seals
3 Sight glass
4 Silicone seals
5 Test fitting
6 Test chamber body
7 Seals
8 Bleed oil delivery pipe
9 Bleed oil return pipe
10 Test tube

Figure B.1 — Apparatus used for leak test



Key

1 Air oil bleed screw
2 Sight tube
3 Oil hamd pump blead
4 Test chamber
5 Test tube
6 Bleed oil delivery pipe
7 Oil return pipe
8 Shut off valve
9 High pressure valve
10 Oil tank
11 Pressure reducer valve
12 Neutral gas cylinder

Figure B.2 — Diagram of assembly for the leak test

Annex C
(normative)

Cold impact apparatus

C.1 Apparatus

The apparatus shall be in accordance with clause 5 of ISO 179-1:—, except for the following:

— subclause 5.1.4

The striking edge of the pendulum shall be as shown in figure C.1.

— subclause 5.1.6

Two specimen supports shall be used to retain the tube.

The supports shall be in accordance with figure C.2 and table C.1.

Dimensions in millimetres

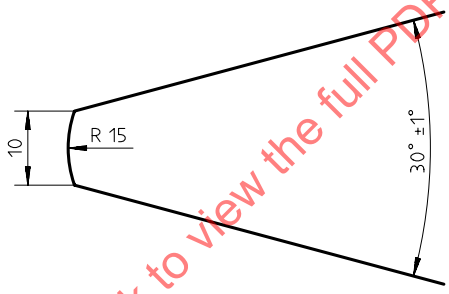
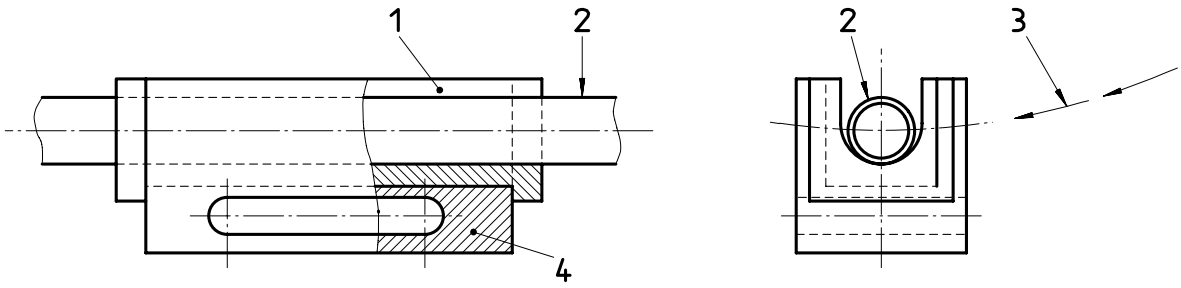
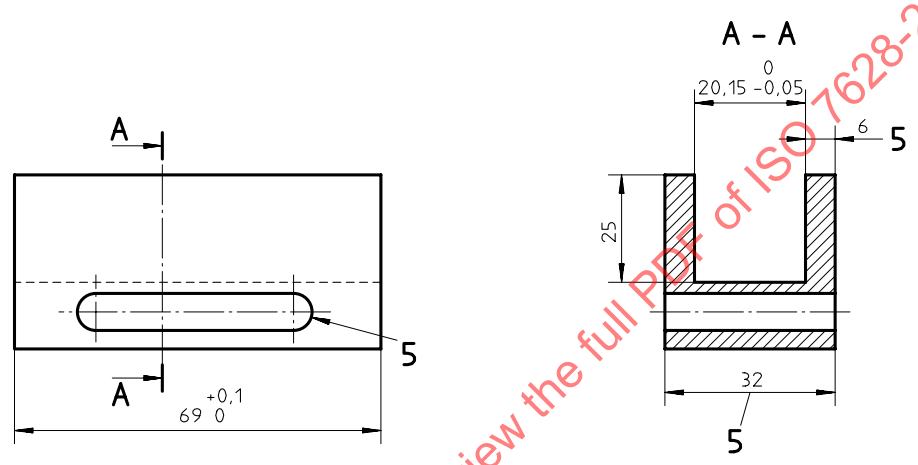


Figure C.1 — Pendulum striker

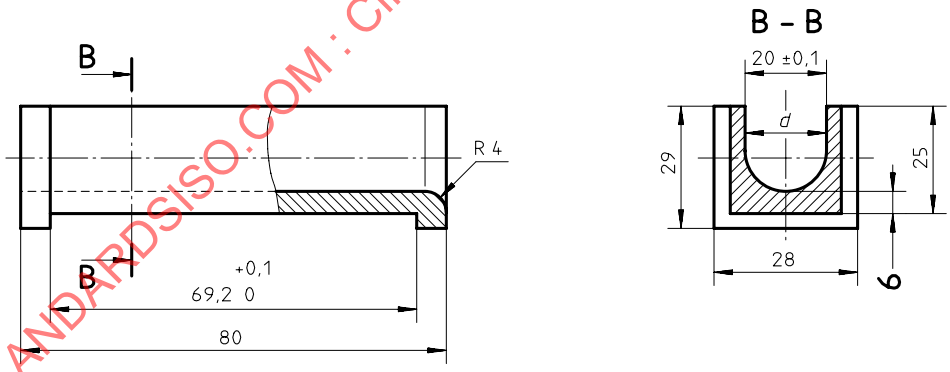
Dimensions in millimetres
Surface texture *Ra* = 6,3 µm



a) Assembled support showing tube sample in position



b) Part 1 (material: general purpose steel with a tensile strength of 370 N/mm^2 to 450 mm^2)



c) Part 2 [material: polyamid (PA) unsaturated polyester (UP), epoxyplastic (EP)]

Key

1 Part 2
2 Tube sample
3 Pendulum swing
4 Part 1
5 Dimensions 6 and 32, and the elongated hole may be changed to fit with any given apparatus.
6 Dimensions shall be such that the impact of the striking edge is in the centre of the specimen.

Figure C.2 — Sample support

Table C.1

Dimensions in millimetres

D_1	4	6	8	12	16
D_2	7	9	9	17	17

The supports shall be firmly fixed to the lower part of the frame so that:

a) the supporting surfaces of the two supports are in line with each other and perpendicular to the pendulum swing plane;

b) the front ends of the supports with the radius of 4 mm face each other;

c) the distance between supports is in accordance with table C.2.

Table C.2

Dimensions in millimetres

D_1	4	6	8	12	16
Distance between supports	35	40	50	60	70

The supports shall be adjusted in such a way that the impact of the striking edge is in the middle of the two supports within ± 0,5 mm.

The test apparatus shall have the following characteristics:

— impact energy: 7,5 J;

— velocity at impact: 3,8 m/s (± 5 %).

C.2 Procedure

The test procedure shall be in accordance with ISO 179-1.

Furthermore, the specimens shall be straightened and kept in a straight position. Pins may be inserted to keep the specimen straight but must be removed before testing.

Annex D
(normative)

Tests on tube assemblies (tube with end fittings)

D.1 General

These tests shall be performed with approved end fittings (see 5.1). The same type of fittings shall be used throughout all tests of this annex.

For the purpose of these tests, the tube assembly samples shall be at least 72 h old. Unless otherwise stated, the tests are performed at an ambient temperature of (23 ± 2) °C, a relative humidity between 45 % and 75 %, and unpressurized.

D.2 List of tests according to tube material

Depending on the material of the tube, table D.1 defines the list of appropriate tests to be performed on all sizes of the tube assemblies. An "X" means the test item shall apply to the corresponding material.

Table D.1 — List of tests

Test item	PA11 types[1)]	PA12 types[1)]	TEEE types[1)]	Other material
Tensile	X	X	X	X
Leak	X	X	X	X
Pulsating pressure fatigue	X	X	X	X
Vibration	X	X	X	X
Stress cracking[2)]			X	X

1) PA11 types, PA12 types and TEEE types are defined in annex A.
2) Applicable only when fir-tree fittings are used.

D.3 Tensile test

This test shall be conducted on three samples of tube assemblies. The tube length shall be 150 mm between the end fittings.

Subject each tube assembly via the end fittings to an axial tensile force specified in table D.2 at a rate of 25 mm/min.

No loosening or pull off shall occur. Neither the tube nor the fittings shall fail.

Table D.2 — Minimum applied tensile force

Outside diameter, mm	4	6	8	12	16
Minimum tensile force, N	170	300	450	900	1 200

D.4 Leak test

The test shall be carried out on three tube assemblies and consists of a temperature cycle from + 100 °C to – 40 °C. The tube assemblies shall be held under pressure with inert gas or dry air. The free length of the tube shall be at least 150 mm.