TECHNICAL REPORT 7628/2

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Road vehicles — Thermoplastics tubing for use in air braking systems — Part 2 : Installation on the vehicle and test methods

Véhicules routiers — Tuyauteries thermoplastiques pour freinage pneumatique — Partie 2 : Conditions de montage sur le véhicule et méthodes d'essai

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ISO/TR 7628/2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

The reasons which led to the decision to publish this document in the form of a technical report type 2 are explained in the Introduction.

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0 Introduction

Certain technical objections were offered by member bodies at the final vote on ISO/DIS 7628/2. They referred particularly to the cold impact test and to ultraviolet resistance : it was therefore agreed to carry out further testing with the purpose of reaching solutions based on wider experience.

In the interim, it was proposed that part 2 of ISO 7628 be published in its present form but deleting the cold impact test, as a Technical Report of type 2. Publication thereby allows dissemination of that part of the work which has already been generally agreed.

1 Scope

This Technical Report (ISO/TR 7628/2) specifies minimum requirements for material, installation on the vehicle and test requirements for thermoplastics tubing for use in air braking systems on road vehicles.

Part 1 of ISO 7628 covers dimensions and marking.

2 Field of application

Tubing meeting the requirements of this Technical Report is suitable for use up to a maximum working pressure of 1 000 kPa (10 bar) and a temperature of −40 to +100 °C.

Coiled tubing for use between tractor and trailer is not covered by this Technical Report.

3 References

ISO 1874/1, *Plastics — Polyamide (PA) homopolymers for moulding and extrusion — Part 1 : Designation.*

ISO 105/A, *Textiles — Tests for colour fastness — Part A : General principles.*

ISO 3795, *Road vehicles — Determination of burning behaviour of interior materials for motor vehicles.*

ISO 4080, *Rubber products — Hoses — Determination of gas permeance.*

4 Materials

Thermoplastics tubing, for example polyamide PA 11 or PA 12 (see ISO 1874/1), shall be extruded from 100 % virgin material. Reinforcement of polyester or equivalent may be used for reinforced tubing.

NOTE — The work in formulating this Technical Report has shown that black-coloured tubing complying with it is capable of long service life. Black colour is obtained by incorporating carbon black which, combined with other additives, improves the resistance to heat and light. The work does not permit evaluation of the performance of tubing in other colours.

5 Installation on the vehicle

5.1 Use of the connections on the vehicle

Conformity to this Technical Report ensures that tubing and connections assembled according to the requirements of the connection manufacturer and tested as a unit can be used in braking systems.

5.2 Installation precautions

The installation conditions indicated by the connection manufacturer shall be respected.

Ensure that tubing and associated connections have been tested as an assembly according to this Technical Report (see annex B).

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

6 Tests

6.1 Quality and surface aspect

The tubing shall show no manufacturing faults, voids, cracks or lack of homogeneity which may affect service use. Additives shall be evenly spread throughout the material.

6.2 Strength test

This test shall be conducted on three new samples of tubing each fitted with connectors, with the assemblies unpressurized, at an ambient temperature of 23 ± 2 °C and a relative humidity of 50 ± 5 %. The length of the tubing shall be 150 mm between the connectors.

Subject each assembly, via the connectors, to the relevant axial tensile force specified in table 1 at a rate of 100 mm/min.

No loosening or slipping shall occur.

Table 1 — Minimum tensile force

Outside diameter, mm	6	8	12	16
Tensile force, N, min.	300	450	900	1 200

6.3 Leak test

This test shall be carried out on three assemblies with lengths of tubing approximately 300 mm between the connectors.

The test consists of a temperature cycle from +100 to −40 °C. The assemblies shall be immersed in silicone oil[1)] and held under pressure with an inert gas or dry air.

Leak detection may be carried out by using either the principle of the test method described in ISO 4080 or with the method shown in annex A[2)].

The temperature cycle and pressure test comprises the following steps :

— immerse the assembly in silicone oil at 100 ± 2 °C for 1 h. At this temperature, subject the assembly under test to a pressure of 1 500 kPa (15 bar) for 1 min;

— return to atmospheric pressure and allow the test device to cool to ambient temperature;

— then reduce the temperature to −40 ± 2 °C and maintain for 4 h. At this temperature, subject the assembly under test to a pressure of 1 500 kPa (15 bar) for 1 min;

— return to atmospheric pressure;

— increase the temperature to 23 ± 2 °C and maintain for 1 h. At this temperature, again subject the assembly under test to a pressure of 1 500 kPa (15 bar).

During the whole temperature cycle no visible leakage shall occur.

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1) Silicone oil characteristics :

Colourless, viscosity at 25 °C	: 20×10^{-6} m^2/s (20 cSt)
Density at 25 °C	: 0,950
Refraction index	: 1,400
Gel point	: −60 °C
Surface tension	: 2 N/m^2
Flash point	: 230 °C

2) The latter method presents fewer operational hazards.

6.4 Burst test

6.4.1 Hoop strength

This test shall be made on five assemblies. The length of the tubing between the connectors shall be approximately 450 mm.

Each assembly shall be capable of withstanding induced stress of 20 000 kPa given by the formula

$$p \geqslant \sigma \frac{2e_{min}}{D_{max} - e_{min}}$$

where

p is the pressure for instantaneous burst, in kilopascals;

σ is the maximum induced stress during the test, in kilopascals;

e_{min} is the smallest measured wall thickness, in millimetres, after conditioning (see 6.4.2);

D_{max} is the maximum average outside diameter, in millimetres, after conditioning.

6.4.2 Conditioning of assemblies

6.4.2.1 Tubes that are more than two weeks (336 h) old after extrusion

Place the samples in air at 23 ± 2 °C with 50 ± 5 % relative humidity for two weeks.

6.4.2.2 Tubes that are less than two weeks (336 h) old after extrusion

Immerse in boiling water as follows

- for 30 min for tubes 0,5 to 1,0 mm inclusive nominal wall thickness;
- for 60 min for tubes 1,25 to 2,5 mm inclusive nominal wall thickness.

Cool in water at 23 ± 2 °C for 10 to 15 min.

Dry and keep for the following times before testing at 23 ± 2 °C and 50 ± 5 % relative humidity :

- 1 h min. for tubes 0,5 to 1,0 mm inclusive nominal wall thickness;
- 2 h min. for tubes 1,25 to 2,5 mm inclusive nominal wall thickness.

6.4.3 Test procedure

Hydrostatic pressure shall be applied smoothly without pulsation by means of a hydraulic pump or accumulator system, incorporating a pressure gauge calibrated in kilopascals. Prior to the application of pressure, ensure that no air is present within the system.

The pressure is then applied so as to cause the tube to burst between 30 and 120 s after pressure is applied (optimum time 100 s).

The burst pressure is the maximum pressure obtained during test.

All five samples shall have a burst pressure higher than the calculated limit in 6.4.1. Fittings shall not separate from the tubing nor shall the assembly visibly leak at less than this limit.

6.5 Deformation under pressure

This test shall be carried out on three assemblies. The length of tubing shall be approximately 450 mm between the connectors.

Condition the assemblies for 24 h at 23 ± 2 °C.

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

Fix one end of the sample.

Expose for 1 h at 100 ± 2 °C and subject the assemblies to an internal pressure of 1 250 ± 50 kPa (12,5 ± 0,5 bar) during the last 5 min.

Check, 1 h after return to 23 ± 2 °C, that :

— the length of the tubing does not deviate by more than ± 3 % from the initial measured length;

— the outside diameter does not deviate by more than ± 10 % from the mean value of the initial measured diameter.

6.6 Cold impact test

(Under study)

6.7 Hot impact test

Three new samples of about 200 mm in length shall be tested.

Expose the samples in a circulating air oven to a temperature of 150 ± 2 °C for 72 h and then cool to 23 ± 2 °C.

After 30 min at this temperature, subject each sample to impact testing. (Test apparatus is under study.)

The tubing shall show no evidence of cracks.

6.8 Moisture absorption

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

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

After 5 min, wipe surface moisture from both the interior and exterior surfaces of the tubing and reweigh. The moisture absorption shall not exceed 2 % by mass.

6.9 Flexibility under low temperature

This test shall be carried out on three new, straight samples of tubing of approximately 450 mm in length.

Place the samples in a cold room for 5 h at −40 ± 2 °C. Include a metallic mandrel of diameter 10 times the outside diameter of the tubing. Remove the samples and, within 1 min, bend them 180° over the mandrel.

The samples shall show no evidence of damage.

Within 30 min after stabilization at ambient temperature (23 ± 2 °C), subject each sample successively to the burst test (6.4).

6.10 High temperature flexion test

This test shall be carried out on three new samples of tubing approximately 450 mm in length.

Bend each sample 180° min. over a metallic mandrel, the outside diameter of which shall be 10 times the outside diameter of the tubing.

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

After the assembly has returned to ambient temperature (23 ± 2 °C), straighten each sample and bend over the mandrel again.

The samples shall show no evidence of damage.

Subject each sample successively to a burst test (see 6.4) (taking the necessary length from the rewound area).

6.11 Resistance to zinc chloride

This test shall be carried out on three samples of tubing approximately 450 mm in length.

Bend each sample 180° min. over a metallic mandrel, the outside diameter of which shall be equal to 10 times the outside diameter of the tubing.

Immerse the whole assembly in a 50 % (m/m) aqueous solution of zinc chloride for 200 h at ambient temperature (23 ± 2 °C).

Remove the tubing, and straighten.

The samples shall show no evidence of cracking.

6.12 Resistance to methyl alcohol

This test shall be carried out on three samples of tubing approximately 450 mm in length.

Bend each sample 180 ° min. over a metallic mandrel, the outside diameter of which shall be equal to 10 times the outside diameter of the tubing.

Immerse the tubing on the mandrel in 95 % methyl alcohol for 200 h at ambient temperature (23 ± 2 °C).

Remove the tubing and straighten.

The samples shall show no evidence of cracking.

6.13 Resistance to battery acid

This test shall be carried out on three new samples of tubing approximately 300 mm in length.

Weigh and measure the samples.

Immerse for 70 h in dilute sulfuric acid of density 1,275 g/cm^3, at a temperature of 23 ± 2 °C.

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

Weigh and measure the samples. Then carry out the tensile test (6.2) on tubing with fittings; they shall withstand at least 80 % of the minimum tensile force of table 1.

No change in dimension shall exceed ± 2 %.

Water absorption shall not exceed 2 %.

The tubing shall show no evidence of cracking.

6.14 Resistance to oil

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

Determine the initial volume, V_1, by the water displacement method, weighing to the nearest 0,001 g. The water temperature shall be 23 ± 2 °C.

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

Aniline point : 69,5 ± 1 °C

Kinematic viscosity : 32 ± 2 m^2/s × 10^{-6} at 37,8 °C

Flash point : 165 °C min.

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

Determine the final volume, V_2, by the same method as before immersion.

The volume change shall not exceed 5 %.

6.15 Resistance to combustion

This test shall be carried out on five samples of tubing approximately 350 mm in length using the test procedures as specified in ISO 3795.

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

6.16 Ultraviolet resistance

This test shall be carried out on three samples of tubing approximately 450 mm in length.

The samples shall be submitted to the tests in ISO 105/A. They shall be exposed to light in the conditions of isolation and for the time necessary to produce fading of standard blue dye No. 7 to a contrast equal to No. 4 on the grey scale.

Then subject the sample to a cold impact test (under study).

Tubing shall show no evidence of cracks.

Then subject each sample to the burst pressure test (6.4).

Tubing shall withstand at least 75 % of the calculated burst pressure as indicated in 6.4.1.

Annex A

Alternative method for leak detection in leak-proof testing

A.1 Apparatus

See figures 1 and 2.

A.2 Procedure

Carry out the following operations to detect leaks in leak-proof (or pressure resistance) testing (see 6.3) :

a) Select test chamber to suit hose size.

b) Remove test chamber end cap complete with glass sight tube.

c) Remove gland nut and silicone sealing ring.

d) Insert the tube to be tested with fir tree already assembled into the test chamber.

e) Slide silicone sealing ring and gland nut onto the tube.

f) Position test fir tree in chamber and tighten gland nut.

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

h) Couple test tube high pressure line with 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 cover.

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 1 500 kPa (15 bar).

s) Observe if air bubbles appear in glass sight tube.

t) Fulfil test conditions as in 6.3.

u) Replace silicone sealing rings after 20 tests.

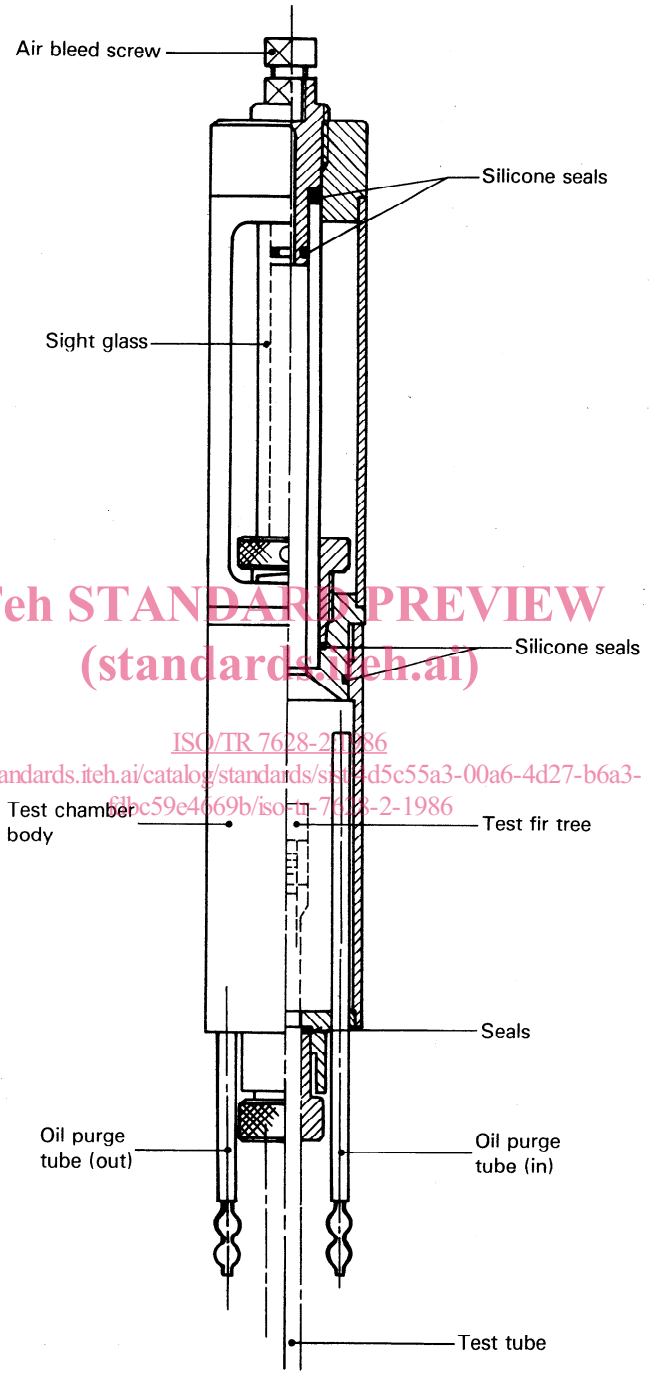

Figure 1 — Apparatus used for the leak test