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

*Tuyaux et flexibles en caoutchouc et en plastique — Essais
hydrostatiques*



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ISO 1402:2009(E)

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Foreword

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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 1402 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 1402:1994), which has been technically revised.

Rubber and plastics hoses and hose assemblies — Hydrostatic testing

1 Scope

This International Standard specifies methods for the hydrostatic testing of rubber and plastics hoses and hose assemblies, including methods for the determination of dimensional stability.

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

ISO 7751, *Rubber and plastics hoses and hose assemblies — Ratios of proof and burst pressure to design working pressure*

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

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

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

4 General

Unless otherwise specified, all tests shall be carried out at standard temperature (see ISO 23529).

5 Apparatus

5.1 Pressure source, capable of applying pressure at the rate specified in 7.2.2, up to the required test pressure.

5.2 Calibrated pressure gauge or pressure transducer with digital readout, chosen for each test so that the test pressure is between 15 % and 85 % of the full-scale reading.

In the interest of accuracy, calibrated pressure gauges or pressure transducers with digital readouts shall be checked at frequent intervals and the fitting of restrictors is recommended to minimize shock damage.

5.3 Dimensional equipment, sliding vernier callipers or micrometer, length measuring tape, circumferential measuring tape (π tape).

6 Test pieces

6.1 Hose assemblies

When hose assemblies are to be tested, the manufactured assembly length shall be used for the test.

6.2 Hoses

The hydrostatic pressure and burst tests shall be carried out on a hose test piece with a minimum free length, excluding end fittings and end reinforcements, of 600 mm when deformation is to be measured and 300 mm when it is not. When a longer test length is required for a particular hose type or size, it must be specified in the individual hose product specification.

6.3 Number of test pieces

At least two test pieces shall be tested.

7 Application of hydrostatic pressure

7.1 General

Water or another liquid suitable for the hose under test shall be used as the test medium.

WARNING — Hoses and hose assemblies pressurized by liquids can fail in a potentially dangerous manner. For this reason, the test shall be performed in a suitable enclosure. Also, the use of air and other gases as test media shall be avoided because of the risk to operators. In special cases, where such media are required for the tests, strict safety measures are imperative. Furthermore, it is stressed that, even when a liquid is used as the test medium, it is essential that all air is expelled from the test piece because of the risk of injury to the operator due to the sudden expansion of trapped air released when the hose bursts.

7.2 Procedure

7.2.1 Fill the test piece with test liquid, expelling all air, and connect to the test equipment. Close the valve and apply the hydrostatic pressure at a uniform rate of increase. Measure the pressure using a calibrated pressure gauge or pressure transducer with digital readout (5.2).

IMPORTANT — It is important to allow unrestricted movement of the free or plugged end of the test piece during the test.

7.2.2 The rate of pressure increase shall be constant and chosen to reach the final pressure after a period of between 30 s and 60 s for hoses with nominal inside diameters up to 50 mm. For hoses with nominal inside diameters greater than 50 mm and less than or equal to 250 mm, the time needed to reach the final pressure shall be between 60 s and 240 s. For hoses with nominal inside diameters greater than 250 mm, the time needed to reach the final pressure shall be decided between the manufacturer and the user.

8 Hydrostatic pressure tests

8.1 Proof pressure hold test

When proof pressure tests are used to determine leakage of hoses or hose assemblies, apply the specified proof pressure in accordance with 7.2.2 and hold it neither for less than 30 s nor for more than 60 s, unless otherwise specified in the product standard, examining the test pieces during this period for evidence of leakage, cracking, abrupt distortions indicating irregularity in material or manufacture, or other signs of failure.

Unless otherwise specified for the hose, the proof pressure shall be related to the maximum working pressure by the ratio given in ISO 7751.

NOTE 1 This text uses the term “maximum working pressure” instead of the deprecated term “design working pressure”.

NOTE 2 The test is not applicable to curved hose.

8.2 Measurement of deformation under pressure

8.2.1 General procedure

8.2.1.1 Setting up the test piece

When tests for determining change in length, change in outside diameter and twisting and/or warping are required, straighten the hose or hose assembly, lay it out horizontally for inspection and apply a hydrostatic pressure of 0,7 bar (0,07 MPa). This is necessary to stabilize the hose/hose assembly. Apply this pressure approximately 5 min after completion of the proof pressure test. The supporting surface upon which the hose/hose assembly rests shall be flat and smooth enough to allow the hose/hose assembly to expand or contract without restriction. Alternatively, the hose/hose assembly may be supported on rollers, or suspended vertically. When a section of hose is used as a test piece, it may also be placed in a test rig in a vertical position.

8.2.1.2 Reference marks

For long hoses or hose test pieces (see 6.2), while maintaining the pressure, make three reference marks (A, B and C) on the outer surface, the middle mark (B) being made approximately midway along the length of the hose, and the outer marks (A and C) 250 mm (minimum) from B. Each mark shall consist of an arc on the circumference of the hose through which is drawn a straight line perpendicular to the arc, the three lines being co-linear (see Figure 1).

For hose assemblies, measure the distance between the contact faces of the end fittings, or place the reference marks on the hose surface near the end of the inserted part of the fitting.

8.2.1.3 Measurement of initial dimensions

Maintain the initial pressure of 0,7 bar (0,07 MPa) for approximately 5 min and make the appropriate measurements (see 8.2.2, 8.2.3 and 8.2.4) at the reference marks A and C with an accuracy of ± 1 mm using the measuring tape (see 5.3) and record these. Also measure the external diameter or circumference accurately.

8.2.2 Change in length at the specified test pressure

NOTE The test pressure will be specified in the appropriate hose product specification and could be the maximum working pressure (see Note 1 to 8.1), the proof pressure or any other pressure below the proof pressure at which the hose deformation characteristics are to be measured.

Raise the pressure to the test pressure specified in the hose product standard at the rate specified in 7.2.2 and maintain it for 5 min (or longer when specified in the hose product standard). At the end of this period,

measure the length between the reference marks A and C or, in the case of hose assemblies, between the contact faces of the end fittings, with an accuracy of ± 1 mm, using the measuring tape (see 5.3) and record these values.

Calculate the change in length, Δl , expressed as a percentage of the original length, from the equation

$$\Delta l = \frac{100 \times (l_1 - l_0)}{l_0}$$

where

l_0 is the distance between the reference marks A and C or the overall length (hose assemblies) measured at the initial pressure of 0,7 bar (0,07 MPa), in metres;

l_1 is the distance between reference marks A and C measured at the specified test pressure, in metres.

The percentage change in length, Δl , will be positive (+) in the case of an increase in length and negative (–) in the case of a decrease in length.

For an illustration of the test procedure, see Figure 3.

8.2.3 Change in external diameter at the specified test pressure, measured at the approximate middle of the hose assembly

8.2.3.1 General

The external diameter should preferably be determined from measurements of circumference made with an accuracy of 1 mm using the circumferential measuring tape (see ISO 4671). The measurements may, however, be made directly, using sliding vernier callipers having a minimum useful tip width of 5 mm.

8.2.3.2 Determination by measuring the change in external circumference

Using the circumferential measuring tape (see 5.3), measure the circumference at each of the three reference marks (A, B and C) at the initial pressure of 0,7 bar (0,07 MPa) (see 8.2.1.3) and at the specified test pressure (during the measurement period described in 8.2.2).

Calculate the change in diameter, ΔD , expressed as a percentage of the original diameter, from the equation

$$\Delta D = \frac{100 \times (\sum C_1 - \sum C_0)}{\sum C_0}$$

where

$\sum C_0$ is the sum of the circumferences at the three reference marks measured at the initial pressure;

$\sum C_1$ is the sum of the circumferences at the three reference marks measured at the specified test pressure.

8.2.3.3 Direct measurement of change in external diameter

Using the sliding vernier callipers (5.3), measure two perpendicular diameters at each of the three reference marks at the initial pressure of 0,7 bar (0,07 MPa) (see 8.2.1.3) and at the specified test pressure (during the measurement period described in 8.2.2).

Calculate the change in diameter, ΔD , expressed as a percentage of the original diameter, from the equation

$$\Delta D = \frac{100 \times (\sum D_1 - \sum D_0)}{\sum D_0}$$

where

$\sum D_0$ is the sum of the six diameters measured at the reference marks at the initial pressure;

$\sum D_1$ is the sum of the six diameters measured at the reference marks at the specified test pressure.

8.2.4 Twisting at the specified test pressure

If twisting of the hose develops under pressure, the original lines forming the reference marks will take up a helical pattern (see Figure 2).

With the hose at the specified test pressure (during the measurement period described in 8.2.2), project a straight line along the length of the hose from reference mark A until it intersects, at C' , the circular arc at reference point C. Alternatively, for short hose assemblies, the reference marks A and C may be placed on the end fittings or on the section of the hose covering the fitting tails.

Then measure the length, s , of the circular arc CC' to the nearest millimetre, using the measuring tape (5.3).

Calculate the amount of twisting per metre, T , expressed in degrees, from the equation

$$T = \frac{s \times 360}{C_c \times l_0}$$

where

s is the length of the circular arc CC' , in millimetres;

C_c is the circumference at reference mark C, in millimetres, measured as described in 8.2.3.1;

l_0 is the distance between A and C, in metres, as measured in 8.2.2.

8.2.5 Warping at the specified test pressure

Warping in hose tests is the deviation from a straight line drawn from fitting to fitting in a plane parallel to the surface on which the hose rests at the initial pressure of 0,7 bar (0,07 MPa). A tightly stretched cord may be used to establish the straight line from centre to centre of the fittings. The amount of warping at the specified test pressure is the maximum deviation of any portion of the hose from the straight line drawn from centre to centre of the fittings at the initial pressure. Express warping as the distance from this line to the centreline of the hose at the point of maximum deviation. Report the result to the nearest 5 mm.

8.3 Burst pressure test

Increase the pressure at a rate in accordance with 7.2.2 until the hose or hose assembly fails. The position and mode of failure shall be recorded in the test report.

For an illustration of the test procedure, see Figure 3.

8.4 Leakage test

8.4.1 Test pieces

The test pieces for the leakage test shall comprise unaged hose assemblies on which the end fittings have been attached for not more than 30 days and not less than 1 day.

8.4.2 Procedure

Subject the test assemblies to a specified hydrostatic pressure equal to 70 % of the specified minimum burst pressure. Maintain this specified test pressure for $5 \text{ min} \pm 0,5 \text{ min}$ and then reduce it to zero. Re-apply the specified test pressure and maintain it for a further period of $5 \text{ min} \pm 0,5 \text{ min}$. This is considered to be a destructive test and the test assemblies shall be destroyed after test.

8.4.3 Criteria for failure

There shall be no leakage or evidence of failure. Leakage at the end fitting, fitting blow-off or rupture of the hose adjacent to the fitting shall be considered as failures in the performance of the assembly.

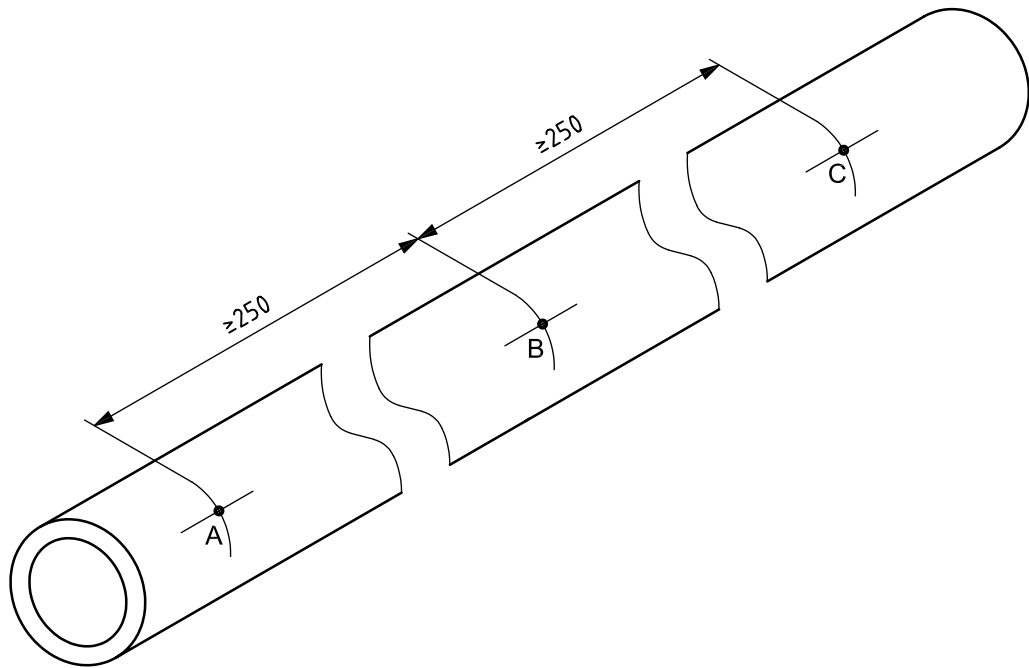
NOTE Such failures do not necessarily demonstrate an inability of the hose to meet the specified requirements with an alternative fitting.

9 Test report

The test report shall include the following particulars for each test undertaken:

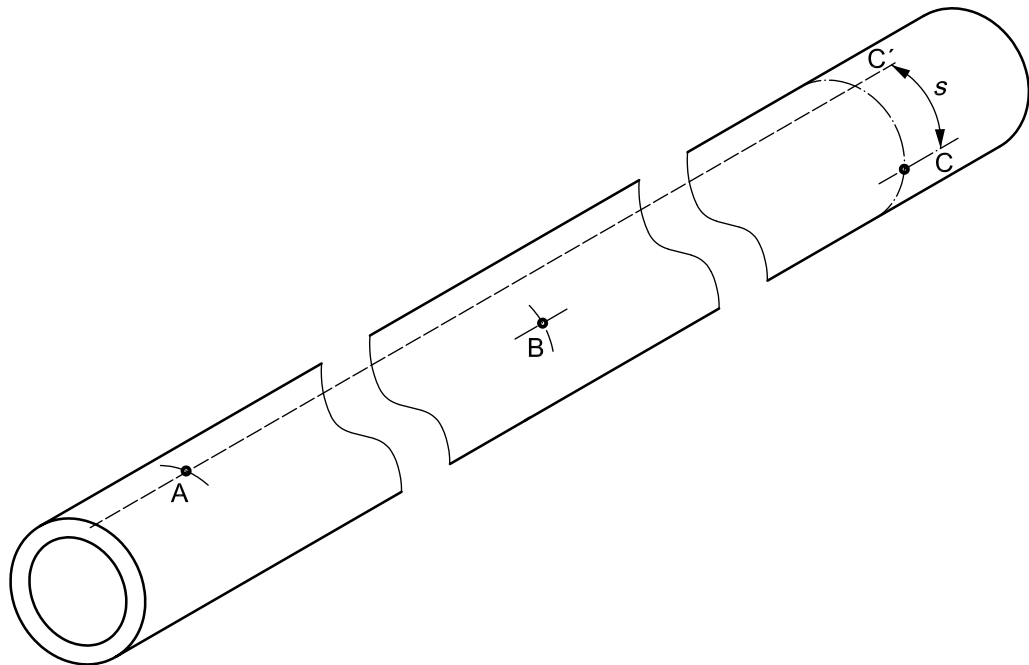
- a) a full description of the hose and, where applicable, the hose assembly tested;
- b) a reference to this International Standard with year of publication, i.e. ISO 1402:2009;
- c) the method used;
- d) the number of test pieces tested and the length of each test piece;
- e) the test pressure and rate of pressure increase;
- f) the test medium (if other than water);
- g) the results obtained for each test piece;
- h) if the test piece fails, the position and mode of failure;
- i) any unusual features noted during the test;
- j) the date of the test.

Dimensions in millimetres



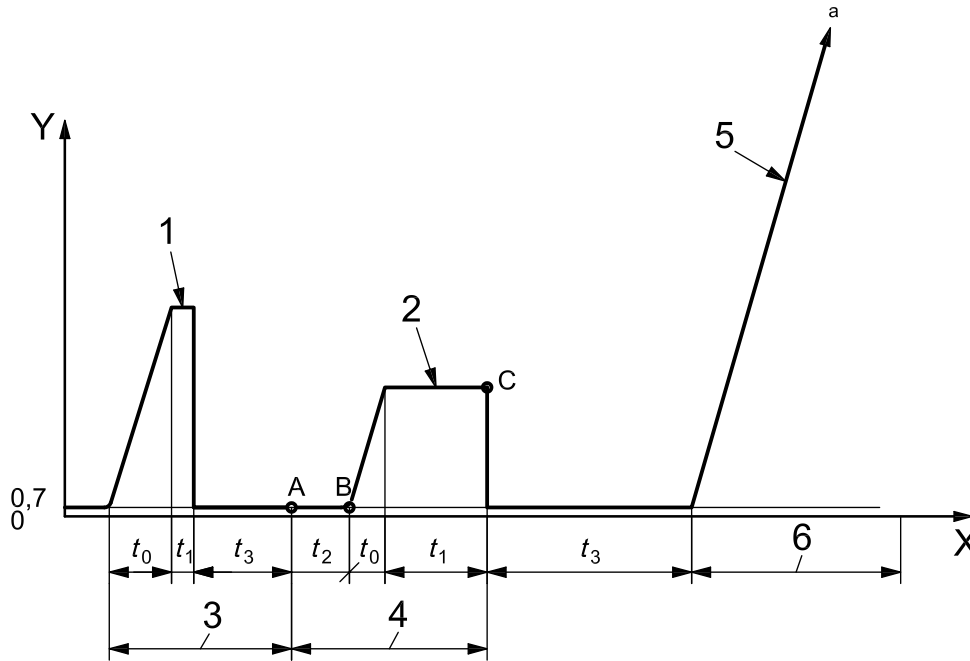
NOTE This also applies to hose assemblies. (End fittings are not shown in this figure.)

Figure 1 — Measurement of dimensional stability



NOTE This also applies to hose assemblies. (End fittings are not shown in this figure.)

Figure 2 — Measurement of amount of twisting



Key

X time, t
 Y pressure, p (bar or MPa)

- 1 proof pressure
- 2 testing pressure
- 3 detecting of leakage and defects
- 4 measuring
- 5 bursting pressure
- 6 bursting

- t_0 specified pressure increasing time
- t_1 specified pressure holding time
- t_2 initial dimensions (length and diameter) at reference pressure [0,7 bar (0,07 MPa)] measuring time
- t_3 specified waiting time between different pressures

a To burst.

This complete test sequence (proof pressure — testing pressure — bursting pressure) only applies to “type tests”. For routine tests, the “measuring sequence” after the proof pressure is only applicable when the relevant hose product standard specifies this.

Measure the initial length and diameter/circumference and place reference marks for twist measurement between points A and B. Measure the increase in the length, diameter/circumference, twist and warping directly in front of point C.

Figure 3 — Example of a hydrostatic test sequence as specified in this International Standard

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