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Hydraulic fluid power — Hoses and hose assemblies — Test methods

*Transmissions hydrauliques — Tuyaux et ensembles flexibles — Méthodes
d'essai*



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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6605 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components*.

This second edition cancels and replaces the first edition (ISO 6605:1986), which has been technically revised.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. A hose assembly is a flexible fluid power conductor consisting of a length of hose attached, at both ends, to hose fittings.

Hydraulic fluid power — Hoses and hose assemblies — Test methods

1 Scope

This International Standard specifies uniform test methods for evaluating the performance of hoses and hose assemblies (hoses and attached hose fittings) used in hydraulic fluid power systems.

Specific tests and performance criteria for evaluating hoses and hose assemblies used in hydraulic applications are in accordance with the requirements of the respective product (hoses or hose fitting) specifications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 471, *Rubber — Temperatures, humidities and times for conditioning and testing*

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

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

ISO 4671:1999, *Rubber and plastics hoses and hose assemblies — Methods of measurement of dimensions*

ISO 4957, *Tool steels*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 6133, *Rubber and plastics — Analysis of multi-peak traces obtained in determinations of tear strength and adhesion strength*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 5598 apply.

4 Visual examination of product

Hose assemblies shall be visually inspected to determine that the correct hose fittings are properly installed.

5 Standard tests

5.1 Dimensional check test

5.1.1 General

NOTE These test methods are technically equivalent to those specified in ISO 4671.

The hoses shall be inspected for conformity with all the dimensions of the relevant hose specification.

5.1.2 Measurement of outside and reinforcement diameters

5.1.2.1 Determine finished outside diameter and reinforcement diameter, where required, by calculation from measurement of the respective circumference. As an alternative, a flexible graduated tape may be used to read the diameters directly.

5.1.2.2 Take outside diameter measurements at a minimum of 25 mm from the hose ends.

5.1.3 Measurement of inside diameter

5.1.3.1 Measure the inside diameter by means of a suitable expanding ball or telescoping gauge in accordance with method 2 given in ISO 4671:1999.

5.1.3.2 Take inside diameter measurements at a minimum of 25 mm from the hose ends.

5.1.4 Measurement of concentricity

5.1.4.1 Measure concentricity over both the reinforcement and the finished outside diameters using either a dial indicator gauge or a micrometer.

5.1.4.2 Take concentricity measurements at a minimum of 15 mm from the hose ends.

5.1.4.3 Round the foot of the measuring instrument to conform to the inside diameter of the hose.

5.1.4.4 Take readings at 90° (1,57 rad) intervals around the hose. Acceptability is based on the total variation between the highest and lowest readings.

5.2 Proof test

5.2.1 Test the hose assemblies hydrostatically to the specified proof pressure in accordance with the relevant product specification using the method specified in ISO 1402, for a period of between 30 s and 60 s for all sizes.

5.2.2 Hose assemblies that exhibit no leakage or other evidence of failure after being subjected to the proof test shall be deemed to have passed the test.

5.3 Change-in-length test

5.3.1 Conduct measurements for the determination of elongation or contraction on a previously unused, unaged hose assembly having a free length between hose fittings of at least 600 mm.

5.3.2 Attach the hose assembly to the pressure source in an unrestricted straight position. If the hose is not straight due to its natural curvature, it may be fastened laterally to achieve a straight position. Pressurize to the operating pressure for a period of 30 s, then release the pressure.

5.3.3 Place accurate reference marks 500 mm (l_0) apart on the outer cover of the hose, midway between hose fittings, after allowing the hose assembly to restabilize for a period of 30 s following pressure release.

5.3.4 Re-pressurize the hose assembly to the specified operating pressure for a period of 30 s.

5.3.5 Measure the distance between reference marks while the hose is pressurized and record this as l_1 .

5.3.6 Determine the change in length using the following formula in accordance with ISO 1402:

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

where

l_0 is the distance between the reference marks after the hose assembly restabilizes pressurized following the initial pressurization and release of pressure, in millimetres;

l_1 is the distance between the reference marks while the hose assembly is under pressure, in millimetres;

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

5.4 Burst test

5.4.1 General

This is a destructive test. Hose assemblies that have been subjected to this test should be destroyed.

5.4.2 Procedure

5.4.2.1 Subject hose assemblies on which the hose fittings have been attached for less than 30 days to a hydrostatic pressure, increased at a constant rate in accordance with ISO 1402.

5.4.2.2 Reject hose assemblies showing leakage, hose burst or indication of failure below the specified minimum burst pressure.

5.5 Cold bend test

5.5.1 General

NOTE This test is technically identical to method B in ISO 4672:1997.

This is a destructive test. Hose assemblies that have been subjected to this test should be destroyed.

5.5.2 Procedure

5.5.2.1 Condition hose assemblies at a temperature equal to the minimum application temperature of the relevant product specification in a straight position for 24 h.

5.5.2.2 While still at the minimum application temperature, bend the samples once, taking a time of between 8 s and 12 s, over a mandrel having a diameter equal to twice the specified minimum bend radius.

In the case of hose sizes up to and including 22 mm nominal inside diameter, bend them through 180° over the mandrel; in the case of hose sizes larger than 22 mm nominal inside diameter, bend them through 90° over the mandrel.

5.5.2.3 After bending, allow the sample to warm to room temperature, visually examine it for cover cracks and subject it to the proof test (see 5.2).

5.5.2.4 Hose assemblies that exhibit no visible cracks, leakage or other evidence of failure after the cold bend test shall be deemed to have passed the test.

5.6 Cyclic endurance (impulse) test

5.6.1 General

NOTE This test method is technically equivalent to that specified in ISO 6803.

This is a destructive test. Hose assemblies that have been subjected to this test should be destroyed.

5.6.2 Procedure

5.6.2.1 Test hose assemblies with hose fittings that have been attached for less than 30 days.

5.6.2.2 Calculate the free (exposed) length of hose under test, as shown in Figure 1, using the appropriate formula for the inside diameter of the hose under test, as follows:

a) hose sizes up to and including 22 mm nominal inside diameter:

$$180^\circ \text{ bend free length} = \pi (r + d/2) + 2d$$

b) hose sizes larger than 22 mm nominal inside diameter:

$$90^\circ \text{ bend free length} = \pi/2 (r + d/2) + 2d$$

where

r is the minimum bend radius;

d is the hose outside diameter.

5.6.2.3 Connect the test hose assemblies to the apparatus. These shall be installed according to Figure 1. The hose assemblies of nominal inside diameter up to and including 22 mm shall be bent through 180°, and hose assemblies of nominal inside diameter larger than 22 mm shall be bent through 90°.

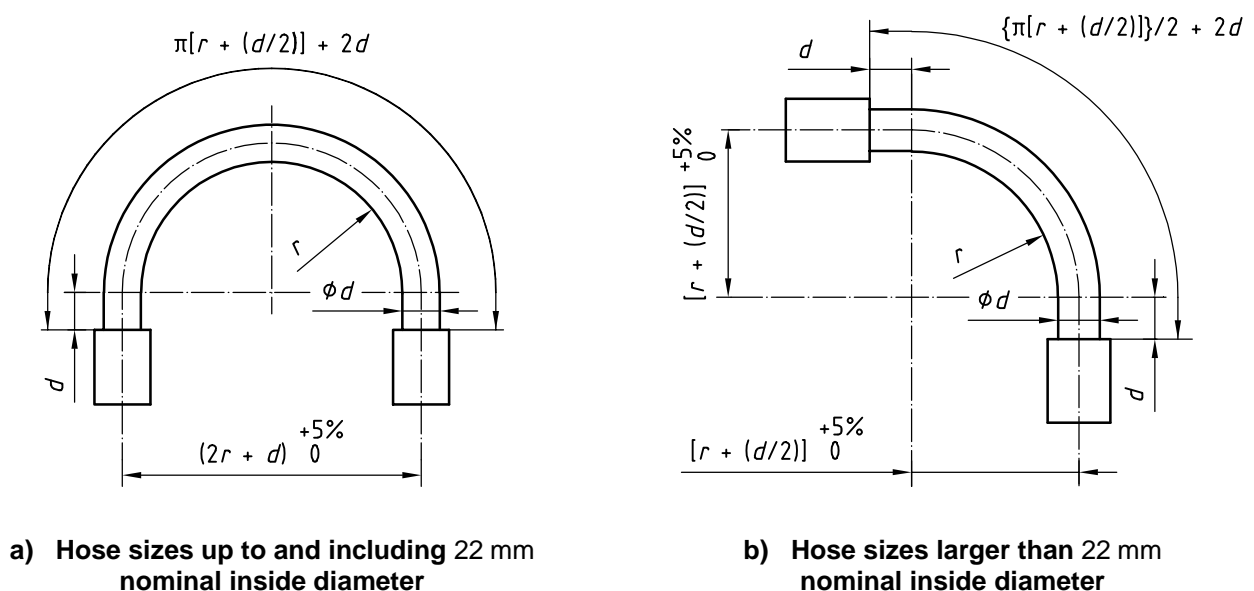


Figure 1 — Hose assemblies for cyclic endurance (impulse) test

5.6.2.4 Select a test fluid that meets with the requirements of viscosity grade ISO VG 46 ($46 \text{ cSt} \pm 4,6 \text{ cSt}$ at $40 \text{ }^\circ\text{C}$) in accordance with ISO 3448, and circulate it at a rate sufficient to maintain a uniform fluid temperature within the hose assemblies.

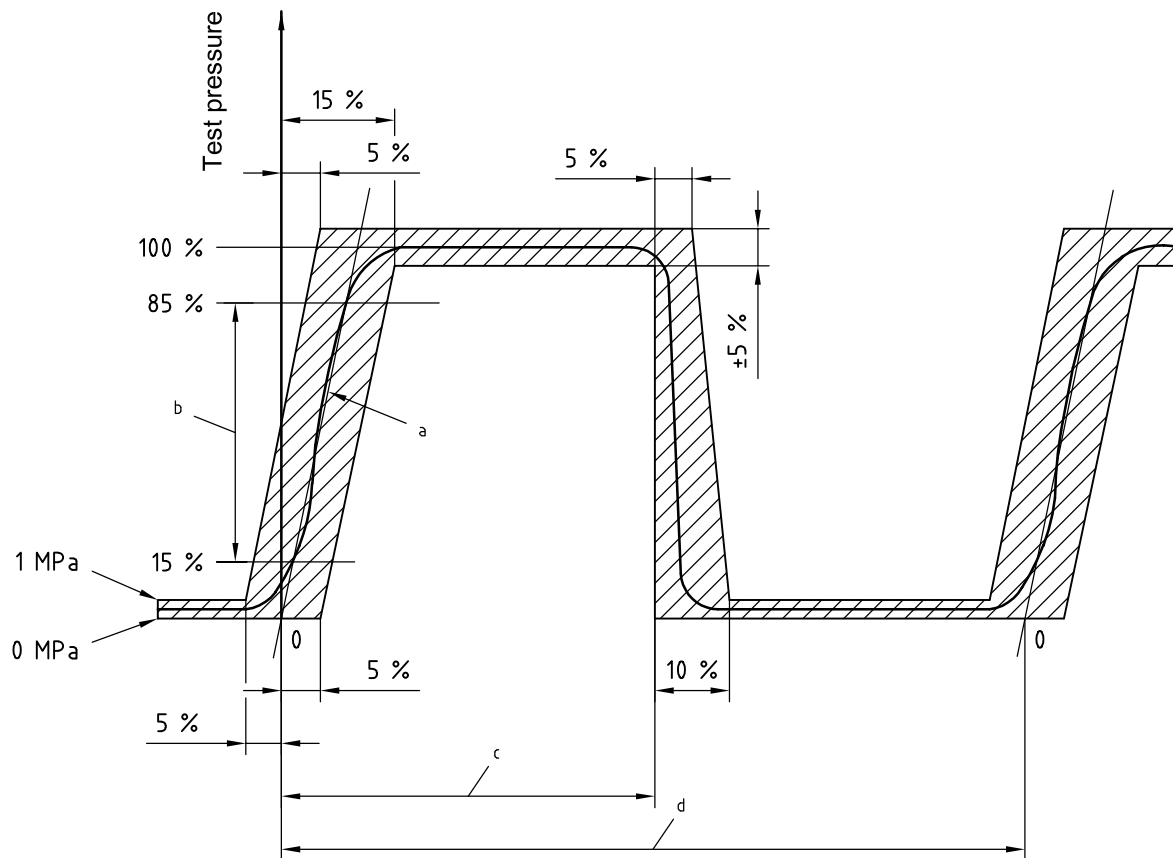
5.6.2.5 Apply a pulsating pressure internally to the hose assemblies at a rate between 0,5 Hz and 1,3 Hz; record the frequency used.

5.6.2.6 The pressure cycle shall fall within the shaded area of Figure 2 and conform as closely as possible to the curve as shown, and the actual rate of pressure rise shall be determined as shown in Figure 2 and shall be within a tolerance of $\pm 10 \%$ of the calculated nominal value.

5.6.2.7 Test the hose assemblies at the impulse test pressure and temperature indicated in the relevant product specification.

5.6.2.8 Determine the duration of the impulse test in total number of impulse cycles by the relevant product specification.

5.6.2.9 Hose assemblies that exhibit no evidence of failure at the completion of the required number of impulse cycles shall be deemed to have passed the test.



NOTE 1 Secant pressure rise is the straight line drawn through two points on the pressure rise curve; one point at 15 % of the test pressure and the other at 85 % of the test pressure.

NOTE 2 Point "0" is the intersection of the secant pressure rise with a pressure of 0 MPa (0 bar).

NOTE 3 Pressure rise rate is the slope of the secant pressure rise expressed in megapascals per second (MPa/s).

NOTE 4 Cycle rate shall be uniform at 0,5 Hz to 1,3 Hz.

NOTE 5 The nominal rate of pressure rise shall be equal to:

$$R = f (10p - k)$$

where

R is the rate of pressure rise in megapascals per second (MPa/s);

f is the frequency in hertz (Hz);

p is the nominal impulse test pressure in megapascals (MPa);

k is equivalent to 5 megapascals (MPa).

a Secant pressure rise rate

b Rate of pressure rise to be determined between these two points.

c 45 % to 55 % of a complete impulse cycle

d One complete impulse cycle

Figure 2 — Cyclic endurance (impulse) test pressure cycle

5.7 Leakage test

5.7.1 General

This is a destructive test. Hose assemblies that have been subjected to this test should be destroyed.

5.7.2 Procedure

5.7.2.1 Subject hose assemblies on which the hose fittings have been attached for less than 30 days, to a hydrostatic pressure of 70 % of the specified minimum burst pressure for a period of 5 min to 5,5 min.

5.7.2.2 Reduce the fluid pressure to 0 MPa (0 bar).

5.7.2.3 Reapply 70 % of minimum burst hydrostatic pressure for another period of 5 min to 5,5 min.

5.7.2.4 Hose assemblies that exhibit no leakage or other evidence of failure after the leakage test shall be deemed to have passed the test.

5.8 Abrasion resistance test

5.8.1 General

This test method is technically equivalent to that specified in ISO 6945. This is a destructive test. Hoses that have been subjected to this test should be destroyed.

5.8.2 Apparatus

5.8.2.1 Wheel-and-crank device, capable of moving an abrading tool 100 mm back and forth along the test sample, with a sinusoidal motion at a rate of 1,25 Hz (one cycle equals 200 mm of travel).

5.8.2.2 Recording device, capable of recording the number of abrasion cycles completed and of being preset to terminate the test after completion of a specified number of cycles.

5.8.2.3 Abrasion tool, manufactured from S9 steel, in accordance with ISO 4957, and heat-treated to a minimum hardness of HV 890. The principal dimensions shall be as shown in Figure 3.

5.8.2.4 Mandrel, being tightly fitted and having a length of 150 mm, to support each sample internally during the test.

5.8.3 Preparation of test specimens

The test specimens shall be prepared from previously unused, unaged hose samples, and shall be of $150 \text{ mm} \pm 0,5 \text{ mm}$ in length.

5.8.4 Conditioning

The test specimens shall be conditioned for at least 3 h in one of the following standard atmospheres: $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity, or $(27 \pm 2) ^\circ\text{C}$ and $(65 \pm 5) \%$ relative humidity, in accordance with ISO 471. Test specimens shall not be tested within 24 h of manufacture.

Dimensions in millimetres,
Surface roughness values in micrometres

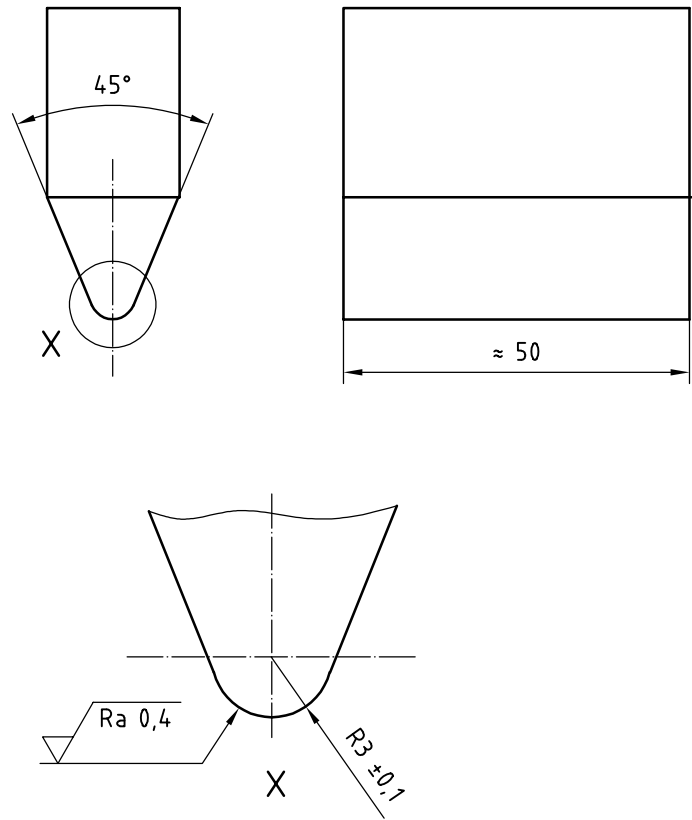


Figure 3 — Details of abrasion tool

5.8.5 Procedure

5.8.5.1 Weigh each test specimen, on or off the support mandrel (5.8.2.4), and record the mass as m_1 . Mount the assembled test specimen and mandrel in the apparatus (5.8.2.1), ensuring that the test piece is restrained from axial and/or rotational movement.

5.8.5.2 Place the abrading tool (5.8.2.3) in contact with the test specimen, apply a vertical static force as specified in the relevant hose standard, and start the test machine (5.8.2.1). Continue the test until the specified number of cycles has been completed.

5.8.5.3 Remove the test assembly (5.8.2.1) from the apparatus and reweigh the test specimen, either on or off the mandrel as in the initial weighing. Remove any loose particles of cover material prior to weighing. Record the mass as m_2 and the number of cycles completed.

Test pieces shall be weighed to an accuracy of $\pm 0,01$ g.

NOTE If the hose reinforcement becomes exposed during the test, remove the test assembly from the apparatus and reweigh as above. Record the mass as m_2 and the number of cycles completed.

5.8.6 Expression of results

Test results shall be expressed in total loss of mass (Δm), in grams, in accordance with the equation:

$$\Delta m = m_1 - m_2$$

where

m_1 is the mass of the test specimen before testing, in grams;

m_2 is the mass of the test specimen after testing, in grams.

5.9 Adhesion test

5.9.1 General

NOTE This test method is technically equivalent to that specified in ISO 8033.

This is a destructive test. Hoses that have been subjected to this test should be destroyed.

5.9.2 Apparatus

5.9.2.1 Power-driven apparatus, equipped with a suitable dynamometer and capable of maintaining a substantially constant rate of traverse of a moving head. The apparatus shall be fitted with an autographic recorder and shall conform to ISO 5893, grade A.

5.9.2.2 Pair of self-tightening grips, capable of holding the test specimen without slippage.

5.9.3 Test specimens

Unless determined by a particular hose specification or otherwise agreed upon between interested parties, the type of test specimen shall be selected in accordance with ISO 8033.

The actual width of each test specimen shall be measured and recorded prior to the test.

5.9.4 Conditioning

The test specimens shall be conditioned for at least 16 h in one of the following standard atmospheres: $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity, or $(27 \pm 2) ^\circ\text{C}$ and $(65 \pm 5) \%$ relative humidity, in accordance with ISO 471. Test specimens shall not be tested within 24 h of manufacture.

5.9.5 Procedure

5.9.5.1 Mount the test specimen in the grips (5.9.2.2) so that the angle of separation is approximately 180° for a strip test piece or 90° for a ring test specimen.

Adjust the apparatus (5.9.2.1) to ensure that tension is distributed uniformly and that no twisting of the test specimen occurs. The power-driven grip shall provide a rate of ply separation of $50 \text{ mm/min} \pm 5 \text{ mm/min}$, with the applied force acting in the plane of separation.

5.9.5.2 During the test record the force, in newtons, over a length of separation of 100 mm minimum or the maximum distance possible if the test specimen is less than 100 mm long.

5.9.5.3 The test apparatus (5.9.2.1) shall record, in graphic form, the variations in the force required to separate the plies of a test specimen.

5.9.6 Expression of results

Determine the median peak force using the appropriate method specified in ISO 6133. Divide the median peak force by the effective width of the test specimen and express the adhesion strength of the test specimen in kilonewtons per metre.

6 Criteria for acceptance

Satisfactory compliance with all the applicable requirements of this International Standard and the relevant hose and hose fittings standards is required for acceptance of the hose assemblies.

7 Identification statement (Reference to this International Standard)

Manufacturers are strongly recommended to use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard:

“Test requirements for hoses and hose assemblies in accordance with ISO 6605:2002, Hydraulic fluid power — Hoses and hose assemblies — Test methods.”

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