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Hydraulic fluid power — Test methods for hoses and hose assemblies

Transmissions hydrauliques — Méthodes d'essai pour les tuyaux et flexibles

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components*.

This third edition cancels and replaces the second edition (ISO 6605:2002), which has been technically revised with the following changes:

— a WARNING was added before the Scope;

— added ISO/TR 11340 and ISO/TS 17165-2 and removed ISO 6945 from the normative references;

— added new ISO verbiage to the terms and definitions;

— added definitions for "change in length", "minimum burst pressure" and "cyclic endurance (impulse) test";

— replaced "operating pressure" with "maximum working pressure" throughout the document;

— added the statements: "The proof pressure shall be twice the maximum working pressure, unless otherwise specified" and "The minimum burst pressure shall be four times the maximum working pressure, unless otherwise specified in the pertinent hose product standard";

— replaced ISO 4672:1997 with ISO 10619-2:2011;

— added: "For values of d less than 25 mm, use d = 25 mm for the $2d$ term in the expression for the hose free length, so that the hose between the end of the hose fitting and the start of the bend radius is straight" and "The actual free hose length shall agree with the calculated free hose length to within +1/-0 % or +8/-0 mm, whichever is greater" to 5.6.2.2;

— redefined the frequency in 5.6.2.5, added a new 5.6.2.6 and 5.6.2.9, revised Figure 2 and added Figure 3;

— deleted the abrasion test;

— updated all the references in the Bibliography.

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 — Test methods for hoses and hose assemblies

WARNING — Some of the tests described in this document are considered hazardous. It is, therefore, essential that, in conducting these tests, all appropriate safety precautions be strictly adhered to. Attention is drawn to the danger of burst, fine jets (which can penetrate the skin) and energy release of expanding gases. To reduce the hazard of energy release, bleed air out of test specimens prior to pressure testing. Tests shall be set up and performed by properly trained personnel.

1 Scope

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3448, *Industrial liquid lubricants — ISO viscosity classification*

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

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*

ISO 8033, *Rubber and plastics hoses — Determination of adhesion between components*

ISO/TR 11340, *Rubber and rubber products — Hydraulic hose assemblies — External leakage classification for hydraulic systems*

ISO/TS 17165-2, *Hydraulic fluid power — Hose assemblies — Part 2: Practices for hydraulic hose assemblies*

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 5598 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
change-in-length
elongation or contraction of the hose or hose assembly due to pressurization

3.2
minimum burst pressure
minimum pressure at which failure of the hose or hose assembly occurs

Note 1 to entry: This failure can be a hose burst, leakage or separation of the hose from the hose fitting.

3.3
cyclic endurance (impulse) test
fatigue test conducted between a lower cyclic test pressure and an upper cyclic test pressure to determine performance of a hose assembly under pressure cycling conditions

4 Visual examination of product

Hose assemblies shall be visually inspected in accordance with ISO/TS 17165-2, to determine that the correct hose and 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.

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 micrometre.

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. The proof pressure shall be twice the maximum working pressure, unless otherwise specified.

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 maximum working 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 Repressurize the hose assembly to the specified maximum working 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 Formula (1) in accordance with ISO 1402:

$$\Delta l = \frac{l_1 - l_0}{l_0} \times 100 \tag{1}$$

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 or hose assemblies that have been subjected to this test should be destroyed.

5.4.2 Procedure

5.4.2.1 Subject unaged hose or hose assemblies, on which the hose fittings have been attached for less than 30 d, to a hydrostatic pressure. Increase the pressure at a rate in accordance with ISO 1402 until the hose or hose assembly fails. The minimum burst pressure shall be four times the maximum working pressure, unless otherwise specified in the pertinent hose product standard.

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 10619-2.

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 d.

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:

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

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

$$90° \text{ bend free length} = \pi/2\left(r + d/2\right) + 2d$$

where

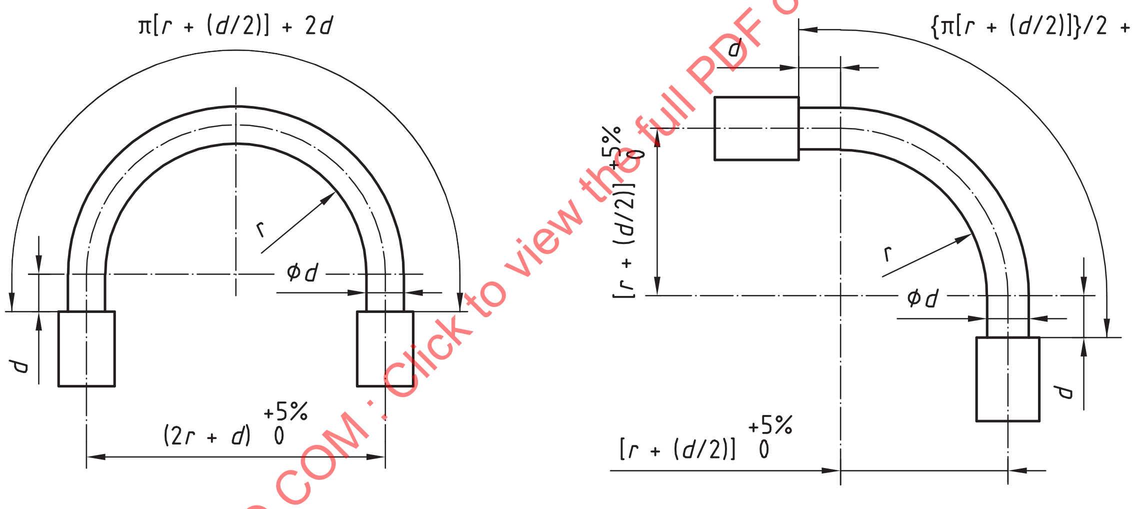
r is the minimum bend radius (the minimum bend radius is found in the relevant hose standards);

d is the hose outside diameter (this is a measured dimension, except for d's smaller than 25 mm).

For values of d less than 25 mm, use d = 25 mm for the $2d$ term in the expression for the hose free length, so that the hose between the end of the hose fitting and the start of the bend radius is straight.

The actual free hose length shall agree with the calculated free hose length to within +1/-0 % or +8/-0 mm, whichever is greater.

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°.



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

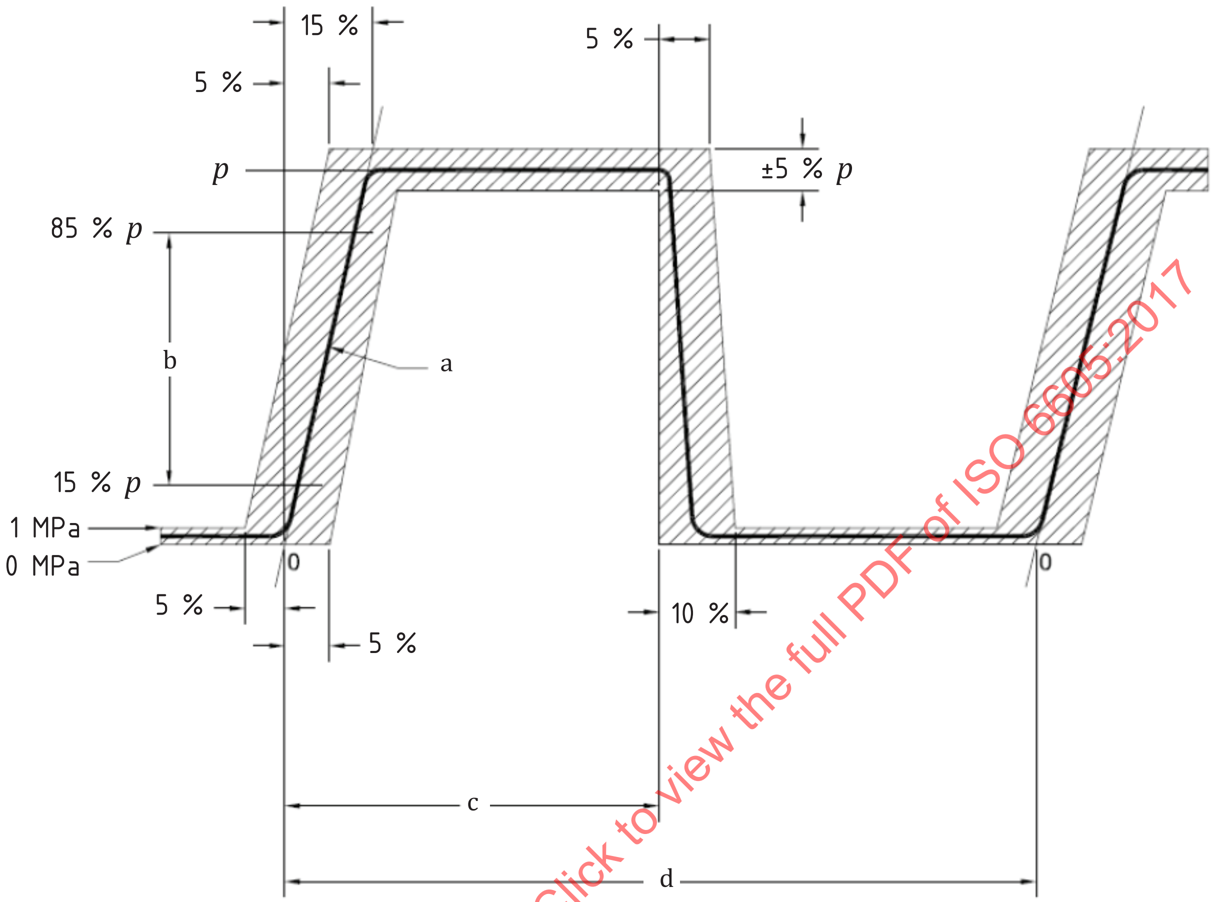
b) hose sizes larger than 22 mm nominal inside diameter

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 cSt ± 4,6 cSt at 40 °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 for high pressure tests and between 0,2 Hz and 1,0 Hz for low pressure tests; record the frequency used.

5.6.2.6 The pressure cycle shall fall within the shaded area of Figure 2 for high pressure tests (greater than 2,5 MPa) and within the shaded area of Figure 3 for low pressure tests (2,5 MPa or less), and conform as closely as possible to the curve as shown. The actual rate of pressure rise shall be determined as shown in Figure 2 and shall be within a tolerance of ±10 % of the calculated nominal value.



Key

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 for high pressure 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).

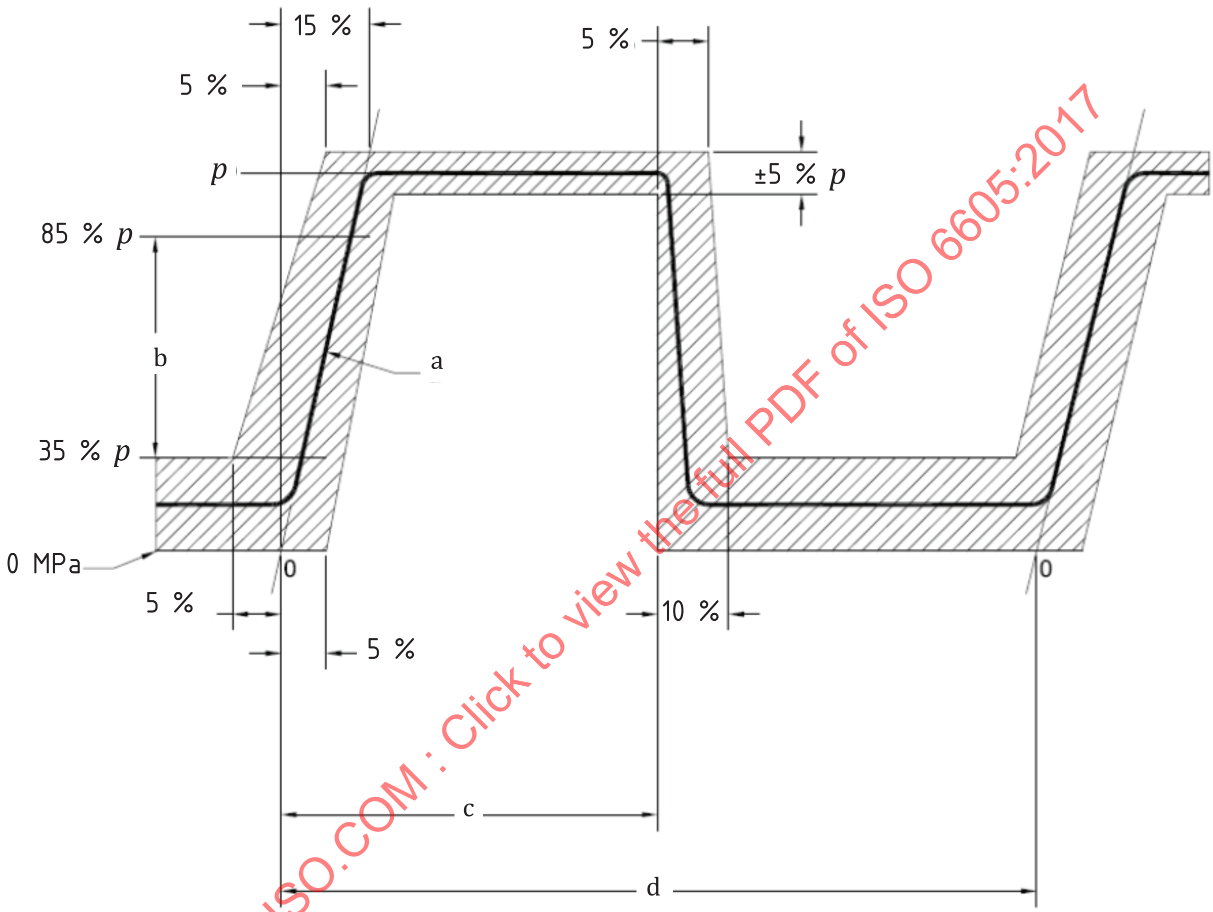
NOTE 4 Cycle rate shall be uniform at 0,5 to 1,3 Hz.

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).



Key

- 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 3 — Cyclic endurance (impulse) test pressure cycle for low pressure test

NOTE 6 Secant pressure rise is the straight line drawn through two points on the pressure rise curve; one point at 35 % of the test pressure and the other at 85 % of the test pressure.

NOTE 7 Point “0” is the intersection of the secant pressure rise with a pressure of 0 MPa (0 bar).

NOTE 8 Pressure rise rate is the slope of the secant pressure rise expressed in megapascals per second (MPa/s).

NOTE 9 Cycle rate shall be uniform at 0,2 to 1,0 Hz.

NOTE 10 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).

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 Conduct the test for the specified number of cycles or until an assembly fails. If a test is stopped before completion of the minimum number of cycles and then restarted, leakage may occur at the hose/hose fitting junction upon restarting the test and until the test temperature is reached. Leakage less than class 4 as defined in ISO/TR 11340 does not constitute a failure of the hose assembly. Any leakage shall be reported in accordance with the classification in ISO/TR 11340.

5.6.2.10 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.

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 d, 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 Adhesion test

5.8.1 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.