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Hydrogen technologies

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Gaseous hydrogen -- Fueling stations -- Part 5: Hoses and hose assemblies

CD 19880-5.2

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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. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 197.

Introduction

This International Standard is to promote the implementation of performance based testing for components of dispensing systems and fueling stations that are based on proven engineering principles, research and the combined expertise of gas utilities, fuel providers, manufacturers, users, and others having specialized experience.

The successful commercialization of hydrogen vehicle technologies requires codes and standards pertaining to fueling stations, vehicle fuel system components, and the global homologation of standards requirements for technologies with the same end use. Essentially this will allow manufacturers to achieve economies of scale by producing one product for use globally.

International harmonization contributes to reducing technical barriers and stimulates related markets. A series of standards that address hydrogen-fueled vehicles and fueling stations is being developed. These standards will provide internationally homologized minimum safety performance criteria at the component level, thus providing a foundation to build a safe “fueling system.”

This Standard was developed using the following document: *CSA HGV 4.2 Hoses for Compressed Hydrogen Fuel Stations, Dispensers and Vehicle Fuel Systems,* under a Copyright License Agreement between CSA and ISO.

This document was developed based on two types, five pressure classes and two temperature ratings of wire or textile reinforced hoses and hose assemblies suitable for use with gaseous hydrogen for hydrogen dispensing at specified temperature ratings. This is based on technologies in use at the time of the development of the requirements.

In the future, other types and classes of hoses and hose assemblies will need to be evaluated to determine the suitability of requirements in this document.

This standard applies to newly manufactured hoses and hose assemblies for:
• connecting the dispenser to the fueling nozzle, high pressure (Type A)
• other flexible hoses used on hydrogen dispensing equipment not accessible to the public (Type B).

Note: A nozzle vent hose is considered Type A, however, rated pressure may be lower than nozzle rating, based on nozzle and dispenser design.

For assemblies connecting hydrogen supply system, (including cylinders and tube trailers) to the fueling station, see ISO 16964.

For general hydrogen safety information, see ISO/TR 15916:2015 - *Basic considerations for the safety of hydrogen systems*.

Gaseous hydrogen -- Fueling stations -- Part 5: Hoses and hose assemblies

1 Scope

This standard relates to two types, wire or textile reinforced hoses and hose assemblies suitable for use with gaseous hydrogen for hydrogen dispensing at specified temperature ratings.

This standard contains safety requirements for material, design, manufacture and testing of gaseous hydrogen hose and hose assemblies.

Hose and hose assemblies excluded from the scope of this document are those:

thread and seal portion of fittings,
used as part of a vehicle on-board fuel storage system, high pressure,
used as part of a vehicle low pressure fuel delivery system,
Metal flexible hoses.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19880-1:20##, *Gaseous Hydrogen – Fueling Stations — Part 1: General requirements*

ISO 188: *Rubber, vulcanized or thermoplastic – Accelerated aging and heat resistance tests*

ISO 1402:2009, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

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

ISO 4080:2009, *Rubber and plastics hoses and hose assemblies - Determination of permeability to gas*

ISO 6802, *Rubber and plastics hose and hose assemblies with reinforcements - Hydraulic Impulse test with flexing*

ISO 6803, *Rubber or plastics hoses and hose assemblies — Hydraulic-pressure impulse test without flexing*

ISO 7326:2006, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 8031:2009, *Testing methods for rubber and plastics hoses -- Part 5: Determination of electrical resistance*

ISO 9227:2012, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 10619-2:2011, *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness ─Part 2: Bending tests at sub-ambient temperatures*

ISO 16964:2015, Gas cylinders – Flexible hoses assemblies – Specification and testing

ISO 30013:2011, *Rubber and thermoplastics hoses- Methods of exposure to laboratory light sources - Determination of change in color, appearance and physical properties*

3 Terms and definitions

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

ISO and IEC maintain technical data bases 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
coupling
connector
end-fitting
fitting, usually made of metal, attached to the end of a hose to facilitate connection to equipment or other hose

3.2
dispenser hoses
fuelling hose
flexible conduit used for dispensing gaseous hydrogen to vehicles through a fuelling nozzle

3.3
fitting
device attached to the end of the hose to facilitate connection to equipment or other hose

3.4
hose assembly
length of hose with a coupling or fitting attached to both ends. hose may include exterior materials which protect cover and/or user from any damage.

3.5
maximum allowable working pressure
MAWP
maximum pressure that a component may experience in service, including upset conditions, independent of temperature, before initiating mitigation options, and typically the basis for the set point of the pressure relief device protecting the vessel or piping system.

NOTE The maximum allowable working pressure may also be defined as the design pressure, the maximum allowable operating pressure, the maximum permissible working pressure, or the maximum allowable pressure for the rating of pressure vessels and equipment manufactured in accordance with national pressure vessel codes.

3.6
maximum operating pressure
MOP
highest pressure that is expected for a component or system during normal operation

NOTE This is the pressure from which hydrogen at a temperature of 85ºC would settle at the NWP at a temperature of 15ºC.

3.7
minimum bend radius
smallest specified radius to which a hose may be bent in service. hose should not be bent smaller than the minimum bend radius shown in Table 4.

3.8
nominal working pressure
NWP
service pressure
pressure for which the dispenser is intended to be operated for a given gas temperature of 15 ºC.

NOTE This defines a full vehicle tank gas density, of either 35MPa or 70MPa at 15°C.

3.9
pressure relief device
PRD
device designed to release pressure in order to prevent a rise in pressure above a specified value due to emergency or abnormal conditions

3.10

proof pressure
pressure applied during a non-destructive test and held for a specified period of time to prove the integrity of the construction

4 Classification

4.1 Types

This standard applies to newly manufactured hose and hose assemblies for:

Type A: dispenser hoses connecting the dispenser to the fueling nozzle

Type B: other flexible hoses used on hydrogen dispensing equipment not accessible to the public

NOTE A nozzle vent hose is considered Type A; however, MOP may be lower than nozzle rating, based on nozzle and dispenser design.

For hose assemblies connecting hydrogen supply systems, (including cylinders and tube trailers) to the fueling station, see ISO 16964.

4.2 Pressure classes

Each type of hose assemblies shall be designated according to five pressure classes, depending on the pressure used for dispensing hydrogen distinguished by each category of pressure defined in clause 3. Terms and Definitions as shown in Table 1.

Table 1 — Pressure classes

Pressure class	H11	H25	H35	H50	H70
NWP[a](MPa)	11	25	35	50	70
MOP[b](MPa)	13.75	31.25	43.75	62.5	87.5
MAWP[c](MPa)	15.13	34.38	48.13	68.75	96.25
a Nominal Working Pressure b Maximum Operating Pressure (1.25 x NWP) c Maximum Allowable Working Pressure (1.1xMOP)					

NOTE: The pressure class for Type B may not be limited classes shown in Table 1.

4.3 Temperature rating

Temperature ratings for hose assemblies shall be suitable for use at a temperature range shown below.

Rating T0: hoses have the operating temperature range stipulated by the manufacturer.
Rating T1: hoses have the operating temperature range of -40^{o}C to 65^{o}C.

5 Materials and construction

5.1 General

Hose and liner shall be constructed with materials that are resistant to corrosion and exposure to hydrogen.

The construction of hose parts not specifically covered by this standard shall be in accordance with industry recognized practices of safety, substantiality and durability.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such construction as will provide at least equivalent performance.

5.2 Lining

The lining shall be of uniform thickness and free from defects. Defects may include but are not limited to bubbles, thinning, gouging or discoloration.

Volume resistivity of the lining material shall be less than 1015 Ωcm and the dielectric breakdown voltage shall be more than 10 kV for liner thickness.

The lining may also consist of multiple material layers.

5.3 Reinforcement

The reinforcement consists of one or more layers of suitable wire or textile material applied by any suitable technique.

5.4 Cover

The cover shall be resistant to abrasion, cracking and crazing; and the effects of ultraviolet exposure and ozone and be of uniform thickness and free from defects. Defects may include but are not limited to bubbles, thinning, gouging or discoloration. All outer covering shall either be of a permeable material or sufficiently perforated to avoid diffused gas build up.

5.5 Static electricity dissipation

Hose assemblies shall be constructed so as to provide an electrically conductive path between couplings at each end of the hose in order to dissipate static electricity.

6. Dimensions and tolerances

6.1 Diameters

When measured in accordance with ISO 4671, typical diameters of hoses are given in Table 2.

Table 2 — Typical Diameters of hoses

Nominal size	Inside diameter mm		Maximum outside diameter of hose mm
	min.	max.	
6,3	5.9	7,0	25
8	7,7	8,5	30
10	9,3	10,1	35

6.2 Concentricity

When measured in accordance with ISO 4671, the concentricity of hoses shall conform to Table 3.

Table 3 Concentricity

Nominal size	Maximum variation in wall thickness between inside diameter and outside diameter mm
Up to and including 6,3	0,8
Over 6,3 and less than or equal to 10	1,0

6.3 Minimum bend radius

Use a test piece having a length at least four times the minimum bend radius. Measure the hose outside diameter with calipers in the straight-lay position before bending the hose. Bend the hose through 180° to the minimum bend radius (see Table 4) and measure the flatness with the calipers.

When the hose is bent to the minimum bend radius given in Table 4, measured on the inside of the bend, the flatness shall not exceed 10 % of the original outside diameter.

Table 4 Minimum Bend Radius

Nominal size	Minimum bend radius mm				
	H11	H25	H35	H50	H70
6,3	150	150	150	200	200
8	200	200	200	250	250
10	200	200	200	300	300

7 Performance

7.1 Leakage

The hose cover with perforated holes may be used as a sample.

7.1.1 Method A for Type test and Production test

When tested in accordance with ISO 4080:2009 Method 3, with the following conditions, the hourly permeation rate shall be less than 20 cm^3N/h.

Test can be done at room temperature. The amount shall be converted to 15 ℃ using equation listed clause 8.12.

The test piece shall be a free length of 0,5 m between the couplings. Connect the test piece to the Hydrogen gas supply with a suitable connector, and purge the test assembly with Hydrogen gas. Adjust the temperature of the water bath to the specified value.

Insert the test assembly into the transparent tube and immerse in the water bath so that they are inclined at approximately 20° to the horizontal.

Apply the gas pressure of MAWP and maintain it for 5 minutes. During this period, collect the gas and measure the amount. The amount is converted to the amount per hour.

7.1.2 Method B for Routine test

When tested in accordance with ISO 4080:2009 Method 3, with the following conditions, a hose assembly shall show no leakage or failure.

For this test length of any assembly hose can be used. Hydrogen or Helium can be used as test gas. Connect the test piece to the test gas supply with a suitable connector, and purge the test assembly with test gas.

The leakage shall be checked visually for any bubbles from hose body and both end fittings.

Also, a gas leak detector, snoop liquid leak detector may be applied to check leakage.

NOTE1: Leakage can be tested by Permeation Test at the first 5 min according to this Method A.

NOTE 2: The hose cover with perforated holes may be used as a sample. The air contained into the reinforcement layer can be omitted.

7.2 Hydrostatic Strength

7.2.1 Proof pressure test

When tested in accordance with ISO 1402, a hose assembly shall withstand a pressure of at least two times of MAWP for 5 min without bursting or visible loss of fluid.

As a test fluid, water or mixture of water and glycol or oil can be used.

This is a non- destructive test.

7.2.2 Ultimate Strength

The hose assembly shall be air oven aged for 70 hours at 85°C ± 1°C;

Following the oven aging, when tested in accordance with ISO 1402, a hose assembly shall withstand without bursting or visible loss of fluid with the pressure of 4 times of MOP for 5 min.

Then, continue to pressurize until burst and measure

NOTE: Ultimate strength test can be performed according to the national standard

As a test fluid, water or mixture of water and glycol or oil can be used.

This is a destructive test, do not use these test samples for any further testing or for resale.

7.3 Ultraviolet Resistance and Water Exposure Test

This provision applies to a single Type A hose only. In accordance with ISO 30013:2011, after the exposure test with the conditions listed below, all hose samples shall be visually checked and there shall be no signs of crazing or cracking.

7.3.1 Test conditions:

Types of test piece: Type 1 (sample of hose with U-shape bent)

Light source: Fluorescent UV lamps Type 1A (UVA-340), Irradiance 0,76 W at 340 nm

Exposure cycles: Method A: Artificial weathering

Dry	8 h at 60℃
Condensation	4 h at 50℃

7.3.2 Length of exposure:

The test sample shall be cycled continuously under the previously specified cycle pattern for 10 weeks or 1680 h hours.

The test sample may be repositioned once per week to obtain uniform exposure to UV radiation, moisture and temperature. Follow manufacturer’s recommendation for rotation.

7.4 Electrical Conductivity

When determined in accordance with clause 4.8 of ISO 8031:2009, electrical resistance between couplings at each end of a dispenser hose shall not exceed 1MΩ per meter, in order to dissipate static electricity.

This test shall be conducted with the hose un-pressurized.

For Type B Hose: TBD

7.5 Vertical load strength

This provision applies to a single Type A hose only. The test piece shall be a free length of 0,5 m between the couplings.

Connect one end of the coupling to the connecter fixed horizontally. Apply the vertical load of 340 N to the other free end and maintain the load for 5 minutes.

After 5 minutes, remove the load and perform 9.2.1 Proof pressure test and 9.4 Electric conductivity for any abnormality.

7.6 Torsion Strength

This provision applies to a single Type A hose only. This test does not apply to a bonded supply/vent line.

When tested in accordance with ISO 6802 with the conditions listed below, a dispenser hose shall withstand 1000 cycles of a horizontally reciprocating movements under atmospheric pressure without damage to the hose or fittings and without leakage in excess of the rate specified in Section 7.2.1 Hydrostatic Proof Test.

7.6.1 Test conditions

Apparatus: Method 2 horizontally reciprocating manifold

Mounting of hose assembly: Offset the sample hose at the distance of four times of outside diameter of hose and mount the test sample at the centre of the stroke making sure there is no twist.

Pressure: Atmospheric pressure

Temperature: -40℃

Required cycle: 1 000 cycle

7.7 Tensile Test of Hose Assembly

This provision applies to a single Type A hose only. For a bonded supply/vent line, only the supply portion of the bonded supply/vent line hose shall be tested. This test does not apply to the vent portion of the bonded supply/vent line hose.

A hose assembly shall withstand a longitudinal pull force of 3 000 N without structural damage or leakage after being subjected to accelerated air oven aging. The hose must comply with Section 7.2.1 Hydrostatic Proof Test and Section 7.5 Electrical Conductivity after the tensile test.

7.7.1 Method of Test

The hose assembly shall be air oven aged for 70 hours at 85°C ± 1°C.

Following the oven aging, the hose assembly shall be maintained at room temperature for 2 h prior to the conduct of the tensile test.

The apparatus outlined in ISO 188 Rubber, vulcanized or thermoplastic -- Accelerated ageing and heat resistance tests is to be used for this test.

The hose end fittings shall then be assembled with corresponding companion parts and tightened. The hose is then to be placed in a tensile testing machine and connected so that the end fittings and hose are subjected to the 3 000 N. With the testing machine adjusted for a rate of travel of 0.2 mm/sec or slower, the pull force is to be applied until 3 000 N is attained.

At the completion of this test, hose assemblies shall be subjected to and shall comply with Sections 7.2.1 Hydrostatic Proof Test and 7.5 Electrical Conductivity.

7.8 Ozone Resistance

When tested in accordance with method 1 of ISO 7326: 2006, depending on the nominal size of the hose, a hose outer cover shall show no visible signs of cracking or damage under X2 magnification after 72 hours of exposure with an ozone partial pressure of (100±5) pphm (parts per hundred million) at temperature of (40± 1) °C (The area immediately adjacent to the wire shall be ignored).

7.9 Corrosion Test

This test shall be applied to Type A, B hose and hose assemblies.

When tested in accordance with ISO 9227:2012 with the conditions listed below, fittings and other metal parts shall not show evidence of corrosion or other deterioration.

Minor corrosion is allowed on areas where there is mechanical deformation of the plating or coating caused by crimping, flaring, bending and other post-plate metal forming operations.

At the completion of this test, hose assemblies shall be subjected to and shall comply with Sections 7.2.1 Hydrostatic Proof Test.

7.9.1 Test conditions

Test specimen: hose assembly

Test method: Acetic Acid Salt Spray (AASS)

Temperature: (35±2)℃

Duration of test: 96 h

This test shall be applied to each nominal diameter, type and material of hose end fitting submitted for examination under this requirement.

7.10 Pressure Cycle Test (Impulse Test)

When tested in accordance with ISO 6803, the test fluid temperature shall be at the highest temperature of the hose being rated. The pressure rise shall be contained within the wave form envelope as shown in Figure 4.

The test fluid for this test is water or mixture of water and glycol or oil.

When tested at impulse pressure equal to 100 % of the maximum operating pressure, the hose shall withstand a minimum of 100 000 impulse cycles.

The pressurization shall be stopped and the impulse test unit shall be allowed to cool down the temperature of the test fluid to room temperature at every 30 000 cycles of impulse cycles.

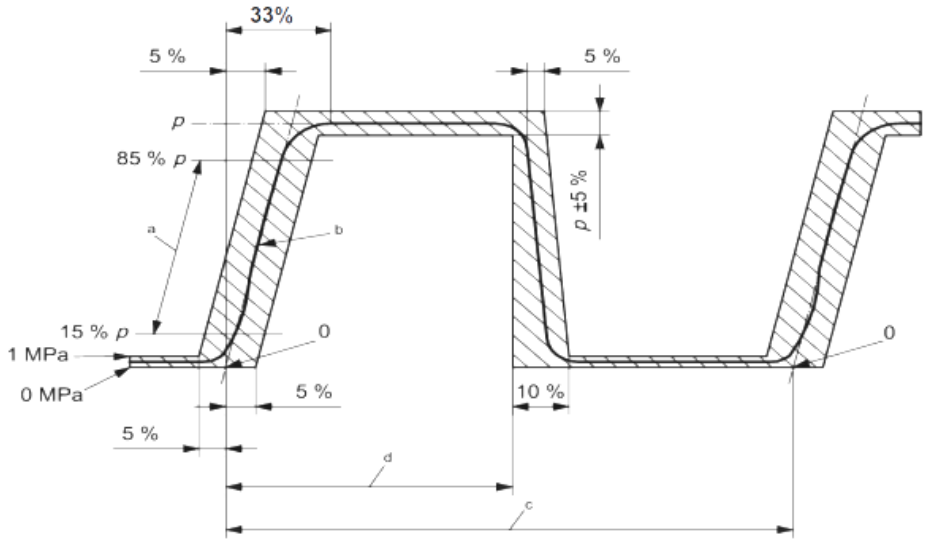
Accelerated cool down procedures, i.e. fans, heat exchangers, etc., may be used to speed the cooling process.

At every cool down, check test assemblies to ensure they are clean and dry. With oil heater turned off, resume the test and observe and note leakage for 1 000 impulse cycles.

After cool down, raise fluid temperature to the specified temperature and restart impulse cycle until next cool down. Run the test until the hose failure or the required cycle.

There shall be no leakage or other malfunction before reaching the specified number of cycles.

This test shall be considered a destructive test and the test piece shall be destroyed.



Key

p	test pressure
a	rate of rise to be determined between these points (50 MPa/s to 100 MPa/s)
b	secant pressure rise
c	one pulse cycle (0,1 Hz to 0,4 Hz)
d	45 % to 55 % of the cycle

Figure 1 — Pressure pulse wave

7.11 Marking Material Legibility

The legibility of marking materials shall not be adversely affected when marking materials are exposed to heat and moisture as specified in the following Method of Test.
This section applies only to markings other than those that are embossed, cast, stamped or otherwise formed in the part.

7.11.1 Method of Test

The following tests shall be conducted on two samples. The manufacturer shall have applied the marking materials to the hoses as they would be applied in production.

a. Marking materials shall exhibit no illegible or defaced printing when rubbed with thumb or finger pressure.

b. The marking materials shall then be placed in an oven for a period of 2 weeks with the oven temperature maintained at 85°C as applicable based on the temperature rating (see Section 1).

Following the oven test, the legibility of the samples shall be checked again as specified in “-a” above. Samples shall then be immersed in water for a period of 24 h, after which the legibility shall be rechecked as specified in “-a” above.

Good legibility shall be obtained for all samples under the above specified test conditions.

7.12 Hose Permeation

When tested in accordance with the following test methods, the hourly permeation rate shall be less than 500 cm^3N/m. After the test, inspect outside of hose for any blistering or swellings. This outside inspection is to verify hose cover Perforation.

7.12.1 Test Method A

Test the hose assembly in accordance with Method 3 of ISO 4080: 2009 with the exceptional conditions listed below.

The test piece shall be a free length of 0,5 m between the couplings. Connect the test piece to the Hydrogen gas supply with a suitable connector, and purge the test assembly with Hydrogen gas.

Adjust the temperature of the water bath to the specified temperature ratings listed clause 5.3.

Insert the test assembly into the transparent tube and immerse in the water bath so that they are inclined at approximately 20° to the horizontal.

Apply the hydrogen gas pressure of MOP and maintain it for 24h before measuring the permeability to gas. Following preconditioning, while still maintaining the specified pressure, collect the gas for 6 h or record the time to collect between 450 cm^3 and 500 cm^3 of gas.

Repeat the measurement a further two times. Calculate the permeability to gas expressed in cubic centimetres of gas per metre of hose per hour $cm^3/(m \cdot h)$. From the three measurements, calculate the average the permeability to gas.

7.12.1 Test Method B

Each sample shall have a minimum hose free length of 0,6 m excluding end fittings and shall be assembled with applicable fittings. Plug one end of each sample using an approved plug appropriate for the fitting(s) used on the hose being tested and connect the other end to a regulated hydrogen pressure source using appropriate connectors and adapters. Connect the test piece to the Hydrogen gas supply with a suitable connector, and purge the test assembly with Hydrogen gas.

Place the test piece in a chamber equipped with an inert gas inlet and outlet. After purging the chamber with an inert gas, constant flaw rate of inert gas is supplied from the inlet. Pressurize the test piece to MOP using hydrogen and hold the sample at 15°C for three hours after the pressure is stabilized. Measure the amount of hydrogen gas contained in the inert gas. The period to determine the permeation rate shall be the last two hours.

7.12.2 Description of the result

Standard pressure and temperature conditions are 101.325 kPa at 15°C. If the condition of standard pressure and 15℃ cannot be controlled, record the pressure and temperature at the test and covert the result to cm^3N using the following formula.

$$V_0 = V_m \times \left[\frac{273 \left(\frac{P_t - SVP \times RH}{P_t} \right)}{273 + T_t} \right]$$

V0:	cm^3N (after conversion)
Vm:	measured Leak ammount in cm^3
Pt:	Pressure at test in MPa
SVP:	Satulated Vapor Pressure at T_t
Tt:	Temperature at test
RH:	Relative Humidity

7.13 Hydrogen Impulse Test (Informative)

Hydrogen Impulse Test guidance is provided in **See Annex C.**

When a Hydrogen Impulse Test is performed, passing criteria requires that no blistering shall be observed. Verification as to whether blistering is observed shall be documented.

7.14 Optional Crush Test

This provision applies to a single Type A hose only. If required based on regional dispenser design, a dispenser hose assembly shall withstand a force of 8900 N applied externally without incurring structural damage or leakage.

7.14.1 Method of Test

The length of the sample hose assembly shall be a minimum of 610 mm. The hose shall be placed against a hard, flat, smooth metallic surface. A force or weight equivalent to 8900 N shall be uniformly applied for 15 min to the hose, with the force or weight evenly distributed over 150 mm of hose length in the approximate center of the sample. The weight shall then be removed and the hose subjected to and shall comply with Sections 7.2.1 Hydrostatic Proof Test and 7.4 Electrical Conductivity.

If applicable, both hoses of a bonded supply and vent hose, shall be on a horizontal plane when tested. Both hoses must be in contact with the crushing fixture.

7.15 Optional Abrasion Resistance Test

When requested by customer or where regional dispenser designs warrant, Dispenser hoses must meet ISO abrasion resistance test, namely International *Standard ISO/PWI 20444, Rubber Hoses - Determination of Abrasion Resistance of the Outer Cover* (currently under construction in TC45/SC1 Hose).

Type B hose is excluded.

8 Instruction Manual

Instructions covering proper selection, installation, inspection, maintenance, safety precautions and usage shall be provided.

The instructions shall include, as a minimum, statements to the effect that:

8.1 General

a. The hose assembly complies with this document

b. The manufacturer shall provide appropriate installation instructions.

1. Safety Precautions.
2. Guidelines for replacement.

8.2 Selection

a. The hose is suitable for use with gaseous hydrogen;

b. The hose shall not be used in a vehicle.

8.3 Installation

a. MAWP must not be exceeded; the user must provide overpressure protection to prevent operation of the hose at pressures greater than the MAWP;

b. The hose assembly shall be of adequate length for the intended use. Hose assemblies shall not be joined together to achieve the required length

c. The hose shall not be used less than the manufacturers specified minimum bend radius for the hose; a. The hose shall not be stretched, kinked, twisted or torqued;

d. The hose assembly shall provide protection for the user from contact damage.

e. The hose shall not be subjected to temperatures outside the temperature limits;

8.4 Inspection and maintenance

a. The hose assembly shall be inspected in accordance with the manufacturer’s instructions. The manufacturer’s instructions shall address such items as:

1. Leakage, in accordance with the applicable installation code.

   CAUTION: Matches, candles, open flame or other sources of ignition shall not be used for this purpose. Leak test solutions may cause corrosion — water rinse after test.

2. Soft spots, bulges, blisters, kinks or stretching in the hose,

3. Excessive abrasion exposing the hose reinforcement.
4. Cuts or cracks in the hose that expose or damage the reinforcement.
5. Evidence of end connector movement or slippage with respect to the hose.
6. Electrical conductivity.

8.5 Safety precautions and usage

a. The hose assembly shall not be stretched, kinked, twisted or torqued.

b. Dragging, dropping, contact with sharp objects or edges, and exposure to chemicals shall be avoided;

9. Marking

Marking of hoses is a function of the hose design and the hose assembly fabrication. In some cases, the hose manufacturer is the hose assembly manufacturer (makes the hose, the hose fitting, assemblies and tests the assembly). However, often times the hose, end fitting and the assembling is done by different entities. In this case; the hose, the end fitting and the assembly each have special marking requirements.

9.1 Hoses

Hoses shall be marked with at least the following information, and the marking shall be repeated every 760 mm or less. Letter height shall be a minimum of 15 % of the hose cover outer circumference.

a) Type, classification; pressure, temperature rating,; (e.g. Type A/H70/T1);

b) the manufacturer's name or identification, e.g. XXX;

c) the manufacturer’s factory identification (MFG internal code); e.g. FAC, if necessary

d) the notifying body identification name or LOGO; e.g. NOT, if necessary

e) the number of this International Standard, i.e. ISO 19880-5;

f) the nominal size, e.g. 8;

g) the two digits of the month and the last two digits of the year of manufacture, e.g. 0317.

EXAMPLE H70/T1/A/ XXX/FAC/NOT/ISO 19880-5/8/0317

9.2 Hose end fitting

Hose end fittings be permanently marked with the following information only necessary in the case fittings are supplied as single article:

a) the Pressure classes, e.g. H70;

b) Manufacturer’s identification, name, LOGO, or Trade Mark, e.g. MAN

c) the number of this International Standard, i.e. ISO 19880-5;

d) the nominal size, e.g. 8;

e) Assembly date (two digits of month and the last two digits of the year)

EXAMPLE H70/MAN/ISO 19880-5/8/0317

NOTE In the case where the hose manufacturer is also the assembly fabricator, only c) and f) are necessary.

9.3 Hose assemblies

Hose assemblies shall be marked with at least the following information:

In the case where the hose manufacturer is also the assembly fabricator, the requirements of 8.1 and 8.2 are sufficient to meet these requirements.

However, c) two digits indicating the assembly date shall be marked.

a) The number of this International Standard, i.e.ISO 19880-5;
b) Assembler (FAB) name or LOGO
c) Assembly date (two digits of month and Year)

EXAMPLE PTP/Date/ISO 19880-5/0317

1) The maximum working pressure of the assembly is the lowest maximum allowable working pressure of any of its components.

2) Hose assemblies shall be marked by the following methods;

a) by stamping on at least one of the couplings;
b) by molding in at least one of the couplings;
d) a molded rubber name plate cemented in place;
e) a metal tag or bracket-type marking retained by at least one of the couplings; or
f) printing on a pressure sensitive label of polyester film.

10 Frequency of testing

Type tests and routine tests shall be carried out as specified in Annex A.

Type tests are those required to confirm that a particular hose or hose assembly design, manufactured by a particular method from particular materials, meets all the requirements of this International Standard. (The tests shall be repeated at a maximum of five-year intervals, or whenever a change in the method of manufacture ormaterials used occurs). They shall be performed on all sizes and types except those of the same size and construction.

Routine tests are those required to be carried out on each length of finished hose or hose assembly prior to dispatch.

Production acceptance tests are tests specified in Annex B, which should preferably be carried out to control the quality of manufacture. The frequencies specified in Annex B are given as a guide only.

11 Test report

When requested by purchaser, the manufacture or supplier will supply a test report representing the purchased product each length or batch of hoses.

Annex A

(normative)

Type tests and routine tests

Table A.1 gives the tests to be carried out for type testing and routine testing as defined in clause 10.

Table A.1

Property	Type test			Routine test		
	Hose	Assem-bly	Number of sample	Hose	Assem-bly	Number of sample
Visual examination (inside and outside)	**X**	**---**	**min. 6**	**X**	**X**	**All**
Measurement of inside diameter	**X**	**---**	**min. 6**	**X**	**---**	**All**
Measurement of outside diameter	**X**	**---**	**min. 6**	**X**	**---**	**All**
Measurement of concentricity	**X**	**---**	**min. 6**	**X**	**---**	**All**
7.1 Leakage test	**---**	**X**	**min. 2**	**---**	**X**	**All**
7.2 Hydrostatic Strength 7.2.1 Proof Test	**---**	**X**	**min. 2**	**---**	**X**	**All**
7.2.2 Ultimate Strength	**---**	**X**	**min. 2**	**---**	**---**	**---**
7.3 Ultraviolet Light	**X**	**---**	**4 includes 1 blank**	**---**	**---**	**---**
7.4 Electrical Conductivity	**---**	**X**	**min. 1**	**---**	**---**	**---**
7.5 Vertical load strength	**---**	**---**	**min. 3**	**---**	**---**	**---**
7.6 Torsion Strength	**---**	**X**	**min. 3**	**---**	**---**	**---**
7.7 Tensile Test of Hose Assembly	**---**	**X**	**min. 2**	**---**	**---**	**---**
7.8 Ozone Resistance	**X**	**---**	**min. 3**	**---**	**---**	**---**
7.9 Corrosion Test	**---**	**X**	**min. 2**	**---**	**---**	**---**
7.10 Pressure Cycle Test (Impulse Test)	**---**	**X**	**min. 3**	**---**	**---**	**---**
7.11 Marking Material Legibility	**X**	**---**	**min. 2**	**---**	**---**	**---**
7.12 Hose Permeation	**X**	**---**	**min. 1**	**---**	**---**	**---**
7.13 Hydrogen impulse Test (Informative)	**---**	**X**	**min. 3**	**---**	**---**	**---**
7.14 Optional Crush Test	**X**	**---**	**min. 2**	**---**	**---**	**---**
7.15 Optional Abrasion Resistance Test	**X**	**---**	**min. 3**	**---**	**---**	**---**

Annex B

(informative)

Production acceptance tests

Table B.1 gives the tests to be carried out for Production acceptance tests as defined in clause 10.

Table B.1

Property	Production Acceptance tests		
	Hose	Assembly	Number of sample
Visual examination (inside and outside)	**X**	**---**	**min. 3**
Measurement of inside diameter	**X**	**---**	**min. 3**
Measurement of outside diameter	**X**	**---**	**min. 3**
Measurement of concentricity	**X**	**---**	**min. 3**
7.1 Leakage test	**---**	**X**	**min. 2**
7.2 Hydrostatic Strength 7.2.1 Proof Test	**---**	**X**	**min. 2**
7.2.2 Ultimate Strength	**---**	**X**	**min. 2**
7.3 Ultraviolet Light and Water Exposure Test	**---**	**---**	**---**
7.4 Electrical Conductivity	**---**	**---**	**---**
7.5 Vertical load strength	**---**	**---**	**---**
7.6 Torsion Strength	**---**	**---**	**---**
7.7 Tensile Test of Hose Assembly	**---**	**X**	**min. 2**
7.8 Ozone Resistance	**---**	**---**	**---**
7.9 Corrosion Test	**---**	**---**	**---**
7.10 Pressure Cycle Test	**---**	**X**	**min. 3**
7.11 Marking Material Legibility	**---**	**---**	**---**
7.12 Hose Permeation	**---**	**---**	**---**
7.13 Hydrogen impulse Test	**---**	**---**	**---**
7.14 Crush Test (Optional)	**---**	**---**	**---**
7.15 Abrasion Resistance Test (Optional)	**---**	**---**	**---**

It is recommended to carry out per 3 000 m of hose production.

Annex C

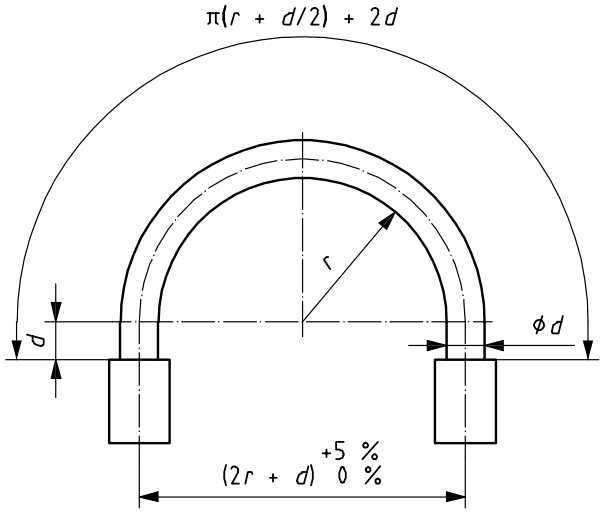
(informative)

Hydrogen impulse test

C.1 Test pieces

Test pieces shall be complete hose assemblies with suitable end fittings attached. Test three unaged hose assemblies with end fittings. Calculate the necessary free length of the hose in the test piece as shown in Figure C.1. For values of d less than 25,4 mm, use d = 25,4 mm for the +2d term in the expression for the hose free length, so that the hose between the fitting shell 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 % or +8 mm, whichever is greater.



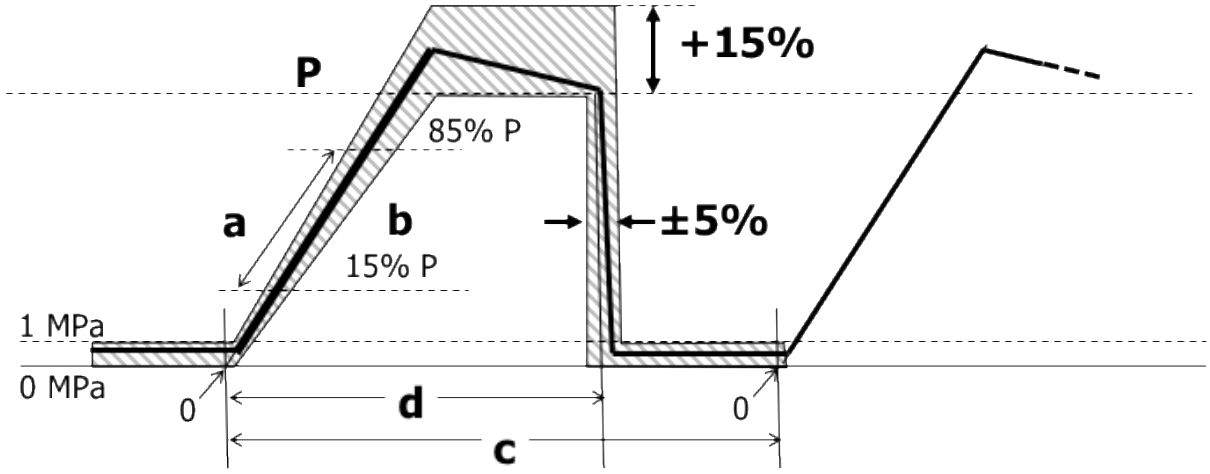
Key
r : minimum bend radius
d : hose outside diameter

Figure C.1 — Test hose assemblies for hydrogen impulse test

C.2 Apparatus

Select a hydrogen gas more than 99.9% in purity as test gas. Pressure-application apparatus, capable of applying an internal pulsating pressure to the test hose assemblies at a pressurization rate, 7±15% MPa/s up to MOP using hydrogen gas pressure through the test hose assemblies. Each pressure cycle shall be within the tolerances shown in Figure C.2. Graphical recorder, digital-storage facility or oscilloscope, capable of measuring the pressure cycle to ensure that the wave form is within the envelope shown in Figure C.2.

If necessary, test chamber capable of controlling the ambient temperature of the test hoses to the same temperature of the test gas with a tolerance of ±3 ℃.



Key

P: Test pressure (MOP)

a: Rate of pressure rise to be determined between these points, shall be set 7±15% MPa/s.

b: Secant pressure rise.

c: One pulse cycle (second), shall be (MOP/a+14) +15%

d: Pressurized time, d/c=0.66±20%.

The 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. Point 0 is the intersection of the secant pressure rise with 0 pressure.

The actual rate of pressure rise shall be determined as shown in the figure and shall be within a tolerance of ±15 % of the calculated nominal value.

Figure C.2 — Pressure pulse wave form envelope

C.3 Procedure of Test

Test temperature is normally selected the lowest temperature of each temperature rating with a tolerance of +7 °C/-20 °C. The tolerance of gas temperature includes temperature drop during decompression process. Ambient temperature of the test hoses shall be controlled to the same temperature as that of gas with a tolerance of ±3 °C.

Connect the test hose assemblies to the apparatus. The test hose assemblies shall be installed in accordance with Figure 1, i.e. test pieces of hose shall be bent through 180°

Apply the gas pressure of MOP and maintain it for more than 12 hours before start applying pulsating gas pressure.

Bring the test gas to the test temperature and then apply pressure cycles, which shall fall within the shaded area of Figure 2. Continue the test for the required numbers of cycles or until an assembly fails. Required numbers of cycles shall be determined between manufacturer and the customer depending on the service life of the hose. If no required numbers of cycles are specified, 10 000 cycles can be used. Record the number of pressure cycles to failure or, if failure did not occur, the number of pressure cycles completed. At the completion of this test, hose assemblies shall be subjected to and shall comply with Sections 7.2.1 Hydrostatic Proof Test and 7.5 Electrical Conductivity.

NOTE This is a destructive test. Assemblies which have been subjected to this test, should therefore be discarded. The test results obtained are only valid for the combination of hose, fitting type and fitting design that was actually tested.

Bibliography:

Referenced Documents:

ISO/TR 15916:2015 - Basic considerations for the safety of hydrogen systems

Other Relevant Documents: