**ISO/TC22 N 2809_Form 04_Annex 2 (Draft) = Reintroduction of**
**ISO/TC197 N 391_Form 04_Annex 2 (Draft) = Reintroduction of**

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# Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen Blends fuel system components — Part 2: Performance and general test methods

*Véhicules routiers — Composants ... — Partie 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.

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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.

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ISO XXX-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 25, *Road vehicles using gaseous fuels*.

ISO XXX consists of the following parts, under the general title *Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen Blends fuel system components*:

— *Part 1: General requirements and definitions*

— *Part 2: Performance and general test methods*

— *Part 3: Pressure regulator*

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# Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen Blends fuel system components — Part 2: Performance and general test methods

## 1 Scope

This Standard specifies performance and general test methods for compressed gaseous hydrogen fuel system components, intended for use on the types of motor vehicles defined in ISO 3833.

It is applicable to vehicles using hydrogen in accordance with ISO 14687 (mono-fuel, bi-fuel or dual-fuel applications). It is not applicable to the following:

a) liquefied hydrogen (LH2) fuel system components located upstream of, and including, the vaporizer;

b) fuel containers;

c) stationary gas engines;

d) container mounting hardware;

e) electronic fuel management;

f) refuelling receptacles.

NOTE 1 It is recognized that miscellaneous components not specifically covered herein can be examined to meet the criteria of this Standard and tested according to the appropriate functional tests.

NOTE 2 All references to pressure in this Standard are to be considered gauge pressures unless otherwise specified.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this 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 188:1998, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 1817, *Rubber, vulcanized — Determination of the effect of liquids*

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

ISO 3833:1977, *Road vehicles - Types - Terms and definitions*

ISO 14687:1999, *Hydrogen fuel - Product specification*

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ISO XXXXX-2[1)] , *Road vehicles - Compressed gaseous hydrogen (CGH2) and Hydrogen Blends fuel system components- Part 1: General requirements and definitions*

ISO XXXXX-3[2)] , *Road vehicles - Compressed gaseous hydrogen (CGH2) and Hydrogen Blends fuel system components- Part 3: Pressure regulator*

ISO 15869[3)] , *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks*

## 3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in ISO XXXXX-1 apply.

## 4 General

**4.1** Unless otherwise stated, the tests shall be conducted at room temperature: i.e. 20 °C ± 5 °C.

**4.2** Components shall comply with the tests specified in ISO XXXXX-3 and subsequent parts, as well as the applicable tests specified in this Standard. Because of the peculiarities of some components, the list of tests given in this Standard (clauses 5 to 15) is not exhaustive. Where additional tests are required, their provisions are given in another, relevant part.

**4.3** Unless otherwise specified, all tests shall be conducted using dry air or nitrogen. Qualified personnel may also test with gaseous hydrogen provided that appropriate safety measures are taken. The dewpoint of the test gas at the test pressure shall be at the temperature at which there is no icing, or hydrate or liquid formation.

**4.4** It is recognized that new technology may not be covered in ISO XXXXX-3 or subsequent parts of ISO XXXXX.

## 5 Hydrostatic strength

A component shall not rupture when subjected to the following test procedure.

Plug the outlet opening of the component and have the valve seats or internal blocks assume the open position. Apply, with a test fluid, the hydrostatic pressure specified in ISO XXXXX-3 and subsequent parts of ISO XXXXX to the inlet of the component for a period of at least 3 min.

The samples used in this test shall not be used for any other testing.

## 6 Leakage

### 6.1 General

**6.1.1** Prior to conditioning, purge the component or device with nitrogen and then seal it at 30 % of service pressure using nitrogen, dry air or gaseous hydrogen.

---

1) To be developed

2) To be developed

3) Presently at DIS stage

**6.1.2** Conduct all tests while the device is continuously exposed to the specified test temperatures. The device shall either be bubble-free or have a leakage rate of less than 20 cm3/h (normal) using the following test method.

## 6.2 External leakage

**6.2.1** Plug each device outlet with the appropriate mating connection and apply the test pressure to the inlet.

**6.2.2** Apply pressurized air, nitrogen, or gaseous hydrogen to the test device.

**6.2.3** At all test temperatures, immerse the components in a suitable test medium for 2 min or use a helium vacuum test (global accumulation method) or other equivalent method.

**6.2.4** If there are no bubbles for the specified time period, the sample passes the test. If bubbles are detected, measure the leak rate by an appropriate method.

## 6.3 Internal leakage

**6.3.1** The internal leakage test is applicable only to devices having a closed position. The aim of this test is to check the pressure tightness of the closed system.

**6.3.2** Connect the inlet or outlet (as applicable) of the device, with the appropriate mating connection, while leaving the opposite connection or connections open.

## 6.4 Test conditions

### 6.4.1 General

The leakage test conditions depend on whether the component is exposed to cylinder pressure or located downstream of the first stage of pressure reduction.

### 6.4.2 Devices exposed to cylinder pressure

**6.4.2.1** The device shall be conditioned at a low temperature of - 40 °C, and pressurized at 75% and 2,5% of service pressure.

**6.4.2.2** The device shall be conditioned at a room temperature of 20 °C and pressurized at 2,5 % and 150 % of service pressure.

**6.4.2.3** The device shall be conditioned at a high temperature of 85 °C or 120 °C and pressurized at 5 % and 150 % of service pressure.

### 6.4.3 Devices downstream of the first stage of pressure reduction

**6.4.3.1** The device shall be conditioned at a low temperature of - 40 °C, and pressurized at 75% and 2,5% of working pressure.

**6.4.3.2** The device shall be conditioned at a room temperature of 20 °C and pressurized at 2,5 % and 150 % of working pressure.

**6.4.3.3** The device shall be conditioned at a high temperature of 85 °C or 120 °C and pressurized at 5 % and 150 % of working pressure.

## 7 Excess torque resistance

A component designed to be connected directly to threaded fittings shall be capable of withstanding, without deformation, breakage or leakage, a torque effort of 150 % of the rated installation value, according to the following test procedure.

a) Test an unused component, applying the torque adjacent to the fitting.

b) For a component having a threaded connection or threaded connections, apply the turning effort for 15 min, release it, then remove the component and examine it for deformation and breakage.

c) Subject the component to the leakage test specified in clause 6.

## 8 Bending moment

A component shall be capable of operation without cracking, breaking, or leaking when tested according to the following procedure.

a) Assemble the connections of the component, leak-tight, to an appropriate mating connection or connections, representative of design intent. After assembly, the length of the inlet tubing shall be greater than 300 mm (see Figure 1).

b) The outlet connection shall be rigidly supported, 25 mm from the component outlet, except in the following cases:

   — if the component has an integral mounting means independent of the inlet and outlet connections, the component shall be mounted using the integral mounting means specified by the manufacturer;

   — if the component is intended to be mounted by either the integral mounting means or the component outlet, the mounting means that produces the most severe test condition shall be used.

c) Check this assembly for leaks prior to subjecting it to d).

d) With the component in the closed position, pressurize the system to 0,25 times the working pressure and apply a force according to Table 1, 300 mm from the inlet, maintaining it for 15 min. Without removing the force, check the component for leakage, in accordance with the test method given in clause 6, at room temperature.

NOTE Depending on how this test is performed, raising the load to compensate buoyancy could be necessary.

e) Conduct procedure d) four times, rotating the component 90° around the horizontal axis between each test. Between tests, open and close (if applicable) the component three times with the bending moment removed.

f) At the completion of the above tests, remove the component and examine it for deformation; then subject it to the leakage test according to clause 6.

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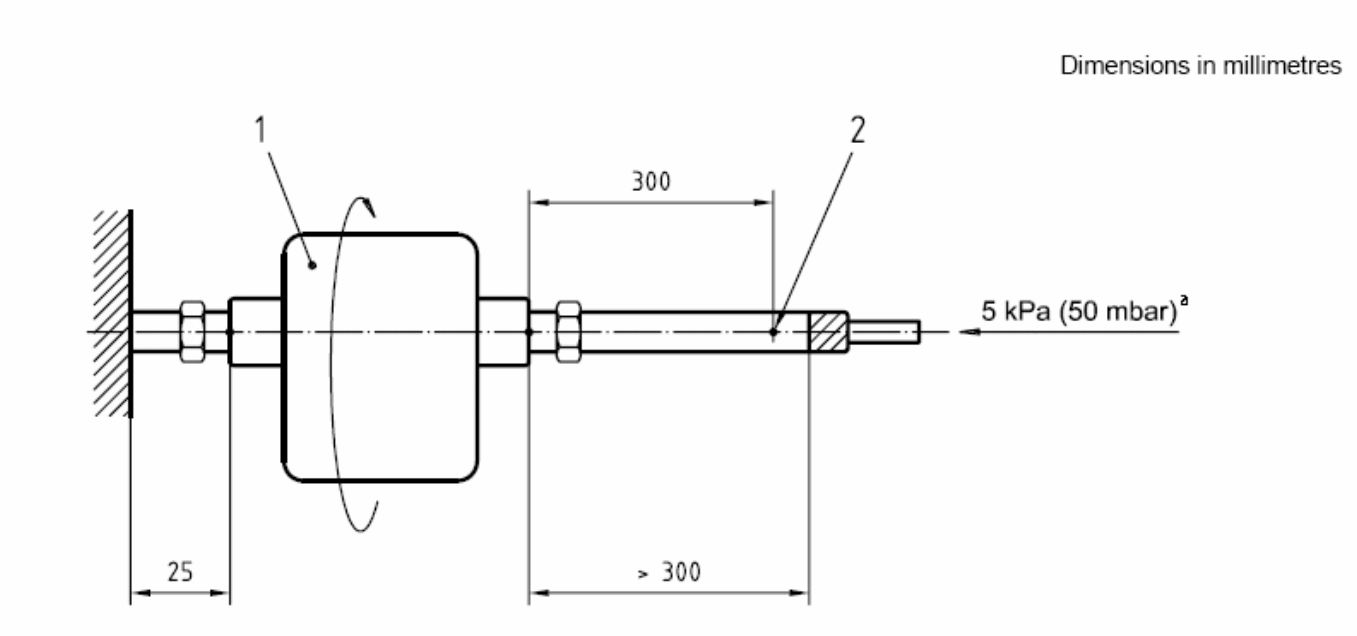
| Outside diameter of tubing<br>Mm | Force<br>N |
|---|---|
| 6 | 3,4 |
| 8 | 9,0 |
| ≥ 12 | 17,0 |

**Table 1 – Bending moment test force**




Key
1 Component
2 Force point
[a] 4 x 90° rotation.

**Figure 1 — Bending moment**

## 9 Continued operation

### 9.1 General

For the details of test methods for particular components, see the other parts of ISO 15500. The method specified in this clause is general in nature and also applies to miscellaneous components.

### 9.2 Test method

#### 9.2.1 Test procedure

Connect the component securely by a suitable fitting to a pressurized source of dry air, nitrogen or gaseous hydrogen and subject it to the number of cycles specified in ISO XXXXX-3 and subsequent parts of ISO

XXXXX. A cycle shall consist of one opening and (if applicable) one closing of the component within a period of not less than 10 s ± 2 s.

During the off-cycle, the downstream pressure of the test fixture shall be lowered to a maximum of 50 % of the test pressure.

In the case of components downstream of the first stage of pressure reduction, the test pressure shall be based on 100 % of the working pressure.

Unless otherwise specified, the conditions of 9.2.2 and 9.2.3 apply.

#### 9.2.2 Room temperature cycling

Operate the component through 96 % of the total cycles at room temperature and at service pressure, according to clause 6.

This test may be interrupted, if desired, at 20 % intervals for leakage testing.

#### 9.2.3 High temperature cycling

Operate the component through 2 % of the total cycles at the appropriate maximum temperature specified in ISO XXXXX-1, subclause 4.4, at service pressure. The component shall comply with clause 6 of this part of ISO XXXXX at the appropriate maximum temperature at the completion of the high temperature cycles.

#### 9.2.4 Low temperature cycling

Operate the component through 2 % of the total cycles at the appropriate minimum temperature specified in ISO XXXXX-1, subclause 4.4, at 50 % service pressure. The component shall comply with clause 6 of this part of ISO XXXXX at the appropriate minimum temperature at the completion of the low temperature cycles.

## 10 Corrosion resistance

**10.1** All components shall perform safely and in compliance with clause 6 following exposure to salt spray according to the following test method.

**10.2** With the component supported in its normal installed position, expose it for 96 h to a salt spray (fog) test as specified in ISO 9227.

**10.3** Maintain the temperature within the fog chamber at between 33 °C and 36 °C.

**10.4** The saline solution shall consist of 5 % sodium chloride and 95 % distilled water, by weight.

**10.5** Immediately following the corrosion test, rinse the sample and gently clean it of salt deposits; then subject it to the test according to clause 6.

## 11 Oxygen ageing

All synthetic or non-metallic parts of components that provide a fuel-containing seal for which a satisfactory declaration of properties is not submitted by the applicant shall not crack or show visible evidence of deterioration after oxygen ageing when tested according to the following procedure.

Subject representative samples to 96 h of exposure to oxygen at a temperature of 70 °C, at 2 MPa (20 bar), in accordance with ISO 188.

## 12 Electrical overvoltages

All electrical components or devices containing electrical subcomponents shall withstand the application of 1,5 times the rated voltage ± 5 % for periods of 3 min without failure.

## 13 Non-metallic synthetic immersion

**13.1** Non-metallic synthetic material used in a component shall be subjected by the test agency to the tests described in subclauses 13.2 and 13.3, except where the applicant submits declarations of results of tests carried out on the material provided by the manufacturer.

**13.2** A part made of non-metallic synthetic material in contact with gaseous hydrogen shall not show excessive change in volume or weight when tested according to the following procedure.

a) Prepare, measure and weigh a representative sample or samples of each non-metallic synthetic material used in a component, then immerse the sample or samples at room temperature in gaseous hydrogen at a pressure of 20 MPa (200 bar) for a minimum of 70 h.

b) Following this period of immersion, rapidly reduce the test pressure to atmospheric pressure without causing shredding or disintegration.

No tested sample shall exhibit swelling greater than 25 % or shrinkage greater than 1 %. The weight change shall not exceed 10 %.

**13.3** Non-metallic synthetic material used in a component that could be exposed to ester-based or alpha olefin-based synthetic compressor oils, including non-synthetic compressor oils, shall not show excessive change in volume or weight when tested in accordance with ISO 1817 or the following procedure.

a) Prepare, measure and weigh a representative sample or samples of each non-metallic synthetic material used in a component, then immerse the sample or samples at room temperature in holders each containing one of the test fluids for a minimum of 70 h.

b) Following this period of immersion, remove and measure the test samples.

No sample shall exhibit swelling greater than 25 % or shrinkage greater than 1 %. The weight change shall not exceed 10 %.

## 14 Vibration resistance

All components with moving parts shall remain undamaged, and shall continue to operate and meet the requirements of their leakage tests after 6 h of vibration, carried out according to the following test procedure.

a) Secure the component in a test apparatus and vibrate for 2 h at 17 Hz with an amplitude of 1,5 mm in each of three orientation axes.

b) On completion of this total of 6 h vibration, the component shall comply with the requirements of clause 6.

## 15 Brass material compatibility

All fuel-containing brass components or subcomponents for which a satisfactory declaration of properties is not submitted by the applicant shall be tested according to the following procedure (component manufacturers able to provide documentation attesting to the field-worthiness of their products are exempted from this requirement).

a) Subject each test sample to the physical stresses normally imposed on, or within, a part as a result of assembly with other components. Apply these stresses to the sample prior to the test, and maintain them during it. Samples with thread, intended to be used for installing the product in the field, shall have the threads engaged and tightened to the torque specified in the instruction manual of the sample. PolyTetraFluorEthylene (PTFE) tape or pipe compounds shall not be used on the threads.

b) Degrease three samples and continuously expose them for 10 d at a set position to a moist, ammonia-air mixture maintained in a glass chamber of approximately 30 l capacity and with a glass cover. Maintain approximately 600 $cm^3$ of aqueous ammonia, with a relative density (specific gravity) of 0,94, at the bottom of the glass chamber, below the samples. Position the samples 40 mm above the aqueous ammonia solution, supported by an inert tray. Maintain the moist ammonia-air mixture in the chamber at atmospheric pressure and at a temperature of 34 °C ± 2 °C.

After being subjected to the conditions of this procedure, samples shall show no evidence of cracking when examined at 25 x magnification.