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Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/ natural gas blend fuel system components —

Part 2: Performance and general test methods

Véhicules routiers — Composants des circuits d'alimentation pour hydrogène gazeux comprimé (CGH2) et mélanges de gaz naturel et hydrogène —

Partie 2: Performance méthodes d'essai en général

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).

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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 22, *Road vehicles*, Subcommittee SC 25, *Vehicles using gaseous fuels*.

ISO 12619 consists of the following parts, under the general title *Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components*:

— *Part 1: General requirements and definitions*

— *Part 2: Performance and general test methods*

— *Part 3: Pressure regulator*

Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blend fuel system components —

Part 2: Performance and general test methods

1 Scope

This part of ISO 12619 specifies performance and general test methods for compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components, intended for use on the types of motor vehicles defined in ISO 3833.

This part of ISO 12619 is applicable to vehicles using CGH2 in accordance with ISO 14687-1 or ISO 14687-2 and hydrogen/natural gas blends using natural gas in accordance with ISO 15403-1 and ISO/TR 15403-2. It is not applicable to the following:

— liquefied hydrogen (LH2) fuel system components;

— fuel containers;

— stationary gas engines;

— container mounting hardware;

— electronic fuel management;

— refuelling receptacles.

NOTE 1 It is recognized that miscellaneous components not specifically covered herein can be examined to meet the criteria of this part of ISO 12619 and tested according to the appropriate functional tests.

NOTE 2 All references to pressure in this part of ISO 12619 are to be considered gauge pressures unless otherwise specified.

NOTE 3 This part of ISO 12619 may not apply to fuel cell vehicles in compliance with international regulations.

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 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

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

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

ISO 11114-2, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials*

ISO 11114-4, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement*

ISO 12619-1:2014, *Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blend fuel system components — Part 1: General requirements and definitions*

ISO 12619-3:2014, *Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blend fuel system components — Part 3: Pressure regulator*

ISO 14687-1, *Hydrogen fuel — Product specification — Part 1: All applications except proton exchange membrane (PEM) fuel cell for road vehicles*

ISO 14687-2, *Hydrogen fuel — Product specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles*

ISO 15500-2, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 2: Performance and general test methods*

ISO 15403-1, *Natural gas — Natural gas for use as a compressed fuel for vehicles — Part 1: Designation of the quality*

ISO/TR 15403-2, *Natural gas — Natural gas for use as a compressed fuel for vehicles — Part 2: Specification of the quality*

ASTM G154, *Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials*

ASTM D4814 –11b, *Standard Specification for Automotive Spark-Ignition Engine Fuel*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12619-1 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 12619-3 and subsequent parts, as well as the applicable tests specified in this part of ISO 12619. Because of the peculiarities of some components, the list of tests given in this part of ISO 12619, (Clauses 5 to 17) 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 hydrogen, helium or blends of nitrogen with a minimum 5 % of hydrogen. The tests shall be performed by qualified personnel and appropriate safety measures shall be taken. The dew point of the test gas at the test pressure shall be at the temperature at which there is no icing, or hydrate or liquid formation. The dew point 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 12619-3 or subsequent parts of ISO 12619.

4.5 Hydrogen used for testing shall comply with either ISO 14687-1 or ISO 14687-2.

5 Hydrostatic strength

A component shall not show any visible evidence of 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 the applicable part of ISO 12619 to the inlet of the component for a period of at least 3 min.

The hydrostatic pressure shall be increased at a rate of less than or equal to 1,4 MPa/sec until component failure. The hydrostatic pressure at failure shall be recorded. The failure pressure of components which have been subjected to previous durability and corrosion tests shall be no less than 80 % of the failure pressure of the virgin component.

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 working pressure using test gases as defined in 4.3. In case of components subjected to more than one working pressure, the test may be conducted in subsequent steps.

6.1.2 Conduct all tests while the device is continuously exposed to the specified test temperatures. The device passes the test if it shall have a leakage rate of less than 10 Ncm^3/h (normal referred to hydrogen) of hydrogen gas using the test method specified in 6.2, 6.3 and 6.4. If test gas other than pure hydrogen is used, the leak rate shall be converted to a 100 % hydrogen gas leak rate equivalent.

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 test gases as defined in 4.3 to the test device.

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

6.2.4 Measure the leak rate by an appropriate method. It should not be more than as specified in 6.1.2.

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.

6.3.3 Apply the test pressure to the inlet or outlet, as applicable, of the device using test gas.

6.3.4 At all applicable temperatures mentioned in 6.4, immerse the component in a suitable test medium for at least 2 min or other equivalent method.

6.3.5 Measure the leak rate at any applicable test pressure mentioned in 6.4, or otherwise specified in the other parts of the ISO 12619 series, by an appropriate method and it should not be more than as specified in 6.1.2.

6.4 Test conditions

6.4.1 The device shall be pressurized at 100 % of service pressure and then conditioned until temperature equilibrium is achieved at low temperature of −40 °C or −20 °C, as applicable, and maintained at that temperature for at least 30 min. Then the device shall be pressurized at 5 % of service pressure and maintained at that temperature for at least 30 min.

6.4.2 The device shall be pressurized at 5 % of service pressure and then conditioned until temperature equilibrium is achieved at the room temperature of 20 °C ± 5 °C and maintained at that temperature for at least 30 min. Then the device shall be pressurized at 150 % of service pressure and maintained at that temperature for at least 30 min.

6.4.3 The device shall be pressurized at 5 % of service pressure and then conditioned until temperature equilibrium is achieved at high temperature of 85 °C or 120 °C, as applicable, and maintained at that temperature for at least 30 min. Then the device shall be pressurized at 150 % of service pressure and maintained at that temperature for at least 30 min.

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.

d) Subject the component to the hydrostatic strength test specified in Clause 5.

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.

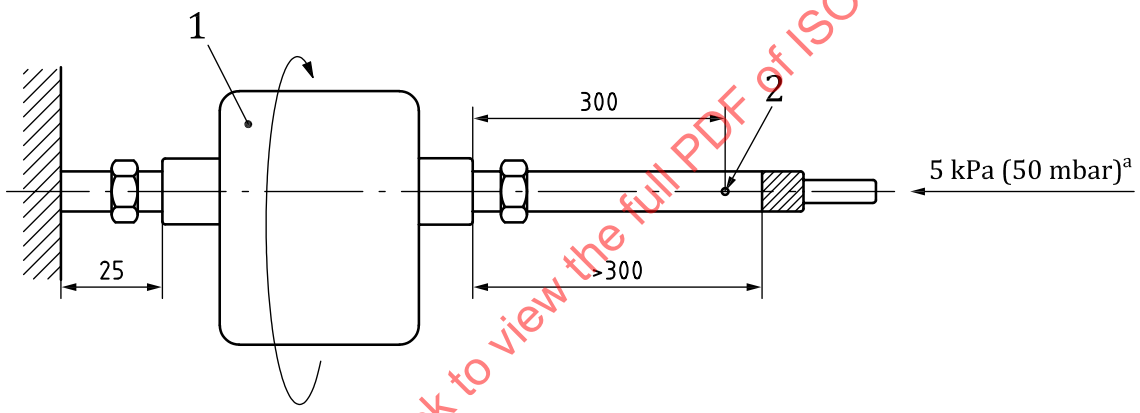
NOTE Depending on how this test is performed, increasing the load to compensate buoyancy could be necessary.

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 and to the hydrostatic test according to Clause 5.

Table 1 — Bending moment test force

Outside diameter of tubing mm	Force N
6	3,4
8	9,0
≥ 12	17,0



Key

1 component
2 force point
a 4 × 90° rotation

Figure 1 — Bending moment

9 Continued operations

9.1 General

For the details of test methods for particular components, see the other parts of ISO 12619. The method specified in this clause is general in nature and also applies to miscellaneous components.

Other components (those for which specific requirements are not specified) shall be subjected to the following continuous operation test for a total number of cycles to be determined by the testing agency. The determination of the total number of cycles shall be generally based on 15 000 fill cycles and/or 50 000 duty cycles.

9.2 Test method

9.2.1 Test procedure

Connect the component securely by a suitable fitting to a pressurized source of test gases as defined in 4.3 and subject it to the number of cycles specified in ISO 12619-3 and parts corresponding to specific component, as applicable. 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.

Unless otherwise specified, the test pressure shall be 100 % of the working pressure.

Unless otherwise specified, the conditions of 9.2.2, 9.2.3, and 9.2.4 apply.

9.2.2 Room temperature cycling

Operate the component through 90 % of the total cycles at room temperature specified in ISO 12619-1, 4.3 and at working pressure. On completion of room temperature cycles, the component shall comply with requirements of Clause 6 of this part of ISO 12619 at room temperature.

9.2.3 High temperature cycling

Operate the component through 5 % of the total cycles at the applicable maximum temperature specified in ISO 12619-1, 4.3 and at working pressure. On completion of the applicable maximum temperature cycles, the component shall comply with requirements of Clause 6 of this part of ISO 12619 at the applicable maximum temperature.

9.2.4 Low temperature cycling

Operate the component through 5 % of the total cycles at the applicable minimum temperature specified in ISO 12619-1, 4.3 and at 50 % working pressure. On completion of the applicable minimum temperature cycles, the component shall comply with requirements of Clause 6 of this part of ISO 12619 at the applicable minimum temperature.

Immediately following the continued operation tests and leakage testing, perform the hydrostatic strength test according to Clause 5.

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 500 h to a salt spray (fog) test as specified in ISO 9227.

10.3 Maintain the temperature within the fog chamber 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.

10.6 Immediately following the corrosion test and leakage testing, subject it to the hydrostatic strength test according to Clause 5.

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 minimum 96 h of exposure to oxygen at a temperature of 70 °C ± 5 °C, at minimum 2 MPa (20 bar), in accordance with ISO 188.

12 Ozone ageing

Sealing materials shall be listed and rated by the manufacturer as being resistant to ozone ageing. Otherwise, they shall not crack or show visible evidence of deterioration subsequent to ozone ageing as specified herein.

The test shall be in compliance with ISO 1431-1.

The test piece, which has to be stressed to 20 % elongation, shall be exposed to air at 40 C with an ozone concentration of 50 parts per hundred million for 120 h.

13 Electrical over voltages

The component shall be connected to a variable DC voltage source. The component shall be operated in the following cycles (see Figure 2):

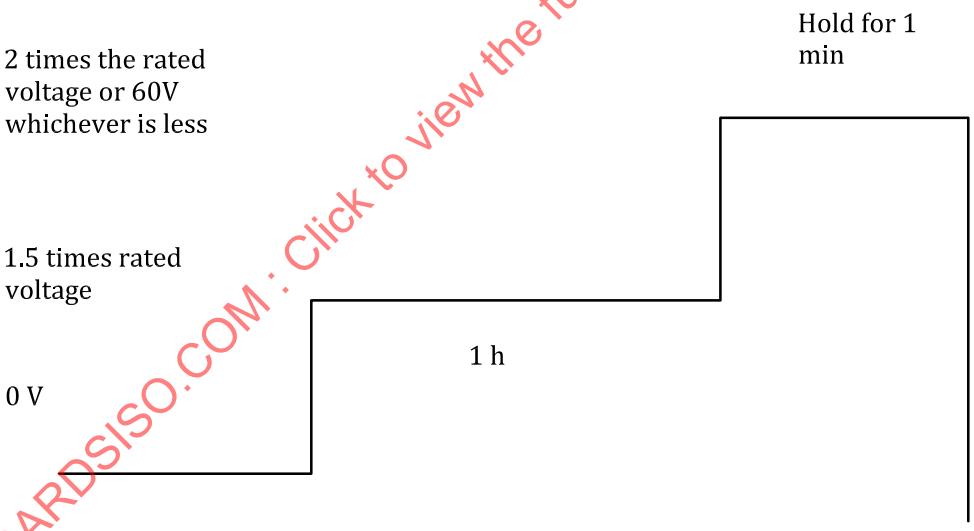


Figure 2 — Abnormal electrical voltages test cycle

The component shall be operated as follows:

— An equilibrium (steady-state temperature) hold is established for 1 hr at 1,5 times the rated voltage.

— The voltage is increased to two times the rated voltage or 60 V, whichever is less, and held for 1 min.

— Any failure shall not result in external leakage, open valve or similar unsafe conditions such as smoke, fire or melting.

The minimum opening voltage at service pressure and room temperature shall be less than or equal to 9 V for a 12 V system and less than or equal to 18 V for a 24 V system.

14 Non-metallic material immersion

14.1 Non-metallic material used in a component shall be subjected by the test agency to the tests described in 14.2 and 14.3, except where the applicant submits declarations of results of tests carried out on the material provided by the manufacturer.

14.2 A part made of non-metallic material in contact with gaseous hydrogen and hydrogen/natural gas shall be in accordance with ISO 15500-2, 13.2 and 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 equal to its working pressure, but not less than 100 kPa 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 %.

14.3 Non-metallic 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, within 1 h.

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

15 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.

Vibrate the component, pressurized to its working pressure with test gases as defined in 4.3 and sealed at both ends, for 30 min along each of the three orthogonal axes at the most severe resonant frequency determined with consideration of installing to the vehicle as follows:

— by an acceleration of 1,5 g;

— within a sinusoidal frequency range of 10 Hz to 500 Hz;

— with a sweep time of 10 min.

If the resonance frequency is not found in this range the test shall be conducted at 500 Hz.

At the completion of the test, the component shall not show any indication of fatigue or component damage, and shall comply with the leakage test specified in Clause 6 and the hydrostatic test specified in Clause 5.

