INTERNATIONAL STANDARD

ISO 17268

Second edition
2012-12-01

Gaseous hydrogen land vehicle refuelling connection devices

Dispositifs de raccordement pour le ravitaillement des véhicules terrestres en hydrogène gazeux

Reference number
ISO 17268:2012(E)

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Published in Switzerland

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Foreword

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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.

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.

ISO 17268 was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies.*

This second edition cancels and replaces the first edition (ISO 17268:2006), which has been technically revised.

Gaseous hydrogen land vehicle refuelling connection devices

1 Scope

This International Standard defines the design, safety and operation characteristics of gaseous hydrogen land vehicle (GHLV) refuelling connectors.

GHLV refuelling connectors consist of the following components, as applicable:

— receptacle and protective cap (mounted on vehicle);

— nozzle.

This International Standard applies to refuelling connectors which have working pressures of 11 MPa, 25 MPa, 35 MPa and 70 MPa, hereinafter referred to in this International Standard as the following:

— H11 – 11 MPa at 15 °C;

— H25 – 25 MPa at 15 °C;

— H35 – 35 MPa at 15 °C;

— H35HF – 35 MPa at 15 °C (high flow for commercial vehicle applications);

— H70 – 70 MPa at 15 °C.

Nozzles and receptacles that meet the requirements of this International Standard will only allow GHLVs to be filled by fuelling stations dispensing hydrogen with nominal working pressures equal to or lower than the vehicle fuel system working pressure. They will not allow GHLV to be filled by fuelling stations dispensing blends of hydrogen with natural gas.

Refuelling connectors dispensing blends of hydrogen with natural gas are excluded from the scope of this International Standard.

NOTE This International Standard can be used for certification purposes.

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

ISO 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

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

ISO 15501-1, *Road vehicles — Compressed natural gas (CNG) fuel systems — Part 1: Safety requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
connector
joined assembly of nozzle and receptacle which permits the transfer of hydrogen

3.2
cycle
the process of a making a positive connection between the nozzle and the receptacle, pressurizing to the maximum working pressure, depressurising and disconnecting

3.3
dry helium
helium with a dew point adequate to prevent condensation during testing and at least 99 % pure

3.4
dry hydrogen
hydrogen which meets or exceeds the quality level in ISO 14687-2

3.5
leak test gas
gas for testing leaks that consists of dry hydrogen, or dry helium, or blends of a minimum 10 % of hydrogen or helium with nitrogen.

3.6
maximum working pressure
maximum pressure that a connector will experience in service independent of temperature

NOTE The maximum working pressure is 125 % of the nominal working pressure at 15 °C for the purpose of testing of nozzles and receptacles in this International Standard.

3.7
nominal working pressure
pressure for which the connector is intended to be operated for a given gas temperature of 15 ºC

NOTE This defines a full tank gas density.

3.8
nozzle
device connected to a fuel dispensing system, which permits the quick connect and disconnect of fuel supply to the vehicle or storage system

3.9
positive locking means
feature, which requires actuation of an interlocking mechanism to achieve proper connection of the nozzle to the receptacle before pressure is applied

3.10
protective cap
means to prevent dirt and other contaminants from getting into the inlet of the vehicle receptacle

3.11
receptacle
device connected to a vehicle or storage system which receives the nozzle

NOTE This can also be referred to as a fuelling inlet of gas filling port in other documents.

4 General construction requirements

4.1 Nozzles and receptacles shall be designed in accordance with reasonable concepts of safety, durability and maintainability.

4.2 Nozzles and receptacles designed and tested in accordance with this International Standard shall

a) prevent hydrogen fuelled vehicles from being filled by fuelling stations with working pressures or flow rates higher than the vehicle,

b) prevent hydrogen fuelled vehicles from being filled by other compressed gas fuelling stations, and

c) prevent other gaseous fuelled vehicles from being filled by hydrogen fuelling stations.

4.3 Nozzles and receptacles shall be well fitted and manufactured in accordance with good engineering practice.

4.4 Nozzles and receptacles shall be

a) designed to minimise the possibility of incorrect assembly,

b) designed to be secure against displacement, distortion, warping or other damage,

c) constructed to maintain operational integrity under normal and reasonable conditions of handling and usage, and

d) designed with no self-evident means of defeating the safety features.

4.5 Nozzles and receptacles shall be manufactured of materials suitable and compatible for use with compressed hydrogen at the pressure and the temperature ranges to which they will be subjected as specified in 5.8 and 6.9. Materials used in the construction of nozzles, receptacles and protective caps shall be non-sparking or spark-reducing. All pressure bearing and wetted components shall also be made from material that is compatible with deionised water. Non-metallic material compatibility shall be documented by the component manufacturer or an independent third party.

4.6 The nozzle shall be connected to or disconnected from the receptacle without the use of tools.

4.7 The H11 and H25 receptacles shall be mounted on the vehicle in compliance with ISO 15501-1. All other receptacles shall be mounted on the vehicle in compliance with the envelope requirements specified in Annex A.

4.8 Protective caps are intended to protect the receptacle from foreign debris and shall not hold pressure. Resistance shall be appropriate to prevent inadvertent dislodging. All protective caps shall have a retainer to attach them to the receptacle or vehicle.

5 Nozzles

5.1 Nozzles shall comply with the dimensional requirements of 6.1 to ensure proper interchangeability. Nozzles shall couple with receptacles of equal or higher nominal working pressures and they shall be designed so that they will not couple with receptacles of lower nominal working pressures. The nozzle shall extend to within 1 mm of the stop ring for all nominal working pressures. Nozzles shall be designed so that they will not couple with gaseous fuelled vehicles other than GHLV.

5.2 Nozzles shall be one of the following three types.

a) TYPE A - A nozzle for use with dispensing hoses that may remain fully pressurized at dispenser shutdown. The nozzle shall not allow gas to flow until a positive connection has been achieved. The nozzle shall be equipped with an integral valve or valves, incorporating an operating mechanism which first stops

the supply of gas and safely vents the trapped gas before allowing the disconnection of the nozzle from the receptacle. The operating mechanism shall ensure the vent connection is open before the release mechanism can be operated and the gas located between the nozzle shut-off valve and the receptacle check valve is safely vented prior to nozzle disconnection.

b) TYPE B - A nozzle for use with dispensing hoses that may remain fully pressurized at dispenser shutdown. A separate three-way valve connected directly, or indirectly, to the inlet of the nozzle shall be used to safely vent trapped gas prior to nozzle disconnection. The nozzle shall not allow gas to flow until a positive connection has been achieved. Venting shall be achieved prior to disconnection of the nozzle. External three-way valves shall be constructed and marked so as to indicate clearly the open, shut and vent positions.

c) TYPE C - A nozzle for use with dispensing hoses which are depressurized (0,5 MPa and below) at dispenser shutdown. The nozzle shall not allow gas to flow until a positive connection has been achieved. The function of preventing flow may be controlled by the dispenser as long as it is receiving a positive connection signal from the nozzle.

5.3 Nozzles shall be designed for a life of 100 000 cycles with manufacturer specified maintenance. The three-way valve used for actuating Type B nozzles shall meet the same number of cycles as the nozzle (i.e. 100 000 cycles).

5.4 The act of venting, or de-pressurising, of the connection space between all nozzle types and receptacles shall be performed prior to disconnection. A provision shall be made for the venting or de-pressurising of all nozzle types to be directed to a safe location.

5.5 The means for attaching the nozzle to the fuel dispensing system hose shall not rely on the joint between the male and female threads for sealing, such as tapered pipe threads.

5.6 The H11 and H25 nozzles shall fit within the envelope described in ISO 15501-1. All other nozzles shall fit within the envelope specified in Annex A.

5.7 Nozzles shall have a means to prevent the ingress of solid matter from upstream sources. For example, the requirement shall be deemed met if the nozzle has a filter upstream of adequate size to protect its functionality.

5.8 The nozzle shall be designed to operate properly at ambient temperatures ranging from –40 °C to 50 °C and at hydrogen gas temperatures ranging from –40 °C to 85 °C.

5.9 The nozzle shall not have any mechanical means of opening the receptacle check valve.

6 Receptacles

6.1 Standard receptacle dimensions: A receptacle shall comply with the design specifications detailed in Annex B.

NOTE The main O-ring seal for all pressure ratings less than 70 MPa is situated at the leading edge of the receptacle. For the 70 MPa receptacle, the main O-ring seal is situated in the bore of the receptacle. The 70 MPa receptacle also includes an O-ring at the leading edge of the receptacle to seal with nozzles having pressure ratings less than 70 MPa.

6.2 Receptacles shall comply with all sections of this International Standard. The failure of any test conducted with the receptacle and nozzle test samples shall constitute a failure of the receptacle design.

6.3 Receptacles shall be designed for a life of 15 000 cycles and 15 years with manufacturer specified maintenance.

6.4 Receptacle designs, which employ means on the back diameter to accommodate mounting, or for mounting accessories or marking purposes, shall not have such means extend beyond the back diameter dimensions of the profile specified in Annex B, as applicable. Acceptable means shall include wrench flats,

protective cap anchoring grooves, use of hex stock, undercutting for marking, and threads for protective caps. Such receptacle designs shall not compromise proper nozzle interchangeability.

6.5 The receptacle shall be equipped with an internal check valve to prevent the escape of gas. The check valve shall be of the non-contact type, opening by differential pressure only.

6.6 The means for attaching the receptacle to the vehicle fuel system shall not rely on the joint between the male and female threads for sealing, such as tapered pipe threads.

6.7 Receptacles shall be designed so that they are either tolerant of solid contamination, or have a means to protect themselves from said contamination to maintain safe functionality. For example, the requirement shall be deemed met if the receptacle has a filter upstream of adequate size to protect the functionality of the check valve. A receptacle shall have a means to prevent the ingress of fluids and foreign matter when disconnected.

6.8 The receptacle shall have provisions to be firmly attached to the vehicle and shall comply with applicable abnormal load tests specified in 7.10.

6.9 The receptacle shall be designed to operate properly from –40 °C to 85 °C.

7 Design verification test procedures

7.1 General requirements

Nozzles and receptacles shall meet the requirements of all sections of this International Standard.

7.2 Test conditions

Unless otherwise stated

a) tests shall be conducted at 20 °C ± 5 °C,

b) all pressure tests shall be conducted with leak test gas unless otherwise noted,

c) all leak tests shall be conducted with leak test gas, and

d) test fluids and devices shall be at equilibrium conditions with the test environment at the beginning of all tests.

7.3 Nozzle tests

Nozzle tests shall be performed with the test fixtures identified under Annex C, Annex D or Annex E, as applicable. A new receptacle test sample shall be used for each nozzle test. The failure of any test conducted with the nozzle and receptacle test sample shall constitute a failure of the nozzle design.

7.4 Receptacle tests

Receptacles shall be evaluated with nozzle(s) which have been deemed compliant to this International Standard. The failure of any test conducted with the receptacle and nozzle test samples shall constitute a failure of the receptacle design.

7.5 User – Machine interface

This test shall be performed to verify the connection and disconnection forces and torques of an unpressurized and pressurized device.

The disconnection forces and torques shall be applied in a direction that tends to disconnect and release the nozzle. The torque shall be applied to the disconnection/release actuator or three-way valve. For example, if there is a handle, the torque shall be applied through axis rotation of the nozzle handle equal to the exterior handling surface of the nozzle mechanism and in such a direction that tends to unhook and release the nozzle.

The test shall be deemed to be successfully passed if the following conditions are met:

— The appearance of the nozzle and receptacle shall be such as to clearly suggest the proper method of use.

— It shall not be possible to deliver gas using any nozzles unless the nozzle and receptacle are connected properly and positively locked.

— It shall not be possible to remove a nozzle when the contained pressure is greater than 1,0 MPa.

— Upon disconnection, all types of nozzles shall stop the flow of gas. No hazardous condition shall result from disconnection. Type C nozzles shall be at 0,5 MPa during this test.

— When the contained pressure is less than or equal to 0,5 MPa, Type A and B nozzles shall be capable of being disconnected with forces less than 225 N and torques less than 7 N•m.

— On unpressurised devices the axial force to connect and lock or unlock and disconnect the device shall be less than or equal to 90 N.

— On a secondary positive locking device which incorporates a rotary locking mechanism, the torque to lock or unlock the locking means shall not exceed 1 N•m.

— On a secondary positive locking device which incorporates an axial locking mechanism, the force to lock or unlock the locking means shall not exceed 90 N.

7.6 Dropping

This test shall be performed to verify that a nozzle can safely withstand a drop of 2 m under –40 °C conditions.

A nozzle conditioned at –40 °C for 24 hours shall be connected to a 5 m length of the appropriately rated fuelling hose, and then dropped 2 m onto a concrete floor as shown in Figure 1. The nozzle shall be dropped ten times within five minutes of removal from the conditioning chamber, then pressurised to maximum working pressure and subjected to ten additional drops within five further minutes.

Dimensions in metres

Key

1 Support
2 11 mm diameter fuelling hose
3 Nozzle
4 Concrete floor

Figure 1 — Test arrangement for dropping test

Following all drops described previously, the nozzle shall be capable of normal connection to the receptacle. In addition, the nozzle shall comply with the leakage tests specified in 7.7 and 7.11 as well as the hydrostatic strength test specified in 7.16.

7.7 Leakage at room temperature

These tests shall be performed to verify leakage rate of nozzle, receptacle, connector and receptacle check valve at room temperature.

Tests shall be conducted at 0,5 MPa and 150 % of the nominal working pressure. All devices shall be checked for leakage from the time of connection, through pressurization, to the time of disconnection.

To verify the leakage rate of the nozzle, the receptacle and the connector, pressurized leak test gas shall be applied to the inlet of the connector, the disconnected nozzle and the outlet of the disconnected receptacle.

To verify the leakage rate of the receptacle check valve, pressurized leak test gas shall be applied to the inlet of the connector. The upstream portion of the receptacle shall be quickly depressurized, the nozzle disconnected and the receptacle check-valve checked for leakage.

Following the tests described above, the nozzle, receptacle, connector and receptacle check valve shall be bubble free for 1 minute. If bubbles are detected then the leak rate shall be measured by either an external vacuum test using leak test gas (global accumulation test) or an equivalent method to show that the leak rate is less than 20 cm^3/h of hydrogen at 20 °C.

NOTE The permitted leakage rate is applicable to tests with 100 % hydrogen only. Permitted leakage rates for other gases or gas mixtures are to be converted to an equivalent leakage rate to that for 100 % hydrogen.

7.8 Valve operating handle

This test shall be performed to verify that nozzles equipped with operating handles can withstand a maximum force without damage.

A 200 N force shall be applied to the valve operating handle at the point furthest away from the axis of rotation in both the opening and closing directions. The test shall be performed with the nozzle properly connected to a receptacle, and with the nozzle intentionally, improperly engaged relative to the receptacle.

Following the tests, the nozzle shall maintain safe operating functionality.

7.9 Receptacle vibration resistance

This test shall be performed to verify receptacle and protective cap resistance to vibration.

The receptacle and protective cap shall be secured in a test apparatus and vibrated at each integer frequency from 5 Hz to 60 Hz for eight minutes at each frequency. The amplitude of the vibration shall be at least 1,5 mm from 5 Hz to 20 Hz, 1,2 mm from 20 Hz to 40 Hz, and 1 mm from 40 Hz to 60 Hz. The tests shall be conducted once in the axial direction, and again in the radial direction.

Following the tests, there shall be no visible damage to the receptacle and protective caps. The receptacle shall comply with all the receptacle leakage tests specified in 7.7 and 7.11 as well as the hydrostatic strength test specified in 7.16.

7.10 Abnormal loads

This test shall be performed to verify that the nozzle and receptacle can withstand abnormal loads in service.

The connected nozzle and receptacle may be subjected to the following abnormal loads in service:

a) pulls along the nozzle or receptacle longitudinal axis;

b) moments applied to the end fitting of the nozzle.

The connected nozzle and receptacle shall be able to withstand abnormal loads of a = 1 000 N, b = 120 N•m without distortion or damage.

Also, the connected nozzle and receptacle shall be able to withstand abnormal loads of a = 2000 N; b = 240 N•m without leakage. The moment arm shall be measured from the point of attachment of the receptacle to the vehicle body to the hose inlet of the nozzle.

The nozzle and receptacle test fixture shall be tested in the pressurized and non-pressurized condition. During the pressurized test the nozzle and receptacle test fixture shall be pressurized to maximum working pressure. The appropriate “Loose Fit” test fixture (see Annex C) shall be used for this test. The test fixture shall be mounted as a cantilever to a supporting member. For the purposes of this test, the supporting member shall be capable of withstanding the specified loads without displacement or deflection. The nozzle shall be properly connected to the test fixture.

Following the tests, the nozzle and connector shall comply with the appropriate leakage tests specified in 7.7 and 7.11 as well as the hydrostatic strength test specified in 7.16.

7.11 Low and high temperatures

7.11.1 Purpose

These tests shall be performed to verify leakage rate and operation of nozzle, receptacle and connector at low and high temperatures.

7.11.2 General

Prior to conditioning, the devices shall be purged with nitrogen and then sealed from atmosphere under a pressure of 7 MPa leak test gas. All tests shall be conducted while the devices are continuing to be exposed to the specified test temperatures. The outlet of the device shall be plugged and the test pressure shall be applied to the inlet of the device.

7.11.3 Leakage tests

Fuelling connection devices shall be leak tested in accordance with the test conditions listed below after 2 hours of conditioning for the components and leak detector (if used):

a) The nozzle and receptacle coupled, conditioned at −40 °C and pressurised at 0,5 MPa and maximum working pressure.

b) The nozzle and receptacle coupled, conditioned at 50 °C and pressurised at 1 MPa and maximum working pressure.

c) The receptacle uncoupled, conditioned at −40 °C and pressurised at 0,5 MPa and maximum working pressure.

d) The receptacle uncoupled, conditioned at 85 °C and pressurised at 1 MPa and maximum working pressure.

e) The nozzle uncoupled, conditioned at −40 °C and pressurised at 0,5 MPa and maximum working pressure.

f) The nozzle uncoupled, conditioned at 50 °C and pressurised at 1 MPa and maximum working pressure.

Pressurised leak test gas shall be applied to the test components. The external body shall then be checked for bubble tight leakage using

g) at −40 °C, immersion in a 100 % denatured ethyl alcohol mixture for 1 min, and

h) at 50 °C or 85 °C, immersion in 50 °C or 85 °C water for 1 min.

Following the tests, the nozzle, receptacle and connector shall be bubble free for 1 minute or have a leak rate less than 20 cm^3/h at 20 °C.

NOTE The permitted leakage rate is applicable to tests with 100 % hydrogen only. Permitted leakage rates for other gases or gas mixtures are to be converted to an equivalent leakage rate to that for 100 % hydrogen.

7.11.4 Operation tests

The devices shall function under the following conditions.

a) The nozzle and receptacle connected and disconnected ten times when conditioned at −40 °C and pressurised to maximum working pressure.

b) The nozzle and receptacle connected and disconnected ten times when conditioned at 85 °C and pressurised to maximum of working pressure.

Following the tests, the devices shall connect and disconnect normally and deliver gas.

7.12 Durability and maintainability

7.12.1 Purpose

These tests shall be performed to verify that the nozzle, receptacle, receptacle check valve and connector can withstand durability cycling.

7.12.2 Nozzle durability test

During the following tests, all devices shall be maintained according to the manufacturer's instructions.

Requirements for maintenance at cycles less than specified by the manufacturer shall be considered as non-compliant with this International Standard.

The nozzle shall be capable of withstanding 100 000 cycles. For the purpose of this test, one cycle of operation for Type A, B and C nozzles shall consist of the following.

a) Properly connecting the nozzle to the receptacle test fixture.

b) Pressurizing the connector to maximum working pressure using leak test gas.

c) Depressurizing the connector.

d) Disconnecting the nozzle.

While disconnected the test fixture shall be rotated relative to the nozzle at random or equal degree increments throughout this test.

The receptacle test fixture shall be replaced at 15 000 cycle intervals as specified in Table 1 below.

Table 1 — Test fixture selection for nozzle durability tests

Number of cycles	Figure	Geometry
0 - 15 000	Annex D	Tight fit
15 000 - 30 000	Annex D	Tight fit
30 000 - 45000	Annex C	Loose fit
45 000 - 60 000	Annex C	Loose fit
60 000 - 75 000	Annex D	Tight fit
75 000 - 90 000	Annex D	Tight fit
90 000 - 100 000	Annex C	Loose fit

At the end of the 100 000 cycles the nozzle locking mechanism shall be checked at the normal disconnect pressure to ensure it is properly engaged on the receptacle.

At the end of the 100 000 cycles the nozzle shall comply with 7.5, 7.7, 7.11 and 7.15. The nozzle shall comply with 7.7 when tested with the appropriate simulated wear pattern test fixture shown in Annex E, as applicable.

After 15 000 cycles, the worn receptacle test fixtures shall not be in excess of wear patterns shown in Annex E as applicable and shall comply with 7.7.

7.12.3 Receptacle check valve durability test

The receptacle check valve shall be capable of withstanding 15 000 operational cycles. For the purposes of this test, one cycle of operation shall consist of the following:

a) Properly connecting the receptacle to the nozzle test fixture.

b) Pressurizing the connector to nominal working pressure in 6 pulses using leak test gas.

c) Depressurizing the connector by first venting the upstream side of the receptacle check valve and then lowering the pressure on the downstream side of the receptacle check valve to between 0 and a maximum of 0,5 MPa prior to the next cycle.

Following 15 000 cycles of operation, the receptacle check valve shall then be subjected to 24 hours of flow at the inlet/outlet flow conditions that cause the most severe chatter.

Following the test, the receptacle check valve shall comply with the leakage tests specified in 7.7 and 7.11 as well as the electrical resistance test as specified in 7.15.

7.12.4 Receptacle durability test

The receptacle shall be capable of withstanding 15 000 operational cycles. For the purposes of this test, one cycle of operation shall consist of the following:

a) Properly connecting the receptacle to the nozzle.

b) Pressurizing the connector to maximum working pressure using leak test gas.