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Ships and marine technology — Technical requirements for dry-disconnect/connect couplings for bunkering liquefied natural gas

Navires et technologie maritime — Exigences techniques relatives au couplage de connexion et de déconnexion à sec pour le soutage de gaz naturel liquéfié

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Technical requirements for dry-disconnect/connect couplings for bunkering liquefied natural gas

1 Scope

This document specifies the design, minimum safety, functional and marking requirements, as well as the interface types and dimensions and testing procedures for dry-disconnect/connect couplings for LNG hose bunkering systems intended for use on LNG bunkering ships, tank trucks and shore-based facilities and other bunkering infrastructures. It is not applicable to hydraulically operated quick connect/disconnect couplers (QCDC) used for hard loading arms, which is covered in ISO 16904.

Based on the technology used in industrial manufacturing at the time of development of this document, it is applicable to sizes of couplings ranging from DN 25 to DN 200.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendment) applies.

ISO 3834 (all parts), *Quality requirements for fusion welding of metallic materials*

ISO 5208:2015, *Industrial valves — Pressure testing of metallic valves*

EN 1092-1, *Flanges and their joints*

EN 12266-1:2012, *Industrial valves — Testing of metallic valves — Part 1: Pressure tests, test procedures and acceptance criteria — Mandatory requirements*

ASME B16.5-2009, *Pipe flanges and flanged fittings*

ASME B31.3-2018, *Process piping*

3 Terms and definitions

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

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

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

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

3.1
bunkering
operation of transferring LNG fuel to a vessel

[SOURCE: ISO 20519:2017, 3.1, modified — Note 1 to entry has been deleted.]

3.2
dry-disconnect
method that reduces LNG or natural gas releases into the atmosphere under normal operation to a negligible amount consistent with safety, either by equipment design or procedural practice

[SOURCE: ISO 20519:2017, 3.6]

3.3
dry-disconnect/connect coupling
coupling
dry disconnect coupling
dry break coupling
mechanical device, consisting of a *nozzle* (3.4) and a *receptacle* (3.5), which permits quick connection and disconnection of a hose bunkering system of the bunker facility to the manifold of the receiving vessel, in a safe manner, without employing bolts

3.4
nozzle
half part of the *dry-disconnect/connect coupling* (3.3) typically mounted on the hose bunkering system of the bunker facility, which permits a quick connection and disconnection to the receiving vessel in a safe manner

Note 1 to entry: It includes an internal valve to seal the nozzle/bunkering system when disconnected and is opened after connection by manual operation.

Note 2 to entry: See 4.2.4.

3.5
receptacle
half part of the *dry-disconnect/connect coupling* (3.3), which is typically mounted to the manifold flange of the receiving vessel, which permits a quick connection and disconnection of the hose bunkering system in a safe manner

Note 1 to entry: It includes an internal valve to seal the receptacle/*manifold* (3.7) system when disconnected and is opened after connection by manual operation of the *nozzle* (3.4).

Note 2 to entry: The receptacle shall always be equipped with a seal, as shown in Figure 3.

Note 3 to entry: See 4.2.4.

3.6
dry gas
gas with moisture content such that the dew point of the gas at the required test pressure is at least 11 °C below the ambient test temperature

3.7
manifold
pipe assembly mounted on board LNG-fuelled vessel to which the flange of the *receptacle* (3.5) is connected

3.8
verification testing
series of tests to assure that each *coupling* (3.3) part (including *nozzle* (3.4) and *receptacle* (3.5)) meets all of its design specifications and requirements and that it fulfils its intended purposes

3.9
production testing
process of measuring the properties or performance of the *coupling* (3.3) and checking it and obtaining an indication of well productivity before being delivered from factory to customer

4 General requirements

4.1 General

The dry-disconnect/connect coupling shall be functionally compatible with the LNG bunkering system; the nozzle shall be functionally compatible with the corresponding receptacles, and vice versa.

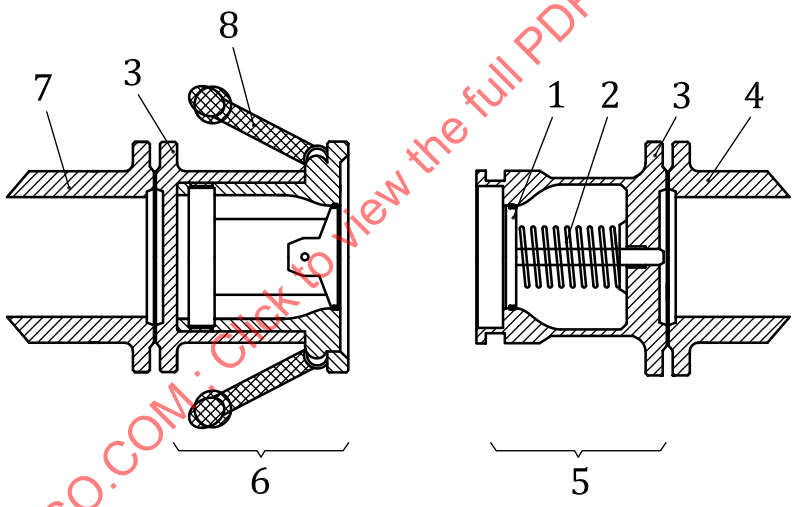
4.2 Basic design principle

4.2.1 The coupling consists of a nozzle and a receptacle. The nozzle allows a quick connection and disconnection of the LNG bunkering system to the receptacle.

4.2.2 The poppet faces of the internal valve from the nozzle interacts and pushes the receptacle poppet toward the open position in order to allow a medium flow.

4.2.3 The nozzle and receptacle shall remain in the final position when the coupling is connected and is in fully open condition.

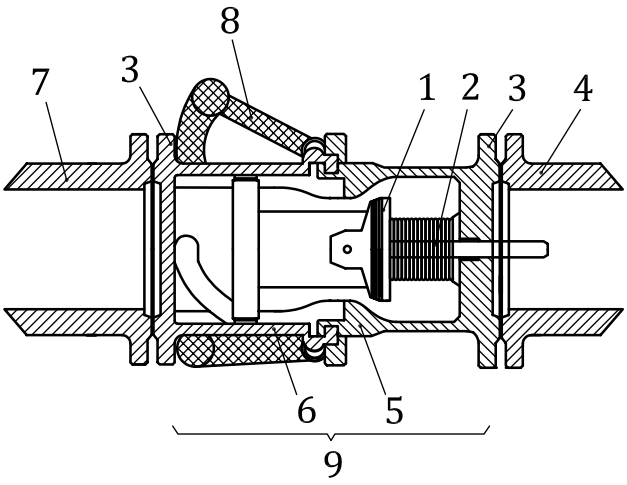
4.2.4 The typical structure of the two-part coupling is shown in Figure 1 and Figure 2:



Key

1 internal valve
2 poppet
3 flange
4 manifold of LNG receiving vessel
5 receptacle
6 nozzle
7 hose of LNG bunkering facility
8 handle

Figure 1 — Sketch structure of a dry-disconnect/connect coupling — Disconnected condition



Key

1 internal valve
2 poppet
3 flange
4 manifold of LNG receiving vessel
5 receptacle
6 nozzle
7 hose of LNG bunkering facility
8 handle
9 coupling

Figure 2 — Sketch structure of a dry-disconnect/connect coupling — Connected condition

4.2.5 The dry disconnect/connect coupling shall be designed according to a design standard for pressure-containing equipment. Accepted design codes are:

— ASTM Boiler and Pressure Vessel Code;

— European Pressure Equipment Directive 2014/68/EU;

— EN 12516 Industrial Valves – Shell design strength;

— ISO 16904:2016, 7.2 Design of QCDC; Section 7.3 QCDC system; 9.3.8 QCDC (Testing requirements).

Other design codes can be accepted if they provide the same level of safety with respect to pressure containment.

The wall thickness of the coupling shall take into account, as a minimum but not limited to, the internal pressure, the external loads and the moments.

4.2.6 The receptacle shall always be equipped with a seal, as shown in Figure 3.

4.3 Design parameters

The design pressure and temperature of the dry-disconnect/connect coupling shall comply with:

a) Minimum design pressure:

1,6 MPa.

b) Design temperature:

–196 °C to + 85 °C.

4.4 Functional requirements

4.4.1 An interlock function shall be included to ensure the coupling is sealed first under connection, before the internal valves are opened. When disconnecting, the internal valves shall be closed first, before it is possible to disconnect the coupling. This may be achieved by an internal interlock device (two-step action) or sequential in one single rotating manoeuvre (single-step action).

4.4.2 The volume between the two internal valves shall be as small as practical and reported by the manufacturer.

4.4.3 Once connected, the coupling shall remain liquid and gas tight under all operating conditions, and shall sustain:

1. The external loads applied at the connection between the bunkering system and the ship's manifold (dynamic and static as well as ice accretion).
2. The internal loads due to the LNG transfer process, either pressure or thermal loads during transient and permanent phases.

The bending loads shall comply with the value specified in Table 5.

4.4.4 It shall be possible to disconnect the nozzle from the receptacle under the maximum manifold loads, including an ice build-up on the device with a thickness of:

1. for DN 25 to DN 80: 10 mm solid ice (d = 800 kg/m^3);
2. for DN 100 to DN 200: 25 mm solid ice (d = 800 kg/m^3).

4.4.5 The design of the coupling shall allow the coupling to be manually connected and disconnected unaided and the maximum force to (dis)connect the nozzle from the receptacle shall not exceed 350 N. Where this force exceeds 350 N, actuation shall be pneumatically or hydraulically assisted.

The nozzle shall be so designed as to be operated without the use of tools (e.g. extension bars) and excessive force for connecting and disconnecting.

4.4.6 The operation direction to open and close shall be indicated with an indelible mark. Connected condition shall be made with a positive indication that the mechanism action is fully made.

4.4.7 The design of the nozzle and receptacle shall allow for the removal of liquid and vapour before disconnection, avoiding vapour and liquid trapped in the dead space during purging operation.

4.4.8 The nozzle shall have an integrated swivel function. It shall allow free rotation, to prevent the application of torsional loads on the bunkering system.

4.4.9 The coupling shall have suitable fire resistance properties and shall be fire type tested in accordance with recognized standards (e.g. ISO 10497).

4.4.10 The coupling shall be made of conductive, non-sparking material.

4.5 Internal valve

The backwards force of the receptacle poppet in fully open position shall be maximum of 460 N.

4.6 Protective cap/plug

A cap/plug or equivalent design feature shall be provided to prevent dust, moisture, and other foreign debris from entering the nozzle and receptacle. The cap/plug shall not allow the build-up of pressure between the receptacle and the cap as well as between the nozzle and the plug.

4.7 Handle

A handle is to be fitted to the nozzle to protect the operator from cold injuries.

5 Materials

5.1 General

The material shall be suitable for the use with LNG and for the test conditions with liquid nitrogen down to –196 °C. Recommendations are mentioned in ISO 16903:2015, Table 3.

5.2 Body of coupling

5.2.1 The coupling shall be made from forged stainless steel ASTM A182 grade F316 or equivalent, in the solution heat-treated condition.

5.2.2 The coupling may be manufactured from bar material according to ASTM A479, EN 10272 or equivalent, in a solution heat-treated condition.

5.3 Bolting

Bolting shall be in accordance with ASME/ANSI B16.5 or EN 1092-1.

5.4 Spring

Any springs used within the receptacle or nozzle shall be suitable for the design pressure and temperature specified in 4.3, and shall be suitable against fatigue for 10 000 cycles that is the same as the endurance test of 8.16.

5.5 Seals

Seals shall be suitable for the design pressure and temperature specified in 4.3.

5.6 Welding

Welds to stainless steel grade 316 (L) shall be made using welding procedures qualified by impact testing at –196 °C in accordance with the requirements of ASME B31.3-2018, 323.2.2 or ISO 3834 (all parts) or equivalent. Material certificates of these welded fittings shall refer to these WPQs.

6 Interface types and dimensions

6.1 The end termination of the receptacle connecting to the manifold system shall be flanged in accordance with 6.3.

6.2 The end termination of the nozzle connecting to the LNG hose bunkering system shall be flanged but may be screwed by NPT or JIC below DN 150 in accordance with ASME 1.20.1 or SAE J514.

6.3 The flange shall have a raised face 'RF' in accordance with ASME/ANSI B16.5 or EN 1092-1, forged integral with the body, or attached by qualified full penetration butt-welding or inertia welding, followed by heat treatment as required by the material specification.

6.4 The receptacle shall comply with the dimensions as shown in Figure 3 and Table 1.

Dimension in millimetres

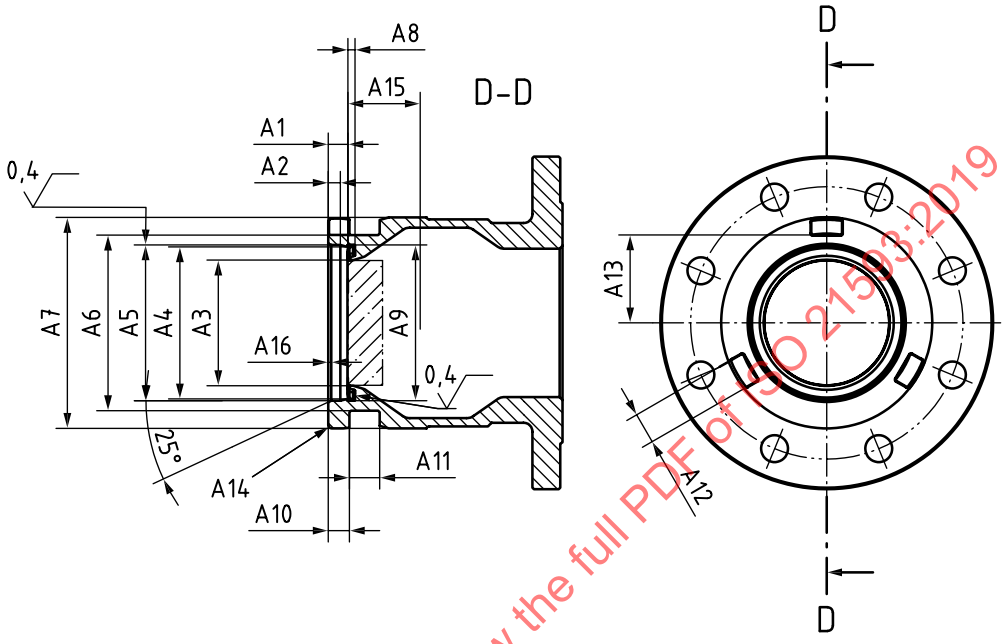


Figure 3 — Interface type and dimensions of the receptacle

Table 1 — Dimensions in millimeters

	DN 25	min	max	DN 50	min	max	DN 65	min	max	DN 80	min	max	DN 100	min	max	DN 150	min	max	DN 200	min	max
A1	**13**	−0,1	0	**14**	−0,1	0	**14**	−0,1	0	**15**	−0,1	0	**18**	−0,1	0	**30**	−0,1	0	**40**	−0,1	0
A2	**11**	−0,1	0	**11**	−0,1	0	**11**	−0,1	0	**12**	−0,1	0	**14**	−0,1	0	**25**	−0,1	0	**28**	−0,1	0
A3	**29**	0	0,05	**43**	0	0,05	**59**	0	0,05	**78**	0	0,05	**87**	0	0,05	**140**	0	0,1	**192**	0	0,1
A4	**48**	0	0,05	**62**	0	0,05	**78**	0	0,05	**97**	0	0,05	**107,5**	0	0,05	**167**	0	0,1	**226**	0	0,1
A5	**48,5**	0	0,05	**62,7**	0	0,05	**78,7**	0	0,05	**97,9**	0	0,05	**109,2**	0	0,05	**169,1**	0	0,1	**229,3**	0	0,1
A6	**62**	−0,15	0,15	**76**	−0,15	0,15	**94**	−0,15	0,15	**116**	−0,15	0,15	**128**	−0,15	0,15	**208**	−0,15	0,15	**266**	−0,15	0,15
A7	**76**	−0,1	0	**90**	−0,1	0	**108**	−0,1	0	**130**	−0,1	0	**158**	−0,1	0	**242**	−0,1	0	**314**	−0,1	0
A8	**2,1**	0	0,1	**2,1**	0	0,1	**3,1**	0	0,1	**3,1**	0	0,1	**4,7**	0	0,1	**6,1**	0	0,1	**6,1**	0	0,1
A9	**49,1**	0	0,1	**63,2**	0	0,1	**80**	0	0,1	**99,2**	0	0,1	**110,3**	0	0,15	**171,8**	0	0,2	**230,8**	0	0,2
A10	**8**	0	0,05	**8,5**	0	0,05	**9**	0	0,05	**9,5**	0	0,05	**14**	0	0,05	**16,8**	0	0,05	**25**	0	0,1
A11	**16**	0	0,05	**16**	0	0,05	**16**	0	0,05	**20**	0	0,05	**28**	0	0,05	**40**	0	0,05	**50**	0	0,05
A12	**16,2**	0	0,2	**16,2**	0	0,2	**16,2**	0	0,2	**20,2**	0	0,2	**28,4**	0	0,2	**40,5**	0	0,2	**50,8**	0	0,2
A13	**31**	−0,1	0,1	**38**	−0,1	0,1	**47**	−0,1	0,1	**58**	−0,1	0,1	**64**	−0,1	0,1	**104**	−0,1	0,1	**133**	−0,1	0,1
A14	**R1,5**	—	—	**R1,5**	—	—	**R1,5**	—	—	**R1,5**	—	—	**R1,5**	—	—	**R2**	—	—	**R2**	—	—
A15	**25**	—	—	**32**	—	—	**34**	—	—	**35**	—	—	**49,5**	—	—	**62**	—	—	**86**	—	—
A16	**3**	—	—	**3**	—	—	**3**	—	—	**3**	—	—	**3**	—	—	**6**	—	—	**6**	—	—

NOTE General limit deviations are according to ISO 2768-m unless otherwise specified.

7 Marking

7.1 Marking shall be affixed visibly, legibly and indelibly to the casings (nozzle and receptacle) or their nameplates.

7.2 Nozzles and receptacles shall bear the following information:

— manufacturer's name;

— trademark or symbol;

— model designation and/or part number;

— design pressure;

— material;

— min/max temperature;

— serial number including year and month of manufacturing;

— applicable medium——LNG only.

8 Testing

8.1 General

8.1.1 This clause lists the minimum requirements of the tests to be performed.

8.1.2 As a general principle, all parameters/characteristics shall be verified by testing.

8.1.3 Every new coupling design shall go through the verification testing program as specified in Table 2. For serial production, 100 % of the couplings shall go through the production testing program before delivery to the customer.

Table 2 — Testing programs

Test	Component	Verification testing	Production testing	Subclause
Shell tightness at ambient temperature	Coupling	X	X	8.5
Shell strength at ambient temperature	Coupling	X	O	8.6
Internal valve tightness at ambient temperature	Nozzle	X	X	8.7
	Receptacle			
Internal valve strength at ambient temperature	Nozzle	X	O	8.8
	Receptacle			
Shell tightness at minimum working temperature	Coupling	X	X	8.9
Internal valve tightness at minimum working temperature	Nozzle	X	X	8.10
	Receptacle			
X – mandatory O – if appropriate N – not applicable				

Table 2 *(continued)*

Test	Component	Verification testing	Production testing	Subclause
Operation test at minimum working temperature	Nozzle and receptacle with protective cap	X	X	8.11
Electrical conductivity	Coupling	X	N	8.12
Manual force at cold conditions under frost	Coupling	X	N	8.13
Bending test	Coupling	X	N	8.14
Drop test	Nozzle only	X	N	8.15
Endurance test	Nozzle and receptacle	X	N	8.16
High pressure test	Coupling	X	N	8.17
X – mandatory O – if appropriate N – not applicable				

8.2 Ambient test conditions

8.2.1 Ambient tests shall be carried out at (20 ± 5) °C. The test fluid to be used shall be:

— either a liquid (water which may contain a corrosion inhibitor, or any other suitable liquid having a viscosity not greater than water); or

— a dry gas (air, nitrogen or other suitable gas).

8.2.2 The connected units shall be tested according to the specifications in the respective subclause with a holding time according to Table 3:

Table 3 — Test duration for ambient tests

Size	Up to DN 50	DN 65 to DN 200
Verification test	10 min	10 min
Production test	15 s	60 s

8.3 Cryogenic test conditions

8.3.1 For tests at cryogenic temperatures, it is necessary to dry the couplings before they cool down.

8.3.2 Tests at minimum working temperature shall be carried out with liquid nitrogen at −160 °C. The liquid phase shall flow through the hose at a 50 kPa differential pressure until the coupling bodies are cooled down (completely covered by ice powder from condensed water from the atmosphere, see also Table 4). The measurement of the holding time shall be started when the liquid phase of nitrogen has been reached in the coupling.

Table 4 — Test duration for cryogenic tests

Size	Cooling down time at least (s)	Test duration at least (min)
DN 25	30	5
DN 40	40	8

Table 4 *(continued)*

Size	Cooling down time at least (s)	Test duration at least (min)
DN 50	45	10
DN 65	60	15
DN 80	60	20
DN 100	90	25
DN 150	120	30
DN 200	300	30

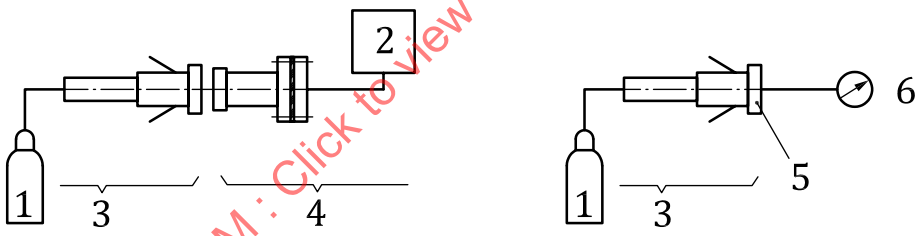
8.4 Test arrangement

8.4.1 The test arrangement for the nozzle is shown in Figure 4.

8.4.2 The hose unit with the nozzle shall be connected to a pressure source.

8.4.3 For cooling down, a tank unit with a receptacle together with an expansion unit behind shall be connected to the hose unit.

8.4.4 When the coupling is cold enough, having reached the cryogenic test condition, the tank unit shall be removed and replaced by a cover with a leakage measuring device behind to detect and measure the leakage rate.



Key

1 pressure source
2 expansion unit
3 hose unit with nozzle
4 tank unit with receptacle
5 cover
6 leakage measuring device

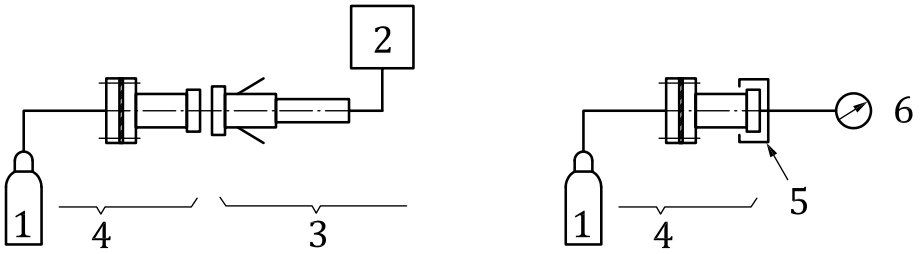
Figure 4 — Test arrangement for the nozzle

8.4.5 The test arrangement for the receptacle is shown in Figure 5.

8.4.6 The tank unit with the receptacle shall be connected to a pressure source.

8.4.7 For cooling down, a hose unit with a nozzle together with an expansion unit behind shall be connected to the tank unit.

8.4.8 When the coupling is cold enough, having reached the cryogenic test condition, the hose unit shall be removed and replaced by a cover with a leakage measuring device behind to detect and measure the leakage rate.



Key

1 pressure source
2 expansion unit
3 hose unit with nozzle
4 tank unit with receptacle
5 cover
6 leakage measuring device

Figure 5 — Test arrangement for receptacle

8.5 Shell tightness at ambient temperature

8.5.1 The shell tightness test shall be carried out according to ISO 5208 or EN 12266-1 P11 or equivalent. The purpose of this test is to confirm the leak tightness of the shell, including the connection sealing against internal pressure.

8.5.2 The coupling shall be pressure-tested with dry gas at least at 0,03 MPa and followed by a pressure of 0,6 MPa. The test pressure shall be maintained for a duration not less than the periods specified in 8.2.2.

8.5.3 Acceptance criteria is that the coupling shall be tight without visually detectable leakage for the duration of the test. No continuous formation of bubbles is permitted when the coupling is coated with a leak detection fluid.

8.6 Shell strength at ambient temperature

8.6.1 Shell strength test shall be carried out according to ISO 5208 or EN 12266-1 P10 or equivalent.

8.6.2 The coupling shall be hydraulically pressure-tested at 1,5 times the design pressure. If the strength test is required as a production test, the coupling needs to be dried carefully before delivery so that absolutely no liquid remains in the coupling.

8.6.3 Acceptance criteria shall be that no visually detectable leakage from any external surface of the shell for the duration of the test is permitted.

8.7 Internal valve tightness at ambient temperature

8.7.1 Internal valve tightness tests of the nozzle and receptacle shall be carried out according to ISO 5208 or EN 12266-1 P12 or equivalent. The purpose of this test is to confirm the capability of the seat to comply with the specified leakage rate.

8.7.2 Both seats of the nozzle and receptacle shall be respectively pressure-tested with dry gas at 0,6 MPa. Both seats of the nozzle and receptacle also shall be tested with a low pressure at 50 kPa. All the test pressures shall be maintained for a duration not less than the periods specified in 8.2.2.

8.7.3 Acceptance criteria shall be that no visually detectable leakage for the duration of the test is permitted (EN 12266-1:2012, Table A.5, Rate A).

8.8 Internal valve strength at ambient temperature

8.8.1 Internal valve strength tests of the nozzle and receptacle shall be carried out according to ISO 5208 or EN 12266-1 P20 or equivalent. The purpose of this test is to check the pressure containing capability of the internal valve.

8.8.2 Both internal valves of the nozzle and receptacle respectively shall be hydraulically pressure-tested at 1,5 times the design pressure. If the strength test is required as a production test, the coupling needs to be dried carefully before delivery so that no liquid remains in the coupling.

8.8.3 Acceptance criteria shall be that no visually detectable leakage from any external surface of the internal valve for the duration of the test is permitted.

8.9 Shell tightness at minimum working temperature

8.9.1 Before this test is performed, the coupling needs to be dry, then the coupling shall be cooled down by liquid nitrogen through the opening hose unit and tank unit as described in 8.4.

8.9.2 The coupling shall be pressure-tested at 1,1 times the design pressure with liquid nitrogen under the test condition as per 8.3.

8.9.3 Special attention shall be taken so that the raising temperature does not increase the pressure in coupling.

8.9.4 Acceptance criteria shall be no visually detectable leakage for the duration of the test (i.e. in ISO 5208:2015, Table 4,Rate A).

8.10 Internal valve tightness at minimum working temperature

8.10.1 Before this test is performed, the nozzle and receptacle need to be dry, then both of them shall be cooled down by liquid nitrogen through the opening hose unit and tank unit as described in 8.4.

8.10.2 Both the nozzle and receptacle seats shall be respectively pressure-tested at 1,1 times the design pressure with liquid nitrogen under the test condition as per 8.3. Both seats of the nozzle and receptacle also shall be tested with a low pressure at 50 kPa. All the test pressures shall be maintained for a duration not less than the periods specified in 8.3.2.

8.10.3 Special attention shall be taken so that the rising temperature does not increase the pressure in the nozzle or receptacle.

8.10.4 Acceptance criteria shall be no visually detectable leakage for the duration of the test (i.e. in ISO 5208:2015, Table 4,Rate A).