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Road vehicles — Dimethyl ether (DME) refuelling connector with pressure equalizing port

Véhicules routiers — Connecteur de ravitaillement en éther diméthylique (DME) avec orifice d'égalisation de pression

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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 document 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 22, *Road vehicles*, Subcommittee SC 41, *Specific aspects for gaseous fuels*.

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.

Introduction

This document was developed for the examination, testing and certification of newly produced dimethyl-ether vehicle fuelling nozzles with a pressure-equalizing port and receptacles with a pressure-equalizing port for pressure-equalization filling systems only. It applies to nozzles with a pressure equalizing port and receptacles with a pressure-equalizing port used in the dimethyl-ether pressure-equalization filling system and not to the fuel system of the vehicle.

A nozzle with a pressure-equalizing port conforming to this document will be functionally compatible from a safety and performance perspective with all listed receptacles with pressure-equalizing ports of compatible profile and system pressure. Similarly, a receptacle conforming to this document will be functionally compatible from a safety and performance perspective with all listed nozzles with pressure-equalizing ports of compatible profile and system pressure.

As there may eventually be many different kinds of nozzles with pressure-equalizing ports and receptacles with pressure-equalizing ports available from a variety of manufacturers which, for safety reasons, should all be compatible with each other, this document specifies one standardized profile of receptacle. This standard profile incorporates the design specifications (mating materials, geometry and tolerances) which may be considered in the certification of a submitted nozzle or receptacle.

Road vehicles — Dimethyl ether (DME) refuelling connector with pressure equalizing port

1 Scope

This document applies only to dimethyl-ether refuelling connectors with a pressure-equalizing port, hereinafter referred to as devices, constructed entirely of new, unused parts and materials. Dimethyl-ether refuelling connectors with a pressure-equalizing port consist of the following components, as applicable:

a) nozzle with a pressure-equalizing port,

The refuelling nozzle and pressure-equalizing port are integrated so that the connecting of the refuelling path and pressure-equalizing path is performed with a single action (mounted on the dispenser side) (see Clause 5).

b) receptacle with a pressure-equalizing port (mounted on vehicle) (see Clause 7).

This document applies to devices which use dimethyl ether as fuel, hereinafter referred to in this document as M15 [see 9.2 c)]:

This document applies to devices with standardised mating components.

This document applies to connectors which prevent dimethyl-ether vehicles from being fuelled by fuel-station dispensers for other gaseous fuels.

This document is applicable to dimethyl ether in accordance with ISO 16861.

All references to pressures (kPa) throughout this document are considered gauge pressures unless otherwise specified.

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 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 16861, *Petroleum products — Fuels (class F) — Specifications of dimethyl ether (DME)*

3 Terms and definitions

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

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

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

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

3.1
dry air
air with moisture content such that the dew point of the air at the required test pressure is at least 11 °C below the ambient test temperature

3.2
working pressure
maximum pressure that a *connector* (3.7) with a pressure-equalizing port can be expected to withstand in actual service

3.3
dimethyl ether
DME
methoxymethane
organic compound with the formula CH_3OCH_3, simplified to C_2H_6O

Note 1 to entry: Dimethyl ether is liquid below −25 °C.

3.4
pressure-equalization filling system
filling system in which liquefied fuel gas in a storage tank is filled into a vehicle fuel container after pressure is equalized between the vehicle fuel container and the storage tank of the filling station

Note 1 to entry: Pressure is equalized by connecting pressure-equalizing piping between the gas phase parts of the container and the storage tank.

3.5
nozzle
dimethyl-ether refuelling nozzle with pressure equalizing port
device which permits quick connection and disconnection of the fuel supply hose and the pressure equalizing hose to the *dimethyl-ether receptacle with pressure equalizing port* (3.6) simultaneously in a safe manner

3.6
receptacle
dimethyl-ether refuelling receptacle with pressure equalizing port
device connected to a vehicle or storage system which receives the *dimethyl-ether refuelling nozzle with pressure equalizing port* (3.5) and permits safe transfer of fuel and DME vapor for pressure equalizing

3.7
connector
dimethyl-ether refuelling connector with pressure equalizing port
joined assembly of *dimethyl-ether refuelling nozzle with pressure equalizing port* (3.5) and receptacle with pressure equalizing port

3.8
non-sparking material
material that does not contain, by mass, more than 7,5 % in total of magnesium, titanium and zirconium

[SOURCE: IEC 60079-0:2018, 8.3]

3.9
service gasket
replaceable gasket ensuring tightness of the connections between ports of the nozzle and receptacle

3.10
cycle life
number of connections and disconnections between the *nozzle* (3.5) and the *receptacle* (3.6) required for testing purposes

3.11
service life
number of operations of the check valve in the receptacle for testing purposes

4 General construction requirements

4.1 Nozzles and receptacles shall be designed with the following safety, durability and maintainability requirements:

1) Working pressure: all nozzles and receptacles are designed to have a working pressure defined by the manufacturer and clearly marked on the device (see 9.2 d).

2) Design life: all nozzles shall be tested at 100 000 connect/disconnect cycles and all receptacles at 20 000 connect/disconnect cycles for conformity with this document. The service gasket may be changed after a minimum of 20 000 cycles.

4.2 Nozzles and receptacles shall be:

— designed to be secure against displacement, distortion, warping or other damage under normal conditions of handling and use;

— designed to release less than 1 cm^3 from liquid connection and 1 cm^3 from vapour connection during disconnection;

— constructed to maintain operational integrity under normal and reasonable conditions of handling and usage;

— manufactured and produced according to the test plan in Annex B.

4.3 Nozzles and receptacles shall be manufactured with materials suitable and compatible for use with dimethyl ether, in accordance with ISO 16861, at the pressure and the temperature ranges to which they will be subjected.

4.3.1 The temperature range shall be:

for the receptacle:

— moderate operating conditions: −20 °C to +85 °C;

— cold operating conditions: −40 °C to +85 °C;

for the nozzle:

— moderate operating conditions: −20 °C to +65 °C;

— cold operating conditions: −40 °C to +65 °C.

In some regions, it is possible that the temperature range specified is not sufficient. In such cases, a wider temperature range, representative of that specific region, shall be considered.

4.4 Nozzles and receptacles shall be operated either to connect or disconnect without the use of tools.

4.5 Jointing components shall provide gas tight sealing performance.

5 Nozzles

The design of the nozzle shall ensure that:

a) it is compatible with the receptacle as specified in Clause 6;

b) entrapment of fingers and/or cold burns are not possible;

c) the maximum push-on force during connection is 100 N at any pressure up to 1 500 kPa in the nozzle;

d) the maximum pull-off force during disconnection is 50 N at 1 500 kPa;

e) the force to operate the lever, if any, applied at the centre of the grip area of the lever, is 150 N maximum at any pressure up to 1 500 kPa in the nozzle;

f) if a latch is provided and in use, it shall be capable of being normally disarmed by the user;

g) it is not possible to open the liquid and vapour flow paths valves in the nozzle if the nozzle is not properly locked and sealed on the receptacle;

h) a locking mechanism is incorporated that locks in the connected position;

i) it is not possible to unlock the nozzle from the receptacle unless the liquid and vapour flow paths valves in the nozzle are closed;

j) internal blocking due to freezing does not occur under intended operating conditions;

k) it will withstand a torque of 150 % of the mounting torque specified by the manufacturer without damage;

l) the external surfaces of the nozzle are corrosion resistant or protected against corrosion and are made of materials (non-sparking materials) that do not cause sparks when dropped on a surface;

m) changing the service gasket shall not result in any dimethyl ether release;

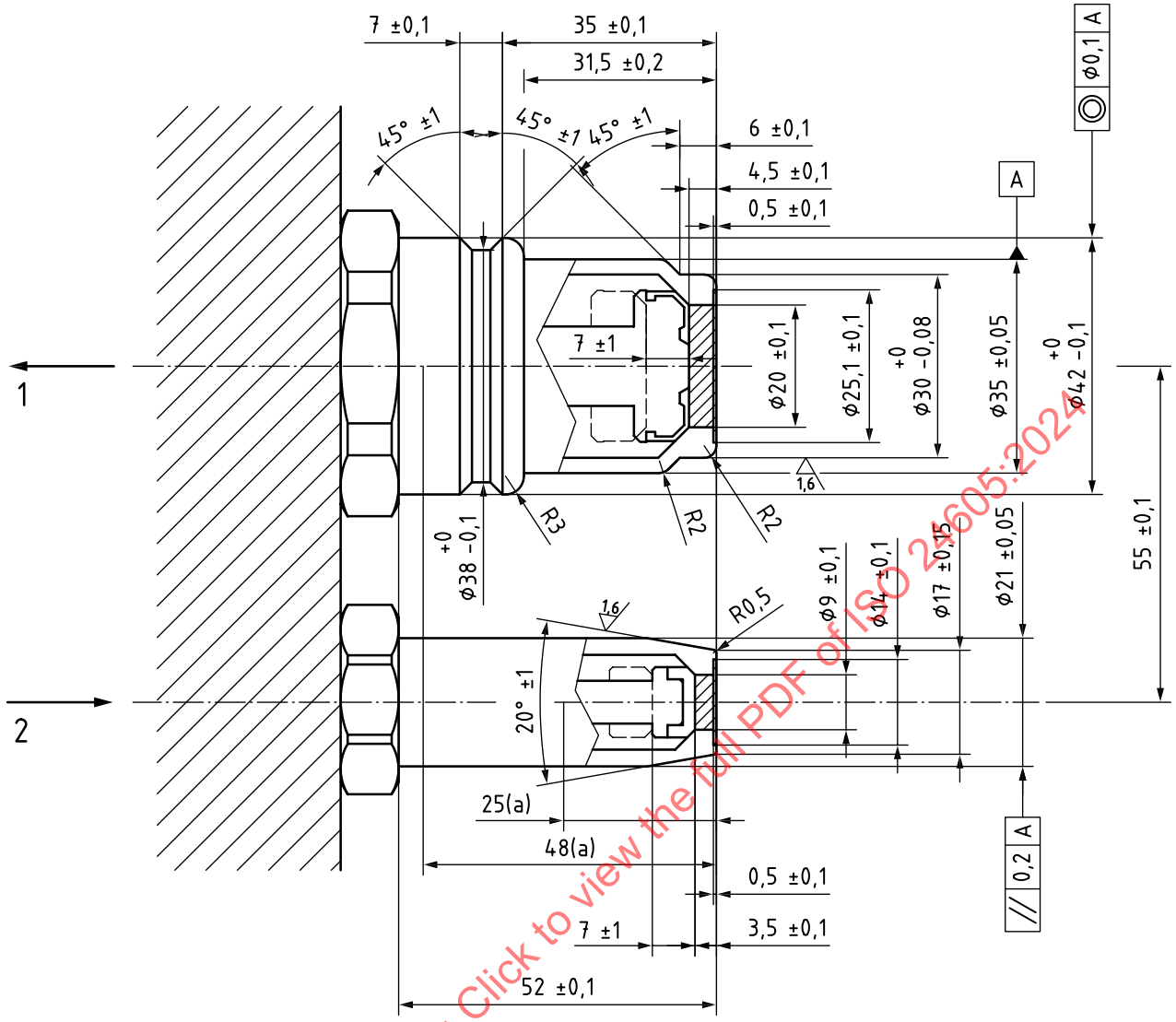
n) the minimum cycle life of the service gasket is 20 000 cycles;

o) the nozzle is provided with a means to securely attach it to the delivery hose and the pressure equalizing hose;

p) the nozzle shall conform to the performance requirements of Clause 10 to ensure interchangeability.

6 Standard receptacle dimensions

A receptacle shall conform to the design specifications detailed in Figure 1.



Key

▨	this area shall be kept free of all components
1	flow filling line
2	flow equalizing line
a	minimum length of the receptacle that is clear of provisions for attachment of the receptacle or protection caps

Figure 1 — M15 receptacle

7 Receptacles

7.1 Receptacles shall conform to Clause 4 and Clauses 6 to 10. Receptacles shall be evaluated with a test nozzle that already conforms to this document.

The failure of any test conducted with the receptacle and nozzle test samples shall constitute a failure of the submitted receptacle, unless the manufacturer can prove the problem was caused by the test nozzle.

7.2 The receptacle shall be equipped with an internal check valve in both the main filling path and the pressure-equalizing path to prevent the escape of pressurized fuel.

The check valve of the main filling path may be made mechanically overridable by the connection of the nozzle.

The equalizing port check valve shall be mechanically overridable by the connection of the nozzle.

The differential opening pressure of the check valve of the main filling path shall not exceed 30 kPa when tested with water.

The trapped volume in the connector, which may be filled with liquid DME during the fuelling and which is opened to the atmosphere upon the disconnection of the nozzle from the receptacle, shall not exceed 0,1 cm^3.

7.3 The method 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 conical threads.

7.4 The interfacing surface of the receptacle shall be constructed of material that is non-sparking and that ensures electrical continuity (see 10.8.8).

7.5 The receptacle shall have provisions to be firmly attached to the vehicle and shall conform to applicable abnormal load tests (see 10.4).

7.6 The receptacle shall be mounted on the vehicle in line with Annex A.

7.7 The receptacle shall not be installed in an area that exceeds a temperature of 85 °C.

7.8 The receptacle shall have a cycle life of more than 20 000 cycles and a service life of more than 100 000 cycles.

8 Instructions

Information required for instructions and provisions shall be given in an easily understood form.

Special tools required for the connection of the receptacle to tubing shall be clearly identified in the instructions.

Manufacturers of the receptacle and nozzle shall provide clear and concise printed instructions and diagrams in a form that can be easily understood and adequate for:

— proper field assembly,

— installation,

— maintenance,

— replacement of components as appropriate,

— for safe operation by all users,

— suitability and use,

— storage and handling.

9 Marking

9.1 Information required for marking and provisions shall be given in an easily understood form. Marking should be embossed, cast, stamped or otherwise formed in the part. This includes markings baked into an enamelled surface.

9.2 The nozzle and the receptacle shall bear the following information:

a) the name, trademark or symbol of the manufacturer or dealer,

b) the model designation,

c) M15,

d) the working pressure,

e) the minimum design temperature,

f) manufacturer code to ensure traceability,

g) a certification mark (if required).

9.3 A marking to identify this document shall be provided for each system. This marking may be located on the package or on a notice placed inside the package in which the device is shipped.

10 Tests

10.1 General requirements

A nozzle and receptacle shall be tested with receptacle and nozzle designs specified under Clauses 4 to 9.

Unless otherwise stated:

a) tests shall be conducted at room temperature (20 ± 5) °C;

b) all pressure or leak tests shall be conducted with dry air, nitrogen or any other suitable gas;

c) devices shall be conditioned to attain equilibrium conditions.

The tolerances for test temperatures and pressures shall be:

— for low temperatures: (+0 / −5) °C;

— for high temperatures: (+5 / −0) °C;

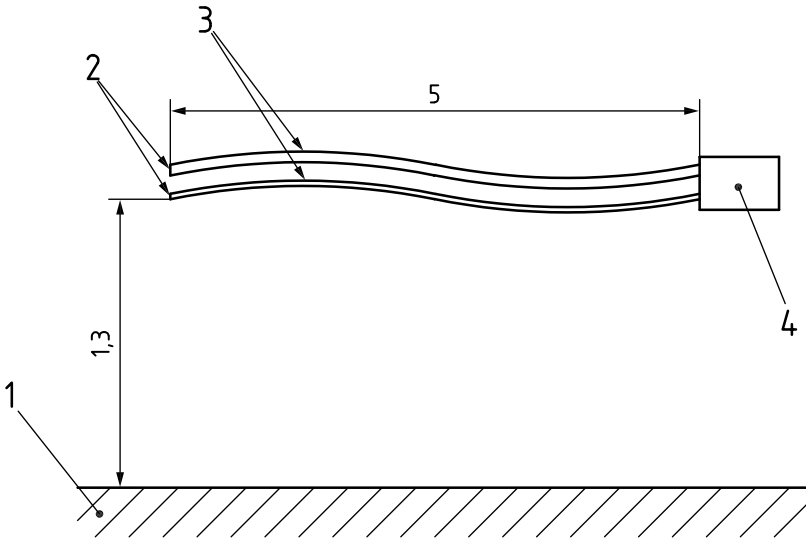
— test pressures: ±10 % of the stated value with a maximum of 100 kPa.

10.2 Impact resistance

10.2.1 Nozzle test

A nozzle conditioned for 4 h at −20 °C for moderate operating conditions or −40 °C for cold operating conditions shall be connected within 2 min to a 5 m length of 19 mm internal diameter refuelling hose and 5 m length of 16 mm internal diameter pressure equalizing hose at room temperature, and then dropped 1,3 m onto a concrete floor as shown in Figure 2. The nozzle shall be dropped ten times, then pressurised at the working pressure and subjected to ten additional drops. Following the drops, the nozzle shall be capable of normal connection and disconnection to the receptacle. In addition, the nozzle shall conform to the leakage tests specified in 10.3.

Dimensions in metres



Key

1 horizontal concrete floor
2 solid fixing point
3 refuelling and pressure equalizing hoses
4 nozzle

Figure 2 — Impact resistance test arrangement

10.2.2 Receptacle test

The receptacle shall be subjected to an impact test of 10 J. A hardened steel mass of 1 kg shall be dropped from a height of 1 m so as to deliver the impact velocity 4,4 m/s. This shall be achieved by mounting the mass in a pendulum. The receptacle shall be installed horizontally on a solid object. The impact of the mass shall be on the centre of the protruding part of the receptacle (see Figure A.1). Following the impact test, the receptacle shall conform to the leakage tests specified in 10.3.

10.3 Leakage at room temperature

Tests shall be conducted at two different pressures: 20 kPa and 1,5 times working pressure.

Pressurised air or nitrogen shall be applied to the coupled (and uncoupled) device. The external body shall then be checked for bubble tight leakage using immersion in room temperature water.

Nozzles and receptacles, coupled and uncoupled, refuelling path and pressure equalizing path shall be either bubble free on the leak test for 2 min or have a leak rate less than 15 cm^3/h at room temperature of 20 °C ± 5 °C. The leak rate shall be determined according to the following method or any other equivalent method.

A graduated cylinder that is calibrated in cubic centimetres, filled with the test liquid, shall be placed inverted above the component.

At the end of the test period, the liquid displacement in the graduated cylinder is recorded.

The leakage rate is then calculated using the following formula:

$$V_1 = V_t \frac{60}{t}\left[\frac{273\,P}{101{,}3\,T}\right]$$

Where:

V_l is the leakage rate of air or nitrogen, in cm^3/h;

V_t is the liquid displacement during the test, in cm^3;

t is the time of the test, in min;

P is the atmospheric pressure during the test, in kPa;

T is the ambient temperature during the test, in K.

10.4 Abnormal loads

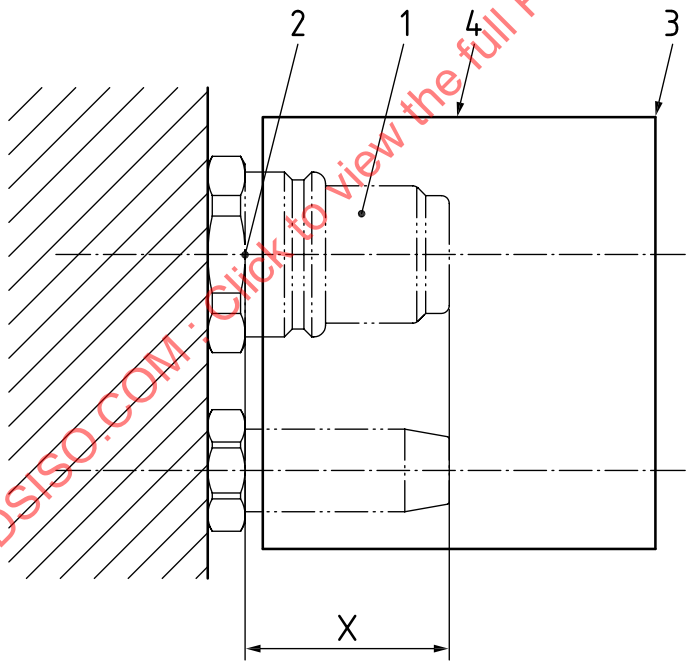
The connected nozzle and receptacle shall be subjected to the following abnormal loads for a period of 5 min in service. These tests shall be conducted separately:

a) pulling {a} along the nozzle or receptacle longitudinal axis;

b) moments {b} are applied in a worst-case scenario.

The nozzle and receptacle shall be able to withstand abnormal loads of (a = 1 350 N; b = 120 Nm) without distortion or damage and (a = 2 000 N; b = 240 Nm) without becoming so damaged as to leak. The load and moment arm shall be measured about a point X = 52 mm (from the front of the receptacle to the hose inlet of the nozzle (see Figure 3, which does not necessarily illustrate the worst case).

After completing these tests, the receptacle shall conform to 10.3.



Key

X distance as described
1 receptacle
2 abnormal load reference
3 moment
4 nozzle

Figure 3 — Abnormal load test

10.4.1 Test in unpressurised condition

The receptacle and nozzle shall not be pressurised during the abnormal load tests.

The receptacle shall be mounted as a cantilever to a supporting member in accordance with the manufacturer's instructions. For the purposes of this test, the supporting member shall be capable of withstanding the specified loads without displacement or deflection.

The loads applied and the device's ability to resist damage shall be as specified in 10.4. After completing the tests, the receptacle shall conform to 10.3.

10.4.2 Test in pressurised condition

The receptacle and nozzle shall be pressurised with air, nitrogen, water or any adequate liquid to working pressure during the abnormal load tests.

The receptacle shall be mounted as a cantilever to a supporting member in accordance with the manufacturer's instructions. 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 receptacle.

The loads applied and the device's ability to resist damage shall be as specified in 10.4. After completing the tests, the receptacle shall conform to 10.3.

10.5 Mounting hardware torque

The receptacle and mounting hardware shall withstand, without damage, a turning force equal to 150 % of the manufacturer's recommended mounting hardware fastening torque.

10.6 Leakage at low and high temperatures

All tests shall be conducted while the nozzles and receptacles are continuously exposed to the following test temperatures: −20 °C for moderate operating conditions or −40 °C for cold operating conditions and 85 °C.

At each test condition the nozzles and receptacles shall be maintained at the specified temperature for at least 4 h.

Tests shall be conducted at two different pressures for each temperature: 100 kPa and 1,5 times working pressure.

Pressurised air or nitrogen shall be applied to the coupled (or uncoupled) device. The external body shall then be checked for bubble tight leakage:

a) at −20 °C for moderate operating conditions or −40 °C for cold operating conditions, immersed in alcohol or another adequate liquid;

b) at 65 °C (nozzles) or 85 °C (receptacles), immersed in water or another adequate liquid.

Nozzles and receptacles, coupled and uncoupled, shall be either bubble free on the leak test for 2 min or have a leak rate less than 15 cm^3/h. The leak rate shall be determined according to 10.3.

10.7 Nozzle freezing

The test shall be carried out as follows:

a) connect the nozzle to a receptacle for which it is designed;

b) plug the outlet of the receptacle;

c) fill the nozzle with pentane to which 200 mg/kg of water is added and plug the inlet of the nozzle;

d) condition the assembly to −20 °C for moderate operating conditions or −40 °C for cold operating conditions, for 4 h;

e) hold the nozzle and the receptacle in the upright position with the receptacle at the bottom;

f) remove the pentane from the nozzle by disconnecting the receptacle from the nozzle and remove the plug from the inlet of the nozzle;

g) carry out an external leak test, according to 10.6, of the unconnected nozzle at −20 °C for moderate operating conditions or −40 °C for cold operating conditions, without warming up the nozzle during the procedure.

The nozzle shall pass the test if it passes the external leak test at −20 °C for moderate operating conditions or −40 °C for cold operating conditions.

10.8 Durability

10.8.1 Endurance

10.8.1.1 General

A durability cycle test shall be carried out at the working pressure and at 20 °C with air, nitrogen, water or any adequate liquid.

10.8.1.2 Nozzle test

All nozzles shall be capable of withstanding 100 000 cycles as described hereunder.

For the purposes of this test, one cycle of operation shall be:

a) properly connecting the pressurized nozzle to a receptacle for which the nozzle has been designed,

b) idling a minimum of 3 s between connecting and disconnecting,

c) disconnecting the nozzle.

Precautions shall be taken to avoid large temperature variations of the nozzle.

The service gasket replacement after 20 000 cycles shall be acceptable.

Before and after changing the service gasket and at the end of the test, an external leak test of the coupled nozzle shall be performed according to 10.3.

At the end of the test, an external leak test of the uncoupled nozzle shall also be performed according to 10.3.

NOTE Replacement of the receptacle is permitted every 10 000 cycles.

The release volume at disconnection shall be measured at the end of the test.

After the test, a visual examination of all components of the nozzle shall be carried out.

The nozzle shall pass the test if:

— it shows no deformation or excessive wear likely to indicate an early failure of any component of the nozzle,

— it complies with the requirements of 10.3,

— it does not have a release volume greater than 1 cm^3 liquid.

10.8.1.3 Receptacle test

A receptacle shall be capable of withstanding 20 000 cycles of operation as described hereunder.

For the purposes of this test, one cycle of operation shall be:

a) properly connecting a pressurized nozzle for which the receptacle has been designed to the receptacle,

b) idling a minimum of 3 s between connecting and disconnecting,

c) disconnecting the receptacle from the nozzle.

The receptacle shall pass the test if:

— it shows no deformation or excessive wear likely to indicate an early failure of any component of the receptacle,

— it complies with the requirements of 10.3.

10.8.1.4 Receptacle check valve test

The receptacle check valve shall be bubble free on the leak test for 1 min and be capable of withstanding 100 000 cycles of operation and 24 h of the flow conditions that cause the most severe chatter.

The receptacle shall be connected to a nozzle test fixture. The working pressure shall be applied to the nozzle and receptacle. Pressure shall then be vented from the upstream side of the receptacle check valve. Pressure on the downstream side of the receptacle check valve shall be lowered to between 0 and a maximum of half of the working pressure prior to the next cycle.

Following 100 000 cycles of operation, the receptacle check valve shall be subjected to 24 h of flow at the inlet/outlet flow conditions that cause the most severe chatter. The receptacle shall then be tested for conformity with the requirements outlined in 10.3.

10.8.2 Corrosion resistance

10.8.2.1 Nozzle test

Any metallic part of a nozzle, subject to dimethyl ether pressure and exposed to corrosive conditions during its normal life, shall be submitted to the 144 h salt spray test in accordance with ISO 9227. AISI series 300 austenitic stainless steels are exempt from corrosion-resistance testing.

The tested part shall be reinstalled in the device and the device shall be subjected to the test of 10.3.

The part shall pass the test if the device complies with the requirements of 10.3.

10.8.2.2 Receptacle test

10.8.2.2.1 Receptacles shall perform safely and conform to 10.3 and 10.6 following exposure to salt spray according to the following test method. AISI series 300 austenitic stainless steels are exempt from corrosion-resistance testing.

With the receptacle supported in its normal installed position, expose it for 144 h to a salt spray test as specified in ISO 9227.

10.8.3 Brass material compatibility

Any brass part subject to dimethyl-ether pressure for which a satisfactory declaration of properties is not submitted by the applicant shall be tested according to the following procedure (part 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 parts. Apply these stresses to the sample prior to the test and maintain them during the test. 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 days 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. Aqueous ammonia having a specific gravity of 0,94 shall be maintained at the bottom of the glass chamber below the samples at a concentration of 21,2 ml per litre of chamber volume. 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 25X magnification.

10.8.4 Resistance to dry heat

Any non-metallic part subject to dimethyl-ether pressure and to atmospheric conditions shall be submitted to the resistance to dry heat test.

The test shall be carried out in accordance with ISO 188. The test piece shall be exposed to air at 65 °C for 168 h.

The requirements for the part to pass the test are if the loss of tensile strength does not exceed 25 % and the change in ultimate elongation does not exceed the following values:

— maximum increase: 10 %;

— maximum decrease: 30 %.

10.8.5 Ozone ageing

Any non-metallic part subject to dimethyl-ether pressure and to atmospheric conditions 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 conform to ISO 1431-1.

The test piece, stretched by 20 % in elongation shall be exposed to air at 40 °C with an ozone concentration of 50 parts per hundred million during 72 h.

The requirement for the part to pass the test is if no cracks are visible in the elongated position.

10.8.6 Temperature cycle

Any non-metallic part subject to dimethyl-ether pressure shall be submitted to a 120 min temperature cycle test, from the minimum design temperature up to the maximum design temperature, at the working pressure, for 96 h.

After this test, the part shall be fitted in the device, which shall be subjected to 10.3.

The requirement for the part to pass the test is when the device, with the tested part, passes the external leak tests.

10.8.7 Compatibility to dimethyl ether

Sealing materials subject to dimethyl-ether pressure shall be submitted to an immersion test carried out with DME in accordance with ISO 1817.

The requirements for the material to pass the test are if the maximum increase in volume measured immediately after the immersion test in accordance with ISO 1817 does not exceed 20 % and the loss of weight after drying does not exceed 5 %.

NOTE As DME is a good solvent, the maximum increase in volume can be adjusted to a higher level in a later phase, based on ISO 1817 measurement results of sealing materials used with positive experience.

10.8.8 Electrical continuity

The tests shall be conducted prior to and after endurance cycling of the nozzle (see 10.8.1.2).

The electrical continuity through the body of the nozzle shall be measured as follows:

a) connect the nozzle to a receptacle for which it has been designed;

b) connect one probe of an ohmmeter with a range of at least 100 Ω to 10 kΩ, to the nozzle inlet;

c) connect the other probe to a point of the receptacle;

d) measure and record the resistance in ohms;

e) repeat for four other points on the nozzle inlet.

The requirement for the nozzle to pass the test is if all five electrical resistance measurements do not exceed 1 kΩ.

10.9 Hydrostatic strength

The tests shall be conducted after the endurance cycling test (see 10.8.1).

The test pressure shall be 2,25 times the working pressure.

The test shall be performed at 20 °C.

The outlet of the nozzle shall be connected to the receptacle, for which the devices are designed. The outlet of the receptacle shall be plugged.

The test medium shall be water or any other suitable liquid.

The pressure shall be raised at a maximum rate of 1 000 kPa per minute until the test pressure is reached.

The test pressure shall then be maintained for at least 1 min.

The device shall withstand the hydrostatic strength test without any visible evidence of rupture or permanent distortion.

10.10 Oxygen ageing

Non-metallic parts of components that provide a fuel-containing seal shall crack or show visible evidence of deterioration after oxygen ageing when tested in accordance with the following procedure.

Expose representative samples to oxygen for a minimum of 96 h at a temperature of 70 °C ± 5 °C and a pressure of at least 2 MPa, in accordance with ISO 188.

10.11 Non-metallic material immersion

10.11.1 A non-metallic material used in a component shall be subjected to the tests described in 10.11.2 and 10.11.3.

10.11.2 A part made of non-metallic material in contact with dimethyl ether shall not show excessive change in volume or weight when tested with dimethyl ether according to ISO 1817 with the following conditions:

a) temperature: 23 °C ± 2 °C for temperate countries or 27 °C ± 2 °C for tropical and subtropical countries;

b) immersion period: 72 h;

c) medium: DME;

d) after taking out the material, measure within 20 min, preferably as fast as possible.

— Prepare, measure and weigh a representative sample or samples of each non-metallic synthetic material used in a component. Immerse the sample or samples according to conditions a) to d) in this subclause.

— Maximum change in volume shall be less than or equal to 20 %.

— After storage in air with a temperature of 40 °C for a period of 48 h, the mass compared to the original value may not decrease more than 5 %.

NOTE As DME is a good solvent, the maximum increase in volume can be adjusted to a higher level in a later phase, based on ISO 1817 measurement results of sealing materials used with positive experience.

10.11.3 A part made of non-metallic material in contact with DME shall not show excessive change in volume or weight when tested in accordance with the following procedure:

a) Prepare, measure and weigh one or more representative samples of each non-metallic material used in a component, then immerse the sample or samples at room temperature in DME, at a pressure equal to its working pressure, but not less than 100 kPa, for a minimum of 70 h.

b) Immediately 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 %.

It is recommended to read section 6.7 of Reference [6] for background information on using sealing material compatible with DME.

NOTE As DME is a good solvent, the maximum increase in volume can be adjusted to a higher level in a later phase, based on ISO 1817 measurement results of sealing materials used with positive experience.

10.11.4 A non-metallic material used in a component that is likely to be exposed to ester-based or alphaolefin-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 one or more representative samples of each non-metallic 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 %.

NOTE As DME is a good solvent, the maximum increase in volume can be adjusted to a higher level in a later phase, based on ISO 1817 measurement results of sealing materials used with positive experience.

10.12 Vibration resistance

This test is applicable to the receptacle only.

Components with moving parts shall remain undamaged and shall continue to operate and meet the requirements of their leakage tests and hydrostatic strength test after the vibration test has been carried out in accordance with the following test procedure.

Vibrate the component for 30 min, pressurized to its working pressure with dry air, nitrogen or dimethyl ether, and sealed at both ends, along each of the three orthogonal axes at the most severe resonant frequency determined as follows:

— by an acceleration of 1,5 *g*;

— within a sinusoidal frequency range of 5 Hz to 200 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.

On completion of the test, the component shall not show any indication of fatigue or component damage and shall conform to the leakage test specified in 10.3 and the hydrostatic strength test specified in 10.9.

10.13 Creep

This test is applicable to the receptacle only.

A non-metallic part containing liquid DME shall conform to the leakage tests mentioned in 10.3 and 10.6 after having been submitted to a hydraulic pressure of 2,25 times the working pressure at a temperature of 120 °C ± 5 °C for a minimum of 96 h. Water or any other suitable hydraulic fluid may be used as a test medium.

10.14 Automotive fluid exposure

10.14.1 General

This test is applicable to the receptacle only.

External portions of components shall be able to withstand exposure to the following fluids without mechanical degradation. Resistance shall be determined by the test in 10.14.2 except when the manufacturer can demonstrate by other means that the material is resistant to these fluids.

10.14.2 Test method

The external surfaces of the component shall be exposed to the following test:

— The inlet and outlet connections of the component shall be connected or capped in accordance with the component manufacturer's installation instructions.

— The test shall be performed at ambient temperature.

— The component shall be exposed by spraying the exterior of the component 24 times at one-hour intervals.

— The test shall either be performed over 24 h continuously or over a maximum of three consecutive days (e.g. eight times a day over three days).

Alternatively, the component may be immersed in the solution for a period of 24 h. In the immersion method, the fluid shall be replenished as needed to ensure complete immersion for the duration of the test.

An individual test shall be performed with each of the three fluids specified in 10.14.3. One component may be used for all three exposures sequentially.