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**LPG equipment and accessories —
Automotive liquefied petroleum gas
components — Other than containers**

National foreword

This British Standard is the UK implementation of EN 12806:2022. It supersedes BS EN 12806:2003, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/19, LPG containers and their associated fittings.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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LPG equipment and accessories for Automotive liquefied petroleum gas components - Other than containers

Équipements pour GPL et leurs accessoires -
Composants pour véhicules au gaz de pétrole liquéfié -
Composants autres que le réservoir

Flüssiggas-Geräte und Ausrüstungsteile - Bauteile für
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European foreword

This document (EN 12806:2022) has been prepared by Technical Committee CEN/TC 1286 "LPG equipment and accessories", the secretariat of which is held by NSAI.

This European Standard shall be given the status of a national standard either by publication of an identical text or by endorsement, at the latest by April 2023, and conflicting national standards shall be withdrawn at the latest by April 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12806:2003.

In comparison with the previous edition, the following technical modifications have been made:

- Revised definitions;
- Updated normative references;
- General reference to *maximum allowable pressure* rather than *design or test pressure*;
- Addition of a new component ("Manual shut-off container valve") and the relative subclause B.8;
- General revision of the Annexes.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

Protection of the environment is a key political issue in Europe and elsewhere. For CEN/TC 286, this is covered in CEN/TS 16765 [7] and this Technical Specification should be read in conjunction with this document. The Technical Specification provides guidance on the environmental aspects to be considered regarding equipment and accessories produced for the LPG industry and the following is addressed:

- a) design;
- b) manufacture;
- c) packaging;
- d) use and operation; and
- e) disposal.

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1 Scope

This document specifies the general design and testing requirements for all components in automotive Liquefied Petroleum Gas (LPG) propulsion systems, which have a maximum allowable pressure equal to or greater than 20 kPa.

This document also specifies the requirements for the Electric Control Unit (ECU), which is not subjected to pressure, and the gas-tight housing which has a maximum allowable pressure below 20 kPa.

This document does not apply to containers.

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.

EN 549:2019, *Rubber materials for seals and diaphragms for gas appliances and gas equipment*

EN 589, *Automotive fuels - LPG - Requirements and test methods*

EN 22768-1, *General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications (ISO 2768-1)*

EN 60529, *Degrees of protection provided by enclosures (IP code)*

EN IEC 60068-2-52, *Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)*

EN ISO 1307:2008, *Rubber and plastics hoses - Hose sizes, minimum and maximum inside diameters, and tolerances on cut-to-length hoses (ISO 1307:2006)*

EN ISO 1402, *Rubber and plastics hoses and hose assemblies - Hydrostatic testing (ISO 1402)*

EN ISO 4080, *Rubber and plastics hoses and hose assemblies - Determination of permeability to gas (ISO 4080)*

EN ISO 8031, *Rubber and plastics hoses and hose assemblies - Determination of electrical resistance and conductivity (ISO 8031)*

EN ISO 9227, *Corrosion tests in artificial atmospheres - Salt spray tests (ISO 9227)*

EN ISO 10619-2:2021, *Rubber and plastics hoses and tubing - Measurement of flexibility and stiffness - Part 2: Bending tests at sub-ambient temperatures (ISO 10619-2:2021)*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

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 1436, *Rubber hoses and hose assemblies — Wire-braid-reinforced hydraulic types for oil-based or water-based fluids — Specification*

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

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

3 Terms, definitions and abbreviations

3.1 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 <https://www.electropedia.org/>

3.1.1

pressure

gauge pressure, unless otherwise stated

3.1.2

test pressure

pressure to which the component, or an assembly of components, is subjected during the test

3.1.3

maximum allowable pressure

maximum pressure for which the equipment is designed

Note 1 to entry: All pressures are gauge pressures, unless otherwise stated.

3.1.4

fusible plug

component protecting the pressure vessel from bursting by venting the LPG content at a pre-set temperature

3.1.5

automotive LPG-system

assembly of components enabling a vehicle to use automotive LPG in its propulsion system

Note 1 to entry: Requirements for each component are specified in their specific annexes (see Table 1 and Table 2).

3.1.6

container

pressure vessel used for the storage of automotive LPG

3.1.7

80 % stop valve

device that limits the filling of the container to 80 % of its water capacity and acts as a non-return valve

3.1.8

level indicator

device that indicates the liquid level in the container

3.1.9

float

device, which may be used in the 80 % stop valve and/or the level indicator, floating on the surface of the liquid to detect the liquid level in the container

3.1.10

pressure relief valve

PRV

self-closing valve which automatically, without the assistance of any energy other than that of the vapour concerned, discharges vapour at a predetermined pressure, and operates with a pop action

Note 1 to entry: This is known as a "safety valve" in ADR.

3.1.11

remote-controlled service valve with excess flow valve

device that allows or interrupts the LPG supply to the vaporizer/pressure regulator which is operated remotely and is combined with an excess flow valve

3.1.12

excess flow valve

valve designed to close automatically, with a small residual flow, when the fluid flow passing through it exceeds a predetermined value, and to re-open when the pressure differential across the valve has been restored below a certain value

3.1.13

pressure relief device

PRD

device protecting the container from bursting, when exposed to fire, by venting LPG at a pre-set temperature and/or pressure

3.1.14

fuel pump

device that pumps liquid LPG to the engine fuel system

3.1.15

gas-tight housing

device that vents any leak from components fitted to the container to the venting tube

Note 1 to entry: It also collects and ducts any leaks to the outside of the vehicle, where necessary through a connecting hose and a lead-through.

3.1.16

power supply bushing

gas-tight electrical power conductor for components installed inside the container

3.1.17

non-return valve

valve designed to close automatically to prevent reverse flow

3.1.18

multi-valve

device, which combines the functions of two or more components specified in Annex B

3.1.19

vaporizer pressure regulator

device that vaporizes LPG, reduces and/or regulates the outlet pressure to a pre-set value independent of variations of the inlet pressure and/or the flow rate

Note 1 to entry: The shut-off valve can be integrated in the vaporizer/regulator.

3.1.20

shut-off valve

valve to provide a leak tight seal which is operated either manually or remotely

3.1.21

remote-controlled shut-off valve

valve to provide a leak-tight seal which is remotely operated

3.1.22

manual shut-off container valve

manually operated shut-off valve which is rigidly fixed to the container

3.1.23

LPG injectors

device that supplies a controlled quantity of LPG to the engine

3.1.24

mixing unit

device that controls the quantity of vaporized LPG to the engine

3.1.25

LPG dosage unit

device that meters and/or distributes the LPG vapour to the engine

3.1.26

flexible hoses

flexible ducts that convey LPG liquid or vapour at various pressures from one point to another

3.1.27

hydrostatic relief valve

self-closing valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges fluid at a predetermined pressure

3.1.28

filter unit

device that removes particulates from the LPG

Note 1 to entry: The filter can be integrated in other components.

3.1.29

pressure sensor

device that measures and transmits the pressure

3.1.30

temperature sensor

device that measures and transmits the temperature

3.1.31

service coupling

connector in the fuel line between the container and the engine for emergency fuelling

Note 1 to entry: If a mono-fuel vehicle is out of fuel, the engine can be operated by means of a service container coupled to the service coupling.

3.1.32

Electronic Control Unit

ECU

device that controls the LPG supply to the engine and the electrical power supply to the remote-controlled service valves

3.1.33

fuel rail

pipe or flexible hose that supplies the fuel to the injection devices

3.1.34

filling unit

device installed on the outside of the vehicle to receive the filling nozzle and enable the filling of the LPG container

3.1.35

gas tube

tubing made of metallic material which has been designed not to flex in normal operation and through which LPG flows

3.1.36

interconnected LPG system

LPG-system having hydraulic interconnections with the petrol or diesel fuelling system

3.1.37

multi-component

component which incorporates two or more service functions and which meets the combined requirements of the individual functions

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

CAN Controller Area Network

EMC Electromagnetic Compatibility

STP Standard Temperature and Pressure [15,6 °C (288,7 K), 1,013 bar absolute (0,101 3 MPa absolute)]

4 Technical requirements

4.1 General

Components shall be designed for use with automotive LPG as specified in EN 589.

The specific requirements for design and testing are detailed in the annexes (see Table 1 and Table 2).

If a device combines two or more functions of separate components, the relevant requirements for each component shall apply.

Table 1 — Annexes dealing with components fitted in or on the container

Component	Annex	Clause
80 % stop valve	B	B.1
level indicator	B	B.2
float	B	B.3
pressure relief valve	B	B.4
remote-controlled service valve with excess flow valve	B	B.5
excess flow valve	B	B.6
pressure relief device (PRD)	B	B.7
manual shut-off container valve	B	B.8
fuel pump	C	
gas-tight housing	D	
power supply bushing	E	
non-return valve	F	
multi-valve	G	
NOTE A fuel pump, multi-valve, gas-tight housing, power supply bushing and a non-return valve can be fitted if required for proper operation of the automotive LPG-system.		

Table 2 — Annexes dealing with components not fitted in or on the container

Component	Annex
pressure regulator / vaporizer	H
shut-off valve	I
gas injection device or injector	J
gas mixing unit	J
gas dosage unit	K
flexible hoses and gas pipes	L
hydrostatic relief valve	M
LPG filter unit	N
pressure and/or temperature sensor	O
service coupling	P
electronic control unit (ECU)	Q
fuel rail	R
filling unit	S
gas tube(s)	T
multi-component	Annexes applicable to the single components

4.2 General design rules

4.2.1 Electrically operated devices containing LPG

Electrically operated devices containing LPG shall not produce sparks in the event of failure.

No current shall flow through LPG containing parts.

The electrical system shall be insulated from the body of the component and from the container.

The insulation resistance shall be greater than 10 MΩ.

The electrical enclosures of the LPG installation inside the boot and passenger compartment and in the LPG container shall comply with class IP 40 according to EN 60529.

All other electrical enclosures shall comply with class IP 54 in accordance with EN 60529.

NOTE See UN/ECE Regulation 10 [3] for electromagnetic compatibility aspects.

4.2.2 Remotely operated valves

Remotely operated valves (e.g. service valve, shut-off valves), shall fail safe and shall remain closed when no power is applied (“normally closed” type).

4.2.3 Heat exchanger materials

Materials shall be compatible with the heat exchange medium. The heat exchanger shall be designed to withstand a pressure of twice the maximum allowable pressure of the heat exchange medium.

4.2.4 Components containing high and low pressure parts

A component, containing both high pressure and low pressure parts, shall be designed to prevent pressure build up in the low-pressure part above 2,25 times the maximum allowable pressure of that part of the component.

4.3 Materials

Materials in contact with LPG shall be LPG compatible.

Materials exposed to corrosive conditions shall be corrosion resistant or protected against corrosion.

The component manufacturer shall maintain records of and provide if requested:

- chemical analysis certificates;
- mechanical property data;
- results of metallurgical and mechanical tests and analysis

for the materials used in construction of the parts subjected to pressure.

The component manufacturer shall maintain a system for the identification and tracing of materials used in the fabrication of parts under pressure.

NOTE For guidance on the choice of non-metallic materials, see EN ISO 11114-2 [6].

4.4 Design temperature

The minimum design temperature shall be $-20\text{ }^{\circ}\text{C}$.

For extreme cold operating conditions, a minimum design temperature of $-40\text{ }^{\circ}\text{C}$ shall apply.

The maximum design temperature shall be:

- $65\text{ }^{\circ}\text{C}$ for components installed on the vehicle;
- $120\text{ }^{\circ}\text{C}$ for components installed in the engine compartment.

5 Classification of components

5.1 General

Components are classified according to their maximum allowable pressure and function, see Annex A:

- | | |
|----------|--|
| Class 0 | High pressure parts including tubes and fittings containing liquid LPG with a maximum allowable pressure $> 3\ 000\text{ kPa}$.

Maximum allowable pressure shall be defined by manufacturer. |
| Class 1 | High pressure parts including pipes and fittings containing liquid LPG with a maximum allowable pressure of $3\ 000\text{ kPa}$, excluding valves and PRDs. |
| Class 2 | Low pressure parts operating in the vapour phase including pipes and fittings with a maximum allowable pressure of 450 kPa . |
| Class 2A | Low pressure parts operating in the vapour phase including pipes and fittings with a maximum allowable pressure of 120 kPa . |
| Class 3 | Valves and PRDs with a maximum allowable pressure of $3\ 000\text{ kPa}$. |

For a component consisting of several parts, each part shall be classified in its own class depending on the maximum allowable pressure and function of that part.

5.2 Classification of automatic valves

Remotely controlled service valves can be classified and marked as follows:

- a) H1, if the engine shuts off automatically when the vehicle comes to a halt;
- b) H2, if, in addition to a), the engine also shuts off automatically when the vehicle drives with the electric motor only;
- c) H3, if, in addition to a) or b), the engine also shuts off automatically when the accelerator pedal is released.

Notwithstanding the above-mentioned provisions, the valve complying with b) shall be deemed to satisfy a), and the valve complying with c) shall be deemed to satisfy a) and b).

According to their classification, remotely controlled service valves shall be submitted to the following numbers of operations during the endurance test of 7.6:

- 200 000 cycles, for valves marked H1;
- 500 000 cycles, for valves marked H2;
- 1 000 000 cycles, for valves marked H3.

6 Construction and workmanship

The manufacturer shall be able to demonstrate that the quality control system ensures that the component produced meets the requirements of this document.

The manufacturer shall maintain records of the inspections that are carried out during production.

7 Tests

7.1 General

Each class of components shall be tested in accordance with Table 3, except the ones regarding flexible hoses that shall be tested in accordance with Annex L.

Each component shall be tested as specified in the relevant Annex.

Table 3 — Type approval and production (routine) tests

Test	Class 0		Class 1		Class 2/2A		Class 3		Clause
	Type approval	Production (routine)	Type approval	Production (routine)	Type approval	Production (routine)	Type approval	Production (routine)	
Overpressure	x		x		x		x		7.2
External leak ^e	x	x	x	x	x	x	x	x	7.3
Seat leak ^b	x	x	x	x	x	x	x	x	7.4
Operational ^b	x						x		7.5
Endurance	x						x		7.6
Vibration	x		x		x		x		7.7
LPG compatibility ^a	x		x		x		x		7.8
Corrosion resistance ^c	x		x		x		x		7.9
Resistance to dry heat ^{a e}	x		x				x		7.10
Ozone ageing ^{a e}	x		x				x		7.11
Creep ^{a d e}	x		x				x		7.12
Temperature cycle ^a	x		x				x		7.13

^a Only applicable for rubber materials.
^b Only applicable for parts containing a valve.
^c Only applicable for metallic parts exposed to corrosive conditions.
^d Except for the 80 % stop valve and excess flow valve as the permitted leak exceeds the requirements of this test.
^e Only for parts having a sealing function.

Test pressure tolerances shall be 10 % of the stated value with a maximum of 100 kPa.

Test temperature tolerances shall be:

- -5 °C for the minimum test temperature;
- +5 °C for the maximum test temperature;
- ±5 °C for 20 °C.

Test medium are specified in each test procedure. However, the manufacturer shall evaluate and choose the proper medium for test at extreme temperature range (e.g. water should not be used below 4 °C and above 90 °C), ensuring that the viscosity does not exceed twice the viscosity of water at the given temperature.

The test medium is not necessarily the same for all temperatures of a temperature range.

Test equipment accuracy shall be able to guarantee the acceptance criteria of each test.

It is recommended to choose an instrument with the accuracy below 1/3 of the acceptance criteria tolerances.

Any tolerances given in this document include measurement uncertainties.

7.2 Overpressure test

7.2.1 General

The test pressure applied shall be 2,25 times the maximum allowable pressure, unless otherwise stated in the specific component annex.

The test shall be performed at a temperature of 20 °C.

If an endurance test is required by Table 3, it shall be performed before the overpressure test.

7.2.2 Test procedure

The outlet of the component compartment to be tested shall be plugged. The level indicator and the float shall be tested installed in a pressure vessel.

The test medium shall be water or any suitable liquid.

The pressure shall be raised gradually.

The test pressure shall be maintained for at least one minute.

7.2.3 Interpretation of the test

The component shall pass the overpressure test without any visible evidence of rupture or permanent distortion.

7.3 External leak tests

7.3.1 Type approval test

7.3.1.1 General

An overpressure test, and an endurance test if required by Table 3, shall be performed before the external leak test.

The test conditions shall be according to 7.3.1.2, unless otherwise stated in the specific component annex.

7.3.1.2 Test procedure

The test shall be performed with air or nitrogen.

All components shall be tested at 20 kPa and at 1,5 times the maximum allowable pressure, in the case of a Class 3 component 2,25 times the maximum allowable pressure, at the following temperatures:

- a) 20 °C;
- b) the minimum design temperature;
- c) the maximum design temperature.

Tests shall be carried out according to the following procedure:

- plug the outlet of the component;
- pressurize the component at the inlet;
- immerse the component in a suitable test liquid;
- maintain the test pressure for not less than 1 min and determine the leak rate.

The components shall be preconditioned at the test temperature for at least 8 h.

7.3.1.3 Leak rate determination

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:

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

where

- V_l is the leakage rate, cm³/hour of air or nitrogen;
- V_t is the liquid displacement during the test in cm³;
- t is the time of test, minutes;
- P is the atmospheric pressure during test in kPa;
- T is the ambient temperature during test in K.

7.3.1.4 Test interpretation

The external leak rate shall be less than 15 cm³/hour, except for the gas-tight housing, for which a leak rate of no more than 100 cm³/hour is allowed.

7.3.2 Production (routine) testing

During production all components shall be tested in accordance with the procedure in 7.3.1.2, at room temperature without preconditioning and at the maximum allowable pressure. Components that fail the test shall be rejected.

7.4 Seat leak test

7.4.1 Type approval testing

7.4.1.1 General

An external leak test, and an endurance test if required by Table 3, shall be performed before the seat leak test.

7.4.1.2 Test procedure

The test shall be performed with air or nitrogen at 20 °C, at 20 kPa and at the maximum allowable pressure unless otherwise stated in the specific component annex.

The components shall be preconditioned at 20 °C for at least 8 h.

The following procedure shall be applied:

- shut-off valves and pressure relief valves shall be pressurized at the inlet with the outlet open, non-return valves shall be pressurized at the outlet with the inlet open;
- pressurize the component, maintain the test pressure for two minutes and determine the leak rate in accordance with 7.3.1.3;
- in the case of an 80 % stop valve and an excess flow valve, the pressure equalizing bypass shall be blanked.

7.4.1.3 Test interpretation

Unless otherwise stated in the annex specific to the component, the seat of the component shall not leak more than:

- 15 cm³/hour for soft seats and seals;
- 500 cm³/hour for metal to metal seats.

7.4.2 Production (routine) testing

During production all components shall be tested in accordance with the procedure in 7.4.1.2 at the maximum allowable pressure without preconditioning. Components that fail the test shall be rejected.

7.5 Operational tests

7.5.1 Pressure relief valve and hydrostatic relief valve

7.5.1.1 General

Three pressure relief valves of each size, design, and setting shall be tested according to the following:

- test No 1: start-to-discharge pressure and resealing pressure test;
- test No. 2: flow capacity test;
- repeat test No. 1, approximately one hour after the test No. 2.

Three hydrostatic relief valves of each size, design and setting shall be submitted to test No. 1.

7.5.1.2 Test No. 1

7.5.1.2.1 General

The same test procedure shall apply to a pressure relief valve and a hydrostatic relief valve.

A minimum of two successive tests shall be performed on each of the three samples.

7.5.1.2.2 Test procedure

The test shall be performed with air or nitrogen at 20 °C. The pressure source shall be capable of maintaining a pressure of at least 500 kPa above the set pressure marked on the valve. A shut-off valve and a pressure gauge (having a pressure range of about twice the test pressure) shall be installed in the pressure supply pipe. The pressure gauge shall be installed in the pipe between the test valve and the shut-off valve. The start-to-discharge pressure and resealing pressure shall be observed, using a water seal not more than 100 mm in depth, and measured on the pressure gauge.

After recording the start-to-discharge pressure of the valve, increase the pressure sufficiently to ensure the valve lifts. Close the shut-off valve slowly, the pressure at which bubbles cease to emerge from the valve shall be recorded as the resealing pressure of the valve.

7.5.1.2.3 Test interpretation before the flow capacity test

The start-to-discharge pressure of each of the three samples of a pressure relief valve shall be within +3 % of the average of the pressures, but the start-to-discharge pressure of any one of the three valves shall be not less than 95 %, not more than 105 %, of the set pressure marked on the valve. The resealing pressure of a pressure relief valve before being subjected to a flow capacity test shall be not less than 50 % of the initially observed start-to-discharge pressure.

7.5.1.2.4 Test interpretation after the flow capacity test

The start-to-discharge pressure of a pressure relief valve shall be at least 85 % of the recorded start-to-discharge pressure during the test performed before the flow capacity test; the resealing pressure shall be at least 80 % of the resealing pressure recorded before the flow capacity test.

7.5.1.3 Test No. 2

7.5.1.3.1 General

The flow capacity test on a pressure relief valve shall be carried out with a calibrated flowmeter. The flowmeter shall be connected to a source of air of adequate flow capacity and pressure.

The flowmeter shall be installed in accordance with the manufacturers' instructions.

7.5.1.3.2 Test procedure

The valve in the air-supply line shall be opened slowly until the flow rating pressure (120 % of the set pressure) is reached. The flow at this pressure is then recorded. The pressure is now decreased and the pressure at which there is no further discharge from the valve, is recorded. This is the blow-down pressure of the valve.

7.5.1.3.3 Test interpretation

The average flow capacity of the three pressure relief valves shall be recorded as the flow capacity of the valve of that specific size, design and setting. The recorded flow capacity shall be corrected to STP.

The flow capacity of any of the three samples of a pressure relief valve shall be at least 90 % of the highest observed capacity.

During the flow capacity tests on each valve there shall be no evidence of abnormal operating conditions.

The blow-down pressure of each valve shall be at least 65 % of the resealing pressure recorded during the start-to-discharge test performed before the flow capacity test.

7.5.2 Excess flow valve

7.5.2.1 General

Three valves of each size and design shall be subjected to the test.

A valve intended to operate in the liquid phase shall be tested with water or any other suitable test liquid.

A valve intended for use in the vapour phase shall be tested with air or any other suitable test gas.

A valve intended for installation in one orientation shall be tested in that orientation only.

A valve not intended for installation in one orientation shall be tested in the vertical, inverted and horizontal orientation.

The flow through the excess flow valve shall be measured using a suitable flowmeter. The flow at the instant just before closing shall be recorded.

7.5.2.2 Test interpretation

The excess flow valves shall operate at the rated closing flow capacity specified by the manufacturer. The acceptable tolerance is -20 % / +10 %.

7.5.3 80 % stop valve

7.5.3.1 General

Three samples of each design of the 80 % stop valve shall be subjected to the following test.

7.5.3.2 Test procedure

The valve to be tested shall be installed in the normal operating orientation.

The valve shall be connected to a liquid supply source that is able to maintain a flow rate from 30 % to 130 % of the flowrate for which the 80 % stop valve is designed.

The rate at which the liquid level rises in the test vessel shall be equivalent to the rate at which the level rises in the type of container for which the valve is designed.

The level at which the 80 % stop valve closes shall be recorded.

The test shall be repeated 10 times at 0,3, 0,8 and 1,3 times the flow rate for which the 80 % stop valve is designed.

Alternative test methods are acceptable provided that they are equivalent.

7.5.3.3 Test interpretation

The maximum level at which any valve closes shall be 80 % of the volume of the smallest container for which the 80 % stop valve is designed.

The difference between the highest and the lowest levels recorded for the smallest container for which the 80 % stop valve is designed shall be:

- -5 % at 0,3 times the design flow rate;
- -5 % at 0,8 times the design flow rate;
- -10 % at 1,3 times the design flow rate.

7.5.4 Fusible plug

7.5.4.1 Test procedure

The test shall be performed in the following manner:

- a) three fusible plugs shall be held at a controlled temperature of at least 90 °C and pressurized to the maximum allowable pressure for 24 h;
- b) the fusible plugs shall be cooled to ambient temperature and inspected;
- c) the fusible plugs shall be gradually heated, the temperature at which the plug opens shall be recorded.

7.5.4.2 Test interpretation

After the test described in 7.5.4.1 b) there shall be no leakage or visible extension of any used fusible metal.

The recorded temperature at which the plug opens shall be between 110 °C and 130 °C.

7.6 Endurance test

7.6.1 General

Three components shall be submitted to a test at the maximum allowable pressure and at 20 °C unless otherwise stated in the specific component annex.

7.6.2 Test procedure

The component shall be installed in its normal operating orientation.

A filling unit or service valve shall be capable of conforming to the applicable leakage test requirements of 7.3 and 7.4, after being subjected to a number of cycles of opening and closing as mentioned in the annexes to this document.

A shut-off valve shall be tested with the valve outlet plugged, the valve body filled with n-hexane, and the valve inlet subjected to a pressure of 3 000 kPa or of maximum allowable pressure in accordance with the classification pressure of the valve.

Shut-off valves and pressure relief valves shall be pressurized at the inlet with the outlet open, non-return valves shall be pressurized at the outlet with the inlet open.

Unless otherwise stated in the annex specific to the component, operate the device for 6 000 cycles at a maximum rate of 10 times per minute.

The temperature shall be kept constant during the test.

Subsequent to this cycle, the component shall be submitted to an external leak test and a seat leak test at 20 °C and at the maximum allowable pressure. The function of the component shall be tested.

7.6.3 Test interpretation

A visual examination of the component shall be carried out.

There shall be no damage or wear of the component indicative of an early failure.

The component shall still comply with the design rules as stated in the specific component annexes.

Gaskets and seals, if fitted, shall be in the design position and shall not be damaged.

The component shall comply with the external and seat leak tests requirements at 20 °C.

7.7 Vibration test

7.7.1 General

To ensure that a component with moving part(s) is constructed to withstand expected dynamic vibration stresses, two samples of each component shall be subjected to the test described in 7.7.2.2 or in 7.7.2.3.

The test shall be carried out along each of the three-dimensional axes of the component.

7.7.2 Test procedure

7.7.2.1 Equipment and mounting techniques

The component shall be attached to the vibration equipment by its normal mounting accessories, either directly to the vibration exciter or transmission table, or by means of a rigid fixture capable of transmitting the specified vibration conditions to the component.

When the component can be installed in more than one position, additional samples shall be tested to cover all mounting positions.

Equipment used to measure and/or record the acceleration level or amplitude level and the frequency shall have an accuracy of at least 10 %.

Procedure A or procedure B shall be used.

7.7.2.2 Procedure A

7.7.2.2.1 Resonance search

Resonant frequencies of the component shall be determined by varying the frequency of the applied vibration slowly through the specified vibration range, at reduced test levels, but with sufficient amplitude to excite the component.

NOTE The sinusoidal resonance search can be performed using the test level and cycling time as specified for the cycling test, provided the resonance search time is included in the time required for the sinusoidal cycling test.

7.7.2.2.2 Resonance dwell test

The component shall be vibrated for 30 min along each axis at the most severe resonant frequencies determined in the resonance search test.

The excitation level of the vibration exciter or transmission table shall be $1,5g$ ($14,7 \text{ m/s}^2$). If more than four significant resonant frequencies are found for any one axis, the four most severe resonant frequencies shall be chosen for this test.

If a change in the resonant frequency occurs during the test, each time of occurrence shall be recorded and the frequency shall be adjusted immediately to maintain the peak resonance condition. The final resonant frequency shall be recorded.

The total dwell test time shall be included in the required time for the sinusoidal cycling test.

7.7.2.2.3 Sinusoidal cycling test

The component fitted on the exciter or transmission table shall be sinusoidally vibrated for 3 h along each of its three-dimensional axes, under the following conditions:

- an acceleration level of $1,5g$ ($14,7 \text{ m/s}^2$);
- a frequency range of 5 Hz to 200 Hz;
- a sweep time of 12 min.

The frequency of the applied vibration shall be swept logarithmically over the specified range.

NOTE The sweep time is the time required to pass the frequency range from 5 Hz to 200 Hz and back.

7.7.2.3 Procedure B

The test shall be performed on a sinusoidal vibrating bench, at a constant acceleration of $1,5g$, and at frequencies ranging between 5 Hz and 200 Hz.

The test shall last 5 h for each of the dimensional axes of the component.

The frequency band shall be 5 Hz to 200 Hz.

The sweep time shall be 15 min.

NOTE The sweep time is the time required to pass the frequency range from 5 Hz to 200 Hz and back.

Alternatively, in case the test is not conducted by utilizing a constant acceleration level, the frequency band from 5 Hz to 200 Hz shall be subdivided into 11 semi-octave bands, each of them covered by a constant amplitude, so that the theoretical acceleration is between $1g$ and $2g$ ($g = 9,8 \text{ m/s}^2$). See Table 4.

Table 4 — Vibration amplitudes

Amplitude (crest value) mm	Frequency (for acceleration = $1g$) Hz	Frequency (for acceleration = $2g$) Hz
10,00	5	7
5,00	7	10
2,50	10	14
1,25	14	20
0,60	20	29
0,30	29	41
0,15	41	57
0,08	57	79
0,04	79	111
0,02	111	157
0,01	157	222

Each frequency band shall be covered in both directions in 2 min.

7.7.2.4 Subsequent testing

After the test, the component shall be subjected to the operational test in accordance with 7.5.3.2.

7.7.2.5 Test interpretation

After the test, the component shall show no mechanical failure.

The values of:

- the filling level at the stop position; and
- the filling rate at the stop position

shall not exceed the values before the vibration test by more than 10 %.

7.8 LPG compatibility test (for rubber materials)

7.8.1 Test procedure

Rubber materials in contact with LPG, shall meet the requirements of EN 549 for resistance to the gas (n-pentane test) and condensate/liquid phase of combustible gases (liquid B test).

7.8.2 Test interpretation

The maximum change in mass after immersion and the maximum change in mass after drying shall be in accordance with EN 549.

7.9 Corrosion resistance test

7.9.1 Test procedure

7.9.1.1 General

Following these tests, the components shall be visually inspected and subjected to an overpressure test and an external leak test.

7.9.1.2 Test procedure for a metallic component subject to LPG pressure

A metallic component subject to LPG pressure, exposed to corrosive conditions during its normal life, shall be submitted to 144 h salt spray test in accordance with EN ISO 9227 or to a salt spray test in accordance with EN IEC 60068-2-52.

The component shall be degreased before the test. All the connections shall be closed off. The component shall not be operated during the test.

Subsequently the component shall be sprayed for 2 h with a salt solution containing 5 % NaCl (by mass) with less than 0,3 % contamination and 95 % distilled or demineralized water, at a temperature of 20 °C. After spraying, the component shall be stored at a temperature of 40 °C and 90 % to 95 % relative humidity for 168 h. This sequence shall be repeated 4 times.

Following this, the component shall be cleaned and dried for 1 h at 55 °C. The component shall be conditioned to ambient temperature for 4 h, before submitting it to further testing.

7.9.1.3 Additional test procedures for copper or brass components subject to LPG pressure

Copper or brass components subject to LPG pressure shall be tested in Ammonia for 24 h in accordance with ISO 6957. All the connections shall be closed off.

Brass parts of a PRD shall be immersed for 30 min in an aqueous mercurous nitrate solution containing 10 g of mercurous nitrate and 10 ml of nitric acid per litre of solution (see ASTM B154 [1]). Following this test, the part shall be fitted in the PRD.

7.9.2 Test interpretation

The component shall be free from cracks and shall pass the overpressure test and the external leak test.

7.10 Resistance to dry heat test

7.10.1 General

A non-metallic component subject to LPG pressure and to atmospheric conditions shall be submitted to the resistance to dry heat test.

7.10.2 Test procedure

The test shall be carried out in accordance with ISO 188. The test piece shall be exposed to air at a temperature equal to the maximum design temperature of the component for 168 h.

7.10.3 Test interpretation

The loss of tensile strength shall not exceed 25 %.

The change in ultimate elongation shall not exceed the following values:

- maximum increase: 10 %;
- maximum decrease: 30 %.

7.11 Ozone ageing test

7.11.1 General

A non-metallic component subject to LPG pressure and to atmospheric conditions shall be submitted to an ozone ageing test.

7.11.2 Test procedure

The test piece, stretched by 20 %, shall be exposed to air at 40 °C with an ozone concentration of 50 parts per hundred million for 72 h in accordance with ISO 1431-1.

7.11.3 Test interpretation

In the stretched condition, the test piece shall be free of cracks.

7.12 Creep test

7.12.1 Test procedure

A non-metallic part containing liquid LPG shall comply with the requirements of the external leak test after having been submitted to a hydraulic pressure at a pressure of 2,25 times the maximum allowable pressure at a temperature of 120 °C for a minimum of 96 h.

Water or any other suitable hydraulic fluid can be used as a test medium.

After this test, the part shall be fitted in the component and the component shall be submitted to an external leak test and a seat leak test at 20 °C.

7.12.2 Test interpretation

The component shall pass the leak tests.

7.13 Temperature cycle test

7.13.1 Test procedure

A non-metallic part in contact with liquid LPG shall be submitted to a 120 min temperature cycle test, from the minimum design temperature up to the maximum design temperature, at the maximum allowable pressure, for a duration of 96 h.

After this test, the part shall be fitted in the component and the component shall be subjected to a seat leak test and an external leak test if applicable in the specific component annex.

7.13.2 Test interpretation

Components shall pass the leak tests.

8 Markings

Approved components shall bear the:

- trade name or mark of the type approval owner;
- type approval mark including the classification of the component; and
- the maximum allowable pressure.

Components made of non-metallic materials shall also bear the manufacturing month and year. This marking shall be clearly legible and indelible.

NOTE 1 Examples of prototype approval application, communication forms and approval mark are shown in UNECE R 67 [2].

NOTE 2 The type approval owner is the holder of the trade name or mark or his accredited representative.

Annex B (normative)

Requirements for the components fitted in or on the container

B.1 80 % stop valve

B.1.1 Design criteria

Component classification class 3
Maximum allowable pressure 3 000 kPa
Maximum design temperature 65 °C

B.1.2 Specific design rules

The 80 % stop valve shall be designed to close at 80_{-5}^0 % of the water capacity of the container, irrespective of the flow rate.

The 80 % stop valve shall be provided with at least one soft seated non-return valve.

NOTE 1 The operating mechanism of the 80 % stop valve can act as the non-return valve.

The component shall withstand, without damage, a torque of 150 % of the mounting torque specified by the manufacturer.

The device shall bear permanent marking, indicating the diameter of the type of container for which it is designed, the correct mounting position and the angle it makes with the horizontal plane when fitted.

NOTE 2 The 80 % stop valve can be combined with the filling unit if the container is not fitted inside the vehicle. If inside the vehicle the filling unit will be outside the vehicle (EN 12979 [4]).

B.1.3 Test procedures

The 80 % stop valve shall be subject to the tests in Table B.1.

Table B.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	The test pressure shall be applied at the inlet and the outlet of the valve in its closed position
External leak	7.3	
Seat leak	7.4	
Operational	7.5.3	
Endurance	7.6	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep test	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

B.2 Level indicator

B.2.1 Design criteria

Component classification	class 1
Maximum allowable pressure	3 000 kPa
Maximum design temperature	65 °C

B.2.2 Specific design rules

The atmospheric side (indicator side) of a level indicator shall be hermetically sealed from the side exposed to LPG.

The LPG liquid level signal to the indicator side shall not be by mechanical means.

NOTE A magnetically transmitted signal is acceptable.

The operating mechanism shall not be deformed under normal operating conditions.

The difference between the actual and the indicated level in the range of (20 to 80) % of the water capacity shall be less than 5 %.

B.2.3 Test procedures

The level indicator shall be subject to the tests in Table B.2.

Table B.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

B.3 Float

B.3.1 Design criteria

Component classification class 1

Maximum allowable pressure 3 000 kPa

Maximum design temperature 65 °C

B.3.2 Specific design rules

The float shall be securely and permanently fixed to the operating mechanism of the device.

The external surface of the float shall be impermeable to LPG.

B.3.3 Test procedures

The float shall be subject to the tests in Table B.3.

Table B.3 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	At 4 500 kPa (pressure to be applied from the outside)
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

B.4 Pressure relief valve

B.4.1 Design criteria

Component classification	class 3
Maximum allowable pressure	3 000 kPa
Maximum design temperature	65 °C

B.4.2 Specific design rules

The pressure relief valve shall:

- be designed to be mounted in or on the container in the vapour phase;
- be designed to withstand, without damage, a torque of 150 % of the mounting torque specified by the manufacturer to ensure adequate tightness;
- be set to open at a pressure of $(2\,700 \pm 100)$ kPa;
- have a flow capacity Q , determined with compressed air at a pressure, 20 % higher than the set pressure as specified above.

$$Q \geq 10,66 A^{0,82}$$

where

Q is the flow of air in standard m^3/min at 100 kPa absolute and temperature of 15 °C;

A is the external surface area of the container in m^2 .

B.4.3 Test procedures

The pressure relief valve shall be subject to the tests in Table B.4.

Table B.4 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	At 20 kPa and at the nominal set pressure minus the tolerance
Seat leak	7.4	At 20 kPa and at the nominal set pressure minus the tolerance
Operational	7.5.1	
Endurance	7.6	With 200 operating cycles
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

B.5 Remote-controlled service valve with excess flow valve

B.5.1 Design criteria

Component classification class 3
 Maximum allowable pressure 3 000 kPa
 Maximum design temperature 65 °C

B.5.2 Specific design rules

The remote-controlled service valve shall:

- be provided with an excess flow valve complying with requirements of B.6;
- withstand, without damage, a torque of 150 % of the mounting torque specified by the manufacturer.

B.5.3 Test procedures

The remote-controlled service valve with excess flow valve shall be subject to the tests in Table B.5.

Table B.5 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	
Endurance	7.6	Number of cycles according to 5.1
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

B.6 Excess flow valve

B.6.1 Design criteria

- Component classification class 3
- Maximum allowable pressure 3 000 kPa
- Maximum design temperature 65 °C

B.6.2 Specific design rules

The excess flow valve shall be provided with a bypass of a maximum of 2 mm² cross-section area to allow pressure equalization.

The excess flow valve shall be designed to close at a flow of 8 000 cm³/min at any pressure difference of 90 kPa or less.

When the excess flow valve is at a cut-off position, the flow through the by-pass shall not exceed 500 cm³/min at a differential pressure of 700 kPa.

B.6.3 Test procedures

The excess flow valve shall be subject to the tests in Table B.6.

Table B.6 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	
Operational	7.5.2	
Endurance	7.6	6 000 cycles
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

B.7 Pressure Relief Device (PRD)

B.7.1 General

The following devices can be considered as a PRD:

- a) fusible plug; or
- b) a pressure relief valve provided that its flow is at least 17,7 m³/min measured at STP; or
- c) a combination of a) and b); or
- d) any other equivalent technical solution, provided that it ensures the same degree of performance.

B.7.2 Design criteria

Component classification	class 3
Maximum allowable pressure	3 000 kPa
Maximum design temperature	65 °C

B.7.3 Specific design rules for the fusible plug

The fusible element of the PRD shall be designed to open at a temperature of 120 °C ± 10 °C.

The flow through the PRD when open shall be in accordance with the following formula:

$$Q \geq 2,73 A$$

where

Q is the flow of air at STP in m³/min (100 kPa absolute at a temperature of 15 °C);

A is the external surface area of the container in m².

The flow test shall be carried out at an upstream air pressure of 200 kPa absolute, and at a temperature of 15 °C.

The device shall be mounted on the container in the vapour phase.

The PRD shall be fitted to the container in such a manner that it can discharge into the gas-tight housing, when its presence is prescribed.

The device shall withstand, without damage, a torque of 150 % of the mounting torque specified by the manufacturer.

B.7.4 Test procedures to be applied

The PRD shall be subject to the tests in Table B.7.

Table B.7 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	The pressure cycling shall be 4 cycles per minute
Operational	7.5.4	
Endurance	7.6	Under the following conditions: — 10 000 cycles at 82 °C at a pressure of 300 and 3 000 kPa; — 10 000 cycles at -20 °C at a pressure of 300 and 3 000 kPa
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
Temperature test at 90 °C and 3 000 kPa for 24 h		At the end no leakage or visible sign of extrusion of any fusible metal used in the design.
NOTE For applicability to prototype and production tests, see Table 3.		

The flow test shall be carried out at an upstream air pressure of 200 kPa absolute and at a temperature of 15 °C. The flow test results shall be corrected to STP.

B.8 Manual shut-off container valve

B.8.1 Design criteria

Component classification	class 3
Maximum allowable pressure	3 000 kPa
Maximum design temperature	65 °C

B.8.2 Specific design rules

The manual container valve shall withstand, without damage, a torque of 150 % of the mounting torque specified by the manufacturer.

B.8.3 Test procedures

The manual container valve shall be subject to the tests in Table B.8.

Table B.8 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	2,5 times the maximum allowable pressure
External leak	7.3	
Seat leak	7.4	
Endurance	7.6	10000 cycles
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

Annex C
 (normative)

Requirements for the fuel pump

C.1 Design criteria

Component classification	class 0/1
Maximum allowable pressure	maximum allowable pressure declared/3 000 kPa
Maximum design temperature	120 °C or 65 °C when the fuel pump is mounted inside the container

C.2 Specific design rules

Pumps of Class 1 shall be so designed that the outlet pressure never exceeds 3 000 kPa, when there is, for example, blocking of the tubing or not opening of a shut-off valve. This shall be done by switching off the pump or by recirculating to the container.

Pumps of Class 0 shall be so designed that the outlet pressure never exceeds the maximum allowable pressure of the components downstream of the pump, when there is, for example, blocking of the tubing or not opening of a shut-off valve. This shall be done by switching off the pump or by recirculation to the container.

C.3 Test procedures

C.3.1 Fuel pump mounted inside the container

The fuel pump mounted inside the container shall be subject to the tests in Table C.1.

As the pump is fitted in the container, the over pressure, external leak and seat leak tests are not applicable.

Table C.1 — Applicable tests

Test	Clause	Test conditions
LPG compatibility	7.8	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts.
NOTE For applicability to prototype and production tests, see Table 3.		

C.3.2 Fuel pump mounted outside the container

The fuel pump mounted outside the container shall be subject to the tests in Table C.2.

Table C.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex D
(normative)

Requirements for the gas-tight housing

D.1 Design criteria

Component classification Not applicable
Maximum allowable pressure 50 kPa
Maximum design temperature 65 °C

D.2 Specific design rules

The outlet of the gas-tight housing shall have a free cross section area of at least 450 mm².

The gas-tight housing shall be leak-proof at a pressure of 10 kPa with the aperture(s) closed off, maximum allowed leak rate of 100 cm³/h vapour and show no permanent deformation.

D.3 Applicable tests

The gas-tight housing shall be subject to the tests in Table D.1.

Table D.1 — Applicable tests

Test	Clause	Test conditions
Overpressure test	7.2	at 50 kPa
External leak test	7.3	at 10 kPa

Annex E
(normative)

Requirements for the power supply bushing

E.1 Design criteria

Component classification class 0/1
 Maximum allowable pressure maximum allowable pressure declared/3 000 kPa
 Maximum design temperature 120 °C

E.2 Specific design rules

Not applicable.

E.3 Applicable tests

The power supply bushing shall be subject to the tests in Table E.1.

Table E.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex F
 (normative)

Requirements for the non-return valve

F.1 Design criteria

Component classification class 2, 2A, 3

Maximum allowable pressure:

- Class 2: 450 kPa
- Class 2A: 120 kPa
- Class 3: 3 000 kPa

Maximum design temperature 120 °C

F.2 Specific design rules

A non-return valve shall close when the pressure at the inlet is lower than the pressure at the outlet of the valve.

F.3 Applicable tests

The non-return valve shall be subject to the tests in Table F.1.

Table F.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	Class 3 components shall undergo the endurance test prior to overpressure test according to 7.6
External leak	7.3	(i)
Seat leak test	7.4	Soft seated non-return valves shall comply with the requirements of this test at any pressure differential between 50 and 3 000 kPa.
Endurance test	7.6	Class 3 parts only
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts of class 3
Ozone ageing	7.11	Only for non-metallic parts of class 3
Creep	7.12	Only for non-metallic parts of class 3
Temperature cycle	7.13	Only for non-metallic parts of class 3
NOTE For applicability to prototype and production tests, see Table 3.		

Annex G
(normative)

Requirements for the multi-valve

G.1 Design criteria

Component classification class 1/3

Maximum allowable pressure 3 000 kPa

Maximum design temperature 65 °C

G.2 Specific design rules

Multi-valve shall fulfil the specific design rules of each component it incorporates.

G.3 Applicable tests

The multi-valve shall be subject to the tests in Table G.1.

The multi-valve shall be tested as a complete unit and each function tested independently.

Table G.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak test	7.4	
Operational test	7.5	
Endurance test	7.6	
Vibration test	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex H
 (normative)

Requirements for the vaporizer/pressure regulator

H.1 Design criteria

Component classification Class 0, 1, 2 and 2A

Maximum allowable pressure:

- Class 0: as declared by the manufacturer
- Class 1: 3 000 kPa
- Class 2: 450 kPa
- Class 2A: 120 kPa

Maximum design temperature 120 °C

H.2 Specific design rules

A component consisting of both high pressure and low pressure parts shall be designed to prevent a pressure build up in the low pressure part above 2,25 times the maximum allowable pressure for which it has been tested.

Where components are connected directly to the container, they shall be designed to the classification pressure of 3 000 kPa. Venting to the engine compartment or outside of the vehicle is not allowed.

H.3 Applicable tests

H.3.1 Class 0/1

The class 0/1 vaporizer/pressure regulator shall be subject to the tests in Table H.1.

Table H.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	The coolant connections shall be open
External leak	7.3	The outlets shall be closed
Seat leak test	7.4	
Endurance test	7.6	50 000 cycles
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

H.3.2 Class 2/2A

The class 2/2A vaporizer/pressure regulator shall be subject to the tests in Table H.2.

Table H.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	The outlets shall be closed
Seat leak	7.4	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex I
 (normative)

Requirements for the remote-controlled shut-off valve

I.1 Design criteria

Component classification class 3
 Maximum allowable pressure 3 000 kPa
 Maximum design temperature 120 °C

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I.2 Specific design rules

If a remotely controlled shut-off valve is used in an interconnected LPG system, the specific provisions of Annex U shall apply.

I.3 Applicable tests

The remote-controlled shut-off valve shall be subject to the tests in Table I.1.

Table I.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	
Endurance	7.6	For remotely controlled service valves provisions of 5.1 apply
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex J (normative)

Requirements for LPG injectors and the mixing unit

J.1 Injector

J.1.1 Design criteria

Component classification:

- Class 0/1: for a liquid injector.
- Class 2/2A: for a vapour injector.

Maximum allowable pressure:

- Class 0: as declared by the manufacturer.
- Class 1: 3 000 kPa.
- Class 2: 450 kPa.
- Class 2A: 120 kPa.

Maximum design temperature 120 °C

J.1.2 Specific design rules

Not applicable.

J.1.3 Applicable tests

The injector shall be subject to the tests in Table J.1.

Table J.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak	7.4	
Endurance test	7.6	100 M cycles
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts of class 1
Ozone ageing	7.11	Only for non-metallic parts of class 1
Creep	7.12	Only for non-metallic parts of class 1
Temperature cycle	7.13	Only for non-metallic parts of class 1
NOTE	For applicability to prototype and production tests, see Table 3.	

J.2 Mixing unit

J.2.1 Design criteria

Component classification Class 2/2A

Maximum allowable pressure:

- Class 2: 450 kPa.
- Class 2A: 120 kPa.

Maximum design temperature 120 °C

J.2.2 Specific design rules

Not applicable.

J.2.3 Applicable tests

The mixing unit shall be subject to the tests in Table J.2.

Table J.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

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Annex K
(normative)

Requirements for the LPG dosage unit

K.1 Design criteria

Component classification Class 2/2A

Maximum allowable pressure:

— Class 2: 450 kPa

— Class 2A: 120 kPa.

Maximum design temperature 120 °C

K.2 Specific design rules

Not applicable.

K.3 Applicable tests

The dosage unit shall be subject to the tests in Table K.1.

Table K.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	The outlets shall be closed
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex L
(normative)

Requirements for the flexible hoses

L.1 Design criteria

Component classification:

- Class 0/1 high pressure hoses
- Class 2 low pressure hose

Maximum allowable pressure:

- Class 0 hoses: as declared by the manufacturer.
- Class 1 hoses: 3 000 kPa.
- Class 2 hoses: 450 kPa.

Maximum design temperature 65 °C for hoses not installed in the engine compartment,
120 °C for hoses installed in the engine compartment.

L.2 Specific design rules

L.2.1 General

Tolerances of the inside diameter of Class 0 and of Class 1 hoses shall be in accordance with Table 1 of EN ISO 1307:2008.

L.2.2 Rubber hose

The hose shall consist of:

- smooth-bore lining resistant to n-pentane;
- reinforcement of one or more interlayer(s);
- cover of suitable synthetic material;
- one or two couplings as required.

The material of the lining shall be smooth and free from pores, holes and impurities.

The cover shall be smooth and free from impurities.

The cover of class 1 hoses shall be pricked.

The cover of class 2 hoses may be pricked.

When the cover is pricked, the interlayer(s) shall be made of a corrosion resistant material or be protected against corrosion.

If the reinforcing layers are made of corrosion resistant material (e.g. stainless steel), a cover is not required.

L.2.3 Synthetic hose

The hose shall consist of:

- thermoplastic lining;
- reinforcement of one or more synthetic interlayer(s);
- cover of suitable thermoplastic material which is oil proof and weather proof;
- one or two couplings as required.

The material of the lining shall be smooth and free from pores, holes and impurities.

The cover shall be smooth and free from impurities.

The cover may be pricked.

L.2.4 Couplings

The couplings shall be of the crimp-fitting type.

Couplings shall have a minimum burst pressure, at least equal to the burst pressure of the hose on which they are fitted.

The leakage of the fitted coupling shall be equal to or less than that specified for the hose.

Couplings on class 0/1 hoses shall also comply with the following requirements:

- the coupling shall be made from steel with a corrosion resistant surface or brass;
- the swivel-nut and the connector on which it is attached shall be provided with the same thread;
NOTE UNF thread according to ASME B1.1-2003 is commonly used.
- the sealing cone shall have an angle of 45 °;
- when couplings on class 1 synthetic hoses use a banjo coupling, the sealing of the banjo bolt shall comply with class A2, H3 of EN 549:2019.

Couplings on Class 2 hoses shall be made from non-corrosive material.

L.2.5 Assembly of hose and couplings

The size of the couplings shall be such that it is not necessary to peel back the cover unless the reinforcement of the hose is made of corrosion-resistant material.

L.3 Tests

L.3.1 Lining

The lining shall be subject to the tests in Table L.1.

Table L.1 — Tests for the lining

Test	Test requirements				Test method/remarks
	High pressure lining Class 1	Low pressure rubber lining Class 2	High pressure synthetic lining Class 1	High pressure synthetic lining Class 2	
Tensile strength and elongation at break: — minimum tensile strength — minimum elongation at break	10 MPa 250 %	10 MPa 250 %	20 MPa 200 %	20 MPa 200 %	ISO 37
Resistance to n-pentane: — maximum change in volume: — maximum change in tensile strength: — maximum change in elongation at break: — maximum decrease of mass after storage in air during 48 h:	20 % 25 % 30 % 5 %	20 % 25 % 30 % 5 %	20 % 25 % 30 % 5 %	20 % 25 % 30 % 5 %	ISO 1817 Test medium: n-pentane Test temperature: 23 °C Immersion period: 72 h
Resistance to ageing after an exposure period of: — maximum change in tensile strength: — maximum change in elongation at break:	168 h 25 % -30 % and 10 %	168 h 25 % -30 % and 10 %	336 h 35 % -30 % and 10 %	336 h 35 % -30 % and 10 %	ISO 188 Test temperature: maximum design temperature minus 10 °C

L.3.2 Cover

The cover shall be subject to the tests in Table L.2.

Table L.2 — Tests for the cover

Test	Test requirements				Test method/remarks
	Cover for high pressure hose Class 1	Cover for low pressure rubber hose Class 2	Cover for high pressure synthetic hose Class 3	Cover for high pressure synthetic hose Class 0	
Tensile strength and elongation at break: — minimum tensile strength — minimum elongation at break	10 MPa 250 %	10 MPa 250 %	20 MPa 250 %	20 MPa 250 %	ISO 37
Resistance to n-hexane: — maximum change in volume: — maximum change in tensile strength: — maximum change in elongation at break:	30 % 35 % 35 %	30 % 35 % 35 %	30 % 35 % 35 %	30 % 35 % 35 %	ISO 1817 Test medium: n-hexane Test temperature: 23 °C Immersion period: 72 h
Resistance to ageing: — maximum change in tensile strength: — maximum change in elongation at break:	25 % -30 % and 10 %	25 % -30 % and 10 %	35 % -30 % and 10 %	25 % -30 % and 10 %	ISO 188 Test temperature: maximum design temperature minus 10 °C Test duration: 336 h
Resistance to ozone:	Cracking in the test pieces is not allowed.	Cracking in the test pieces is not allowed.	Cracking in the test pieces is not allowed. The air shall also have a relative humidity of 50 % ± 10 %.	Cracking in the test pieces is not allowed. The air shall also have a relative humidity of 50 % ± 10 %.	ISO 1431-1 The test shall be performed on test pieces stretched to an elongation of 20 %. Test medium: air with an ozone concentration of 50 parts per hundred million. Test temperature: 40 °C Test duration: 120 h

L.3.3 Uncoupled hose

The uncoupled hose shall be subject to the tests in Table L.3.

Table L.3 — Tests for the uncoupled hose

Test	Test requirements				Test method/remarks
	High pressure uncoupled hose Class 1	Low pressure rubber uncoupled hose Class 0	High pressure synthetic uncoupled hose Class 1	High pressure synthetic uncoupled hose Class 0	
Gas-tightness (permeability): — maximum leakage through the wall of the hose:	95 cm ³ /m	95 cm ³ /m	95 cm ³ /m	95 cm ³ /m	EN ISO 4080 Test piece: a hose with a free length of 1 m. Test medium: liquid propane Test temperature: 23 °C ± 2 °C Test duration: 24 h
Resistance to low temperature:	Cracking or rupture is not allowed.	Cracking or rupture is not allowed.	Cracking or rupture is not allowed.	Cracking or rupture is not allowed.	EN ISO 10619-2:2021 method B Test temperature: -25 °C ± 3 °C
Bending test:	shall not break	shall not break	shall not break	shall not break	See L.3.5
Hydraulic pressure test: — No leakage at — minimum burst pressure:	6 750 kPa 10 000 kPa	1 015 kPa 1 800 kPa	6 750 kPa 10 000 kPa	2,25 × declared maximum allowable pressure 10 000 kPa and at least 2,25 × declared maximum allowable pressure	EN ISO 1402 Test duration: 10 min

In addition to Table L.3, the class 0 and 1 synthetic hose shall be subjected to a high temperature resistance test according to the following procedure:

- a hose with a minimum length of 0,5 m shall be pressurized with air at declared maximum allowable pressure for class 0 hoses, 3 000 kPa for class 1 hoses, and placed in an oven with a temperature of (125 ± 2) °C for 24 h;

- immediately after removing the hose from the oven, the hose shall withstand a pressure of 2,25 times declared maximum allowable pressure for class 0 hoses and 6 750 kPa for class 1 hoses for 10 min. without leaking.

L.3.4 The assembly of hose and couplings

The assembly of hose and couplings shall be subject to the tests in Table L.4.

Table L.4 — Tests for the assembly of hose and couplings

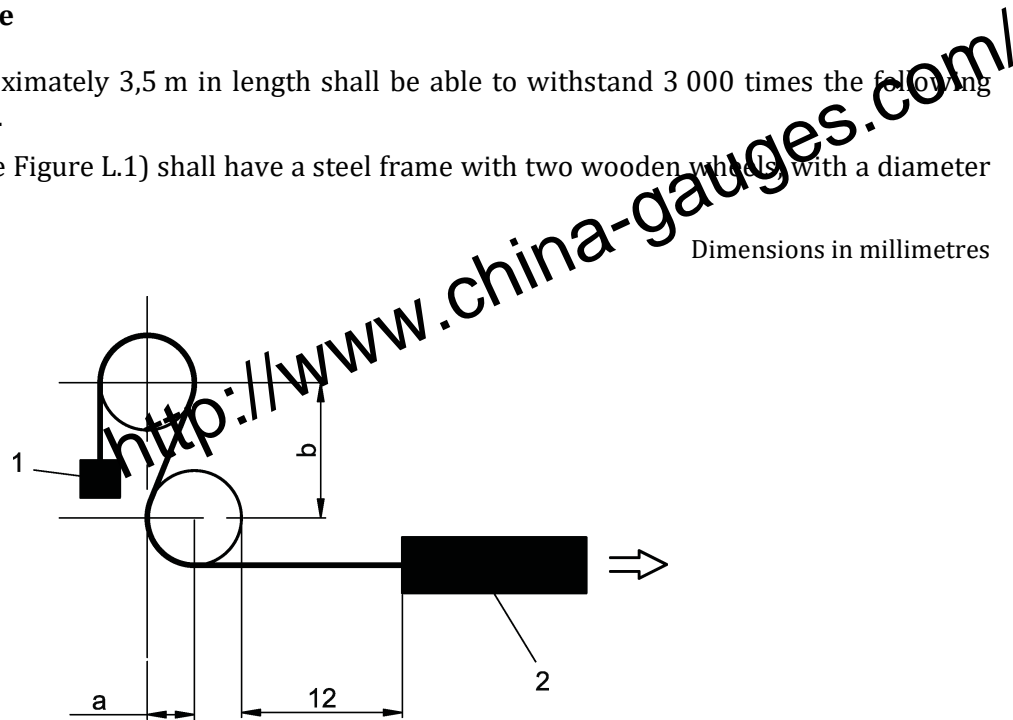
Test	Test requirements				Test method/remarks
	High pressure hoses assembly Class 1	Low pressure rubber hoses assembly Class 2	High pressure synthetic hoses assembly Class 1	High pressure synthetic hoses assembly Class 0	
Impulse test	Pass hydraulic pressure test	Pass hydraulic pressure test	Pass hydraulic pressure test	Pass hydraulic pressure test	See L.3.6
Hydraulic pressure test (after impulse test)					
— No leakage at:	6 750 kPa	1 015 kPa	6 750 kPa	2,25 × declared maximum allowable pressure	Test duration: 10 min
— Minimum burst pressure:	10 000 kPa	1 800 kPa	10 000 kPa	10 000 kPa and at least 2,25 × declared maximum allowable pressure	
Gas-tightness test of the hose and coupling assembly:					
— No leakage at:	3 000 kPa	1 015 kPa	3 000 kPa	1,5 × declared maximum allowable pressure	Test duration: 5 min
Electrical resistance (from coupling to coupling)	Max. 10 ⁶ Ω	Max. 10 ⁶ Ω	Max. 10 ⁶ Ω	Max. 10 ⁶ Ω	ISO 37, EN ISO 8031

L.3.5 Bending test

L.3.5.1 Test procedure

An empty hose of approximately 3,5 m in length shall be able to withstand 3 000 times the following alternating-bending-test.

The testing machine (see Figure L.1) shall have a steel frame with two wooden wheels, with a diameter of c.a. 130 mm.



Dimensions in millimetres

Key

- 1 mass
- 2 propulsion mechanism

Figure L.1 — Example of principle for the testing machine

The circumference of the wheels shall be grooved to guide the hose. The dimensions shall be in accordance with Table L.5.

The longitudinal median planes of both wheels shall be in the same vertical plane and the distance between the wheel-centres shall be in accordance with those mentioned in the Table L.5.

Table L.5 — Main characteristics of the bending test testing machine (see Figure L.1)

Hose inside diameter mm	Bending radius (a) mm	Distance between centres mm	
		Vertical (b)	Horizontal (a)
up to 13	102	241	102
13 to 16	153	356	153
from 16 to 20	178	419	178

Each wheel shall rotate freely around its axle.

A propulsion mechanism pulls the hose over the wheels at a speed of four complete motions per minute.

The hose shall be S-shape-like installed over the wheels (see Figure L.1).

The end, which runs over the upper wheel, shall be provided with a sufficient mass to achieve a complete snugpling of the hose against the wheels. The part that runs over the lower wheel is attached to the propulsion mechanism.

The hose shall travel a total distance of 1,2 m in both directions.

After the bending test, the hose shall be submitted to a hydraulic pressure test.

L.3.5.2 Test interpretation

The hose shall not break during the test and comply with the hydraulic pressure test requirements.

L.3.6 Impulse test

L.3.6.1 Test procedure

The hose assembly (hose and couplings) shall be subjected to an impulse test in compliance with ISO 1436.

The test shall be carried out with oil at a temperature of (93 ± 2) °C and a minimum pressure equal to the declared maximum allowable pressure for class 0 hoses, of 3 000 kPa for class 1 hoses and 1 015 kPa for class 2 hoses.

The hose shall be subjected to 150 000 impulses.

After the impulse test the hose shall be submitted to a hydraulic pressure test as mentioned in Table L.4.

L.3.6.2 Test interpretation

The hose assembly shall comply with the hydraulic pressure test requirements.

L.4 Markings

Every hose shall bear, at intervals not greater than 0,5 m, the following identification marks consisting of characters, figures and symbols (clearly legible and indelible):

- trade name or mark of the manufacturer;
- date of fabrication, e.g. year and month;
- internal diameter of the hose and approval mark;
- identification marking “LPG Class 1” or “LPG Class 2”, where appropriate.

Every coupling shall bear the trade name or mark of the assembling manufacturer.

Annex M
 (normative)

Requirements for the hydrostatic relief valve

M.1 Design criteria

Component classification class 3

Maximum allowable pressure 3 000 kPa

Maximum design temperature 120°C

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M.2 Specific design rules

The hydrostatic relief valve shall be set to open at a pressure of $(3\ 200 \pm 100)$ kPa.

M.3 Applicable tests

The hydrostatic relief valve shall be subject to the tests in Table M.1.

Table M.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak test	7.4	
Operational test	7.5.1	
Endurance test	7.6	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex N
(normative)

Requirements for the filter unit

N.1 Design criteria

Component classification class 1, 2 or 2A

Maximum allowable pressure:

- Parts of Class 1: 3 000 kPa
- Parts of Class 2: 450 kPa
- Parts of Class 2A: 120 kPa

Maximum design temperature 120 °C

N.2 Specific design rules

Not applicable.

N.3 Applicable tests

N.3.1 Class 1 parts

Parts of Class 1 shall be subject to the tests in Table N.1.

Table N.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

N.3.2 Class 2 and/or 2A parts

Parts of Class 2 and/or 2A shall be subject to the tests in Table N.2.

Table N.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex O (normative)

Requirements for the pressure and/or temperature sensor

0.1 Design criteria

Component classification class 1,2 or 2A

Maximum allowable pressure:

- Parts of Class 1: 3 000 kPa
- Parts of Class 2: 450 kPa
- Parts of Class 2A: 120 kPa

Maximum design temperature 120 °C

0.2 Specific design rules

Temperature and pressure sensor shall allow detection of failure conditions, at least open or short circuit condition. Manufacturer shall specify how to detect failure conditions.

0.3 Applicable tests

0.3.1 Class 1

Class 1 pressure and/or temperature sensor shall be subject to the tests in Table 0.1.

Table 0.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

0.3.2 Class 2 and/or 2A

Class 2 and/or 2A pressure and/or temperature sensor shall be subject to the tests in Table 0.2.

Table 0.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

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Annex P
(normative)

Requirements for the service coupling

P.1 Design criteria

Component classification class 3

Maximum allowable pressure 3 000 kPa

Maximum design temperature 20 °C

P.2 Specific design rules

The seat of a service coupling, when in the closed position, shall be free from leakage at any pressure up to 3 000 kPa.

A gas-tight non-return valve shall be fitted, and the provisions of Annex G shall equally apply.

P.3 Applicable tests procedure

The service coupling shall be subject to the tests in Table P.1.

Table P.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
Seat leak test	7.4	
Endurance test	7.6	6 000 cycles
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

Annex Q
(normative)

Requirements for the Electronic Control Unit (ECU)

Q.1 Design criteria

Component classification	Not applicable
Maximum allowable pressure	Not applicable
Maximum design temperature	120°C

Q.2 Specific design rules

The ECU shall switch off the remote controlled service valve(s), cut-off valves and fuel pump of the LPG-system in case of stalling of the engine or when the other fuel is selected.

The switching off delay of the service valves after stalling of the engine shall not be more than 5 s.

NOTE See UN/ECE Regulation 10 [3] for electromagnetic compatibility aspects.

Electrical failure of the vehicle system shall not lead to uncontrolled opening of any valve.

The output of the ECU shall be inactive when the electric power is switched off or removed.

The ECU should read critical shut down signals from the CAN bus and either shut down the LPG system or switch back to the primary fuel.

The electrical power to the fuel pump shall automatically cut off when the ECU becomes defective or loses power.

Annex R
(normative)

Requirements for the fuel rail

R.1 Design criteria

Component classification class 0, 1, 2 or 2A

Maximum allowable pressure:

- Parts of Class 0: as declared by the manufacturer
- Parts of Class 1: 3 000 kPa
- Parts of Class 2: 450 kPa
- Parts of Class 2A: 120 kPa

Maximum design temperature 120 °C

R.2 Specific design rules

If flexible hoses are used the requirements of Annex L shall apply.

R.3 Applicable tests

R.3.1 Class 0/1 fuel rails

Fuel rails of Class 0/1 shall be subject to the tests in Table R.1.

Table R.1 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
NOTE For applicability to prototype and production tests, see Table 3.		

R.3.2 Class 2 and/or 2A fuel rails

Fuel rails of Class 2 and/or 2A shall be subject to the tests in Table R.2.

Table R.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
NOTE	For applicability to prototype and production tests, see Table 3.	

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Annex S (normative)

Requirements for the filling unit

S.1 Design criteria

Component classification class 3

Maximum allowable pressure 3 000 kPa

Maximum design temperature 65 °C

S.2 Specific design rules

S.2.1 General

The filling unit shall be:

- a) equipped with at least one soft seated non-return valve;
- b) protected against dirt;
- c) designed to prevent any unintended movement between parts of the filling unit;
- d) designed to withstand, without damage, a torque of 150 % of the mounting torque, specified by the manufacturer;
- e) the filling unit shall not be dismountable by design.

The critical dimensions of the connecting part of the filling unit shall comply with one of connecting parts illustrated in Figure S.1 to Figure S.5. Unless specified in a different way, all tolerances of Figures S.1 to S.5 shall comply with EN 22768-1 standard with tolerances class "medium".

The filling unit shown in Figure S.6 is only applicable for motor vehicles of categories M2, M3, N₂, N₃, and to M1 having a maximum mass greater than 3,5 tonnes. The filling unit illustrated in Figure S.3 may also be fitted to these vehicle categories.

NOTE Vehicle categories are defined in Table S.1.

Table S.1 — International classification of vehicle categories

Category	Description
M	Motor vehicles with at least four wheels designed and constructed for the carriage of passengers.
M1	Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat.
M2	Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat and having a maximum mass not exceeding 5 tonnes.
M3	Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver's seat and having a maximum mass exceeding 5 tonnes.
N	Motor vehicles with at least four wheels designed and constructed for the carriage of goods.
N1	Vehicles designed and constructed for the carriage of goods and having a maximum mass not exceeding 3,5 tonnes.
N ₂	Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 3,5 tonnes but not exceeding 12 tonnes.
N ₃	Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 12 tonnes.
NOTE	The above categories are defined in (EU) Regulation 2018/858 [5].

S.2.2 Specific requirements for the light vehicle Euro filling unit

The light vehicle Euro filling unit shall be as shown in Figure S.4.

The volume between the front sealing surface of the filling unit and the sealing face of the non-return valve shall not exceed 0,1 cm³.

S.2.3 Specific requirements for the heavy-duty Euro filling unit

The heavy-duty vehicle Euro filling unit shall be as shown in Figure S.5.

The volume between the front sealing surface of the filling unit and the sealing face of the non-return valve shall not exceed 0,5 cm³.

S.3 Applicable tests

S.3.1 General

The filling unit shall be subject to the tests in Table S.2.

Table S.2 — Applicable tests

Test	Clause	Test conditions
Overpressure	7.2	from the outlet of the filling unit, to each non-return valve
External leak	7.3	
Seat leak	7.4	
Operational	7.5.3	only if fitted with an 80 % stop valve
Endurance	7.6	The endurance test shall be carried out with a nozzle specifically intended for the filling unit under test. 10 000 cycles shall be applied according to the following procedure: — connect the nozzle to the filling unit and open the filling system; — leave in open situation for at least 3 s; — close the filling system and disconnect the nozzle.
Vibration	7.7	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts
Creep	7.12	Only for non-metallic parts
Temperature cycle	7.13	Only for non-metallic parts
Impact test	S.3.2	
NOTE For applicability to prototype and production tests, see Table 3.		

S.3.2 Impact test

S.3.2.1 General requirements

The filling unit shall be subjected to an impact test of 10 J.

S.3.3 Test procedure

A hardened steel mass of 1 kg shall be dropped from a height of 1 m in order to deliver an impact velocity of 4,4 m/s. This can be achieved by mounting the weight in a pendulum or by dropping the mass vertically. The filling unit shall be attached to a solid vertical object in the same position, as it would be fitted on the vehicle. The mass shall strike the filling unit at the point as indicated in Figure S.6.

After the impact test, the filling unit shall be submitted to an external, and seat leak tests at ambient temperature.

S.3.4 Test interpretation

The filling unit shall comply with the external leak test and seat leak test requirements at ambient temperature.

S.4 Main dimensions of different types of vehicle filling units in use in Europe

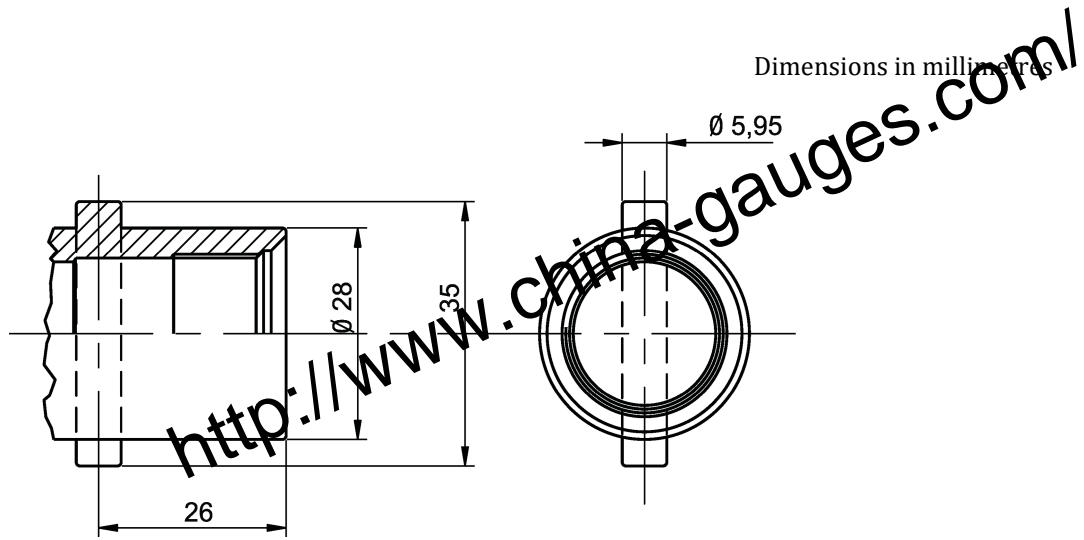


Figure S.1 — Connecting part of the bayonet filling unit

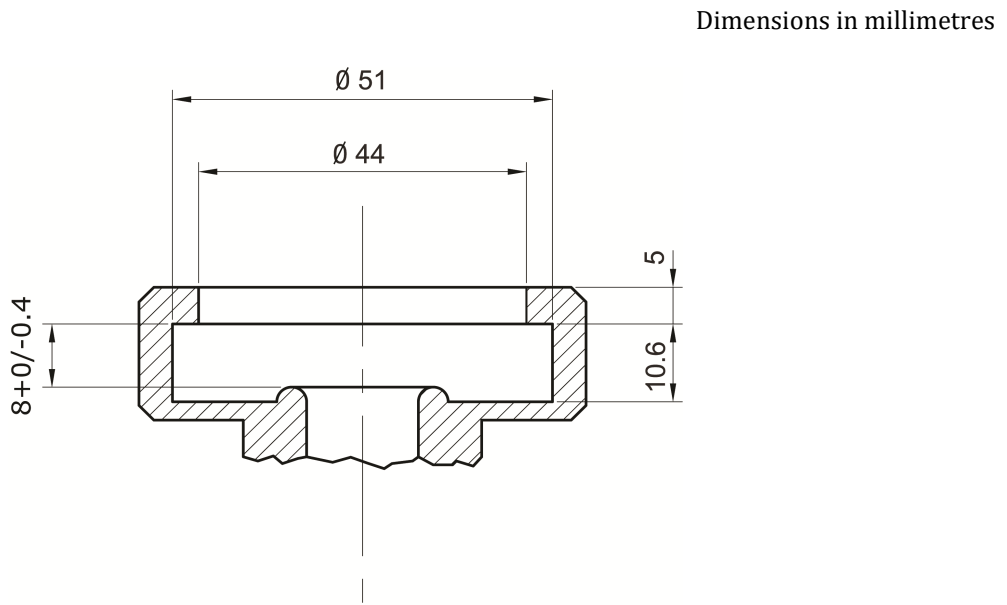


Figure S.2 — Connecting part of the dish filling unit

Dimensions in millimetres

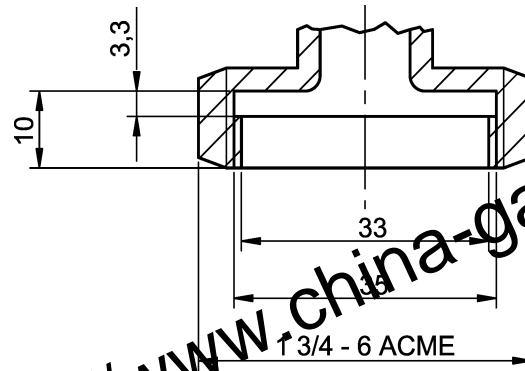
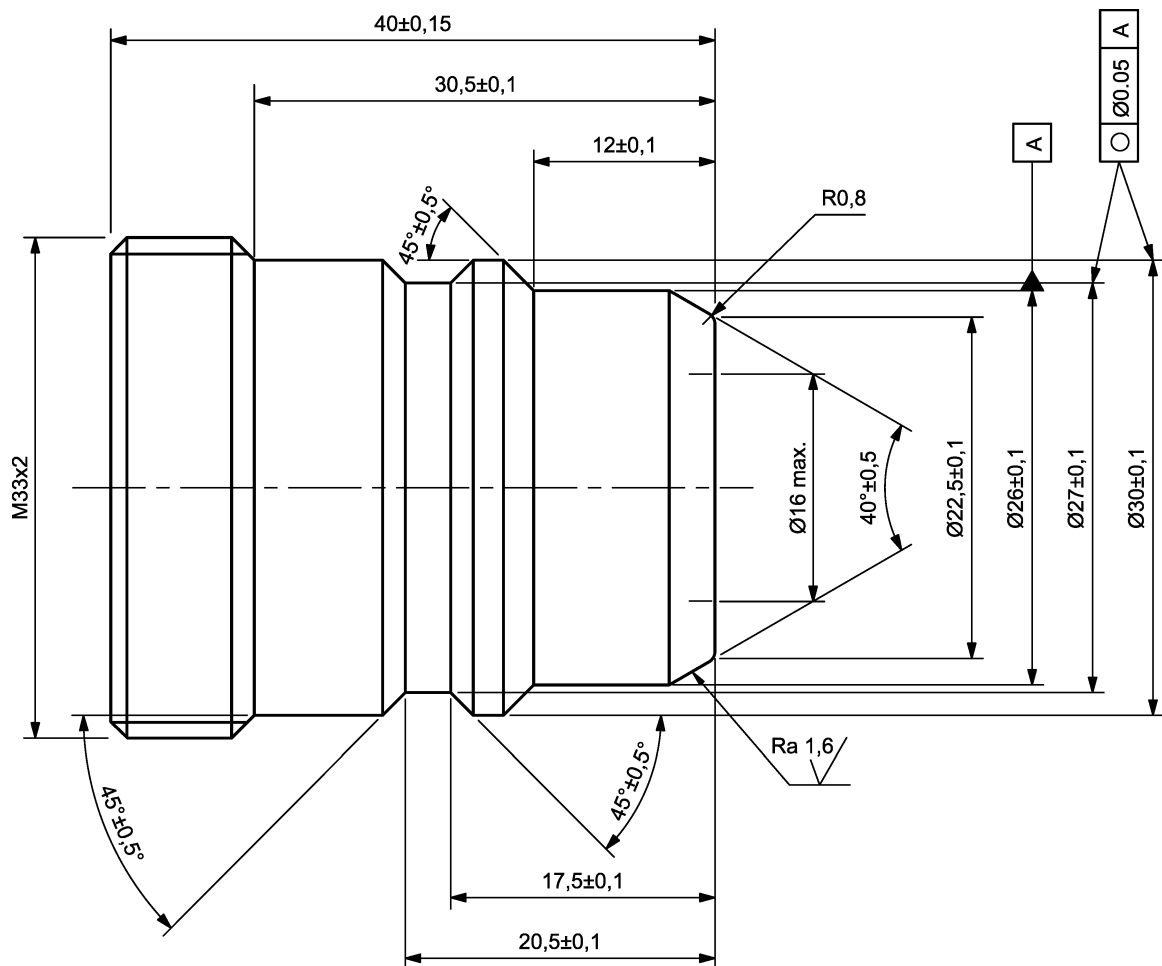


Figure S.3 — Connecting part of the ACME filling unit

Dimensions in millimetres

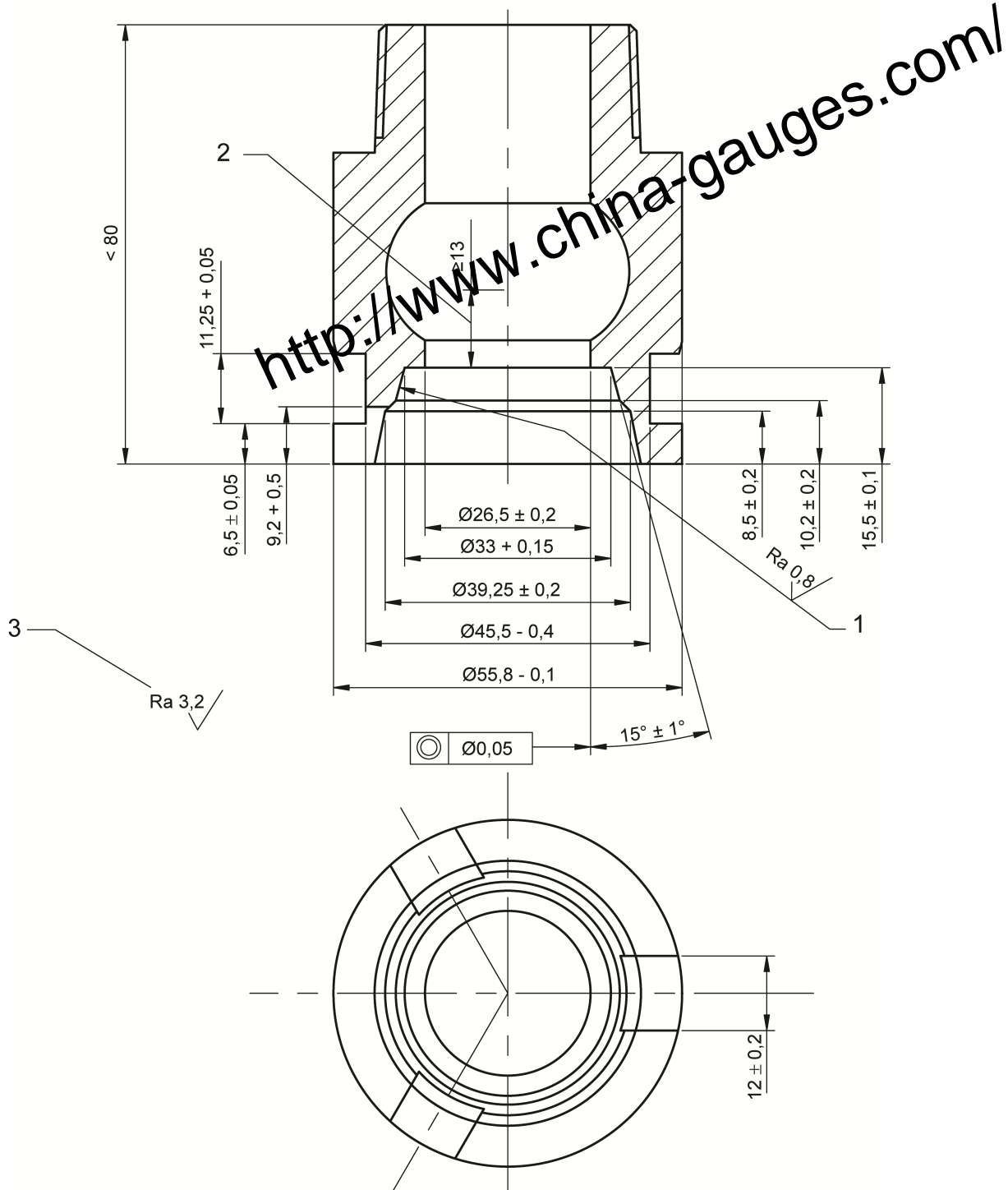


Key

A maximum valve seat diameter

Figure S.4 — Critical dimensions of the light vehicle Euro filling unit

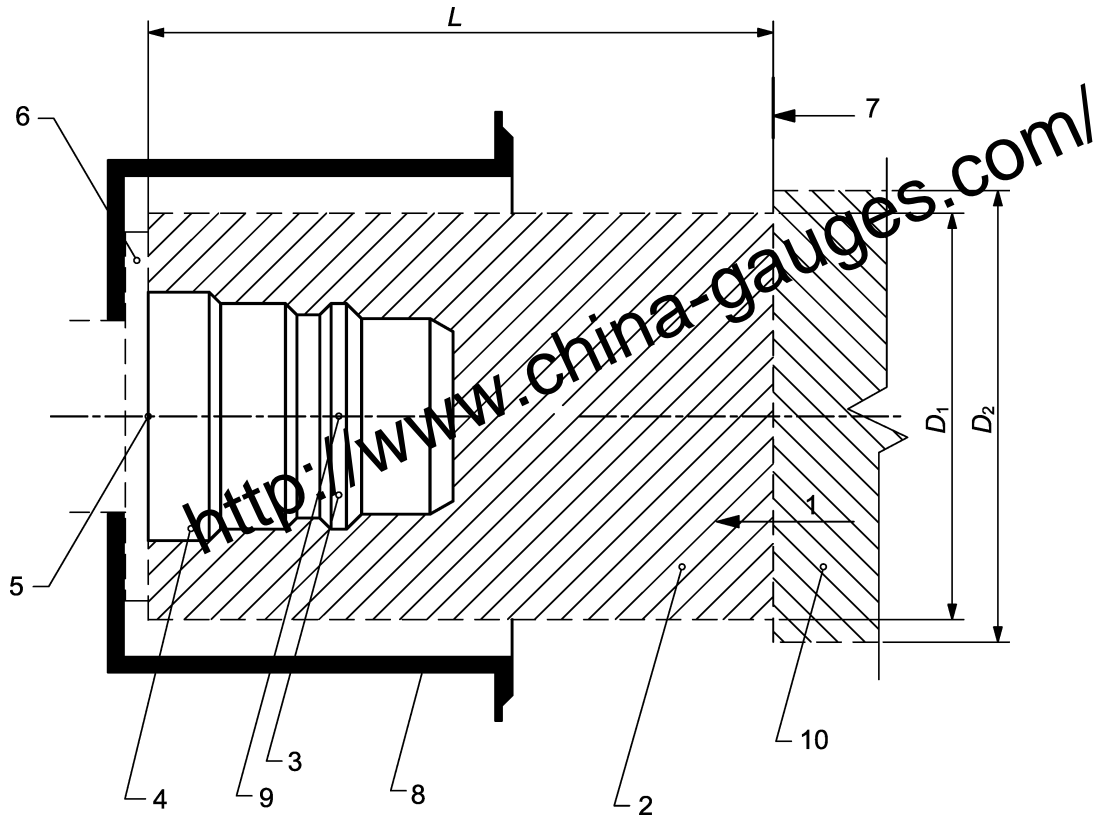
Dimensions in millimetres



Key

- 1 nozzle sealing surface
- 2 valve travel
- 3 general tolerance

Figure S.5 — Critical dimensions of the heavy-duty vehicle Euro filling unit



Key

- 1 fuel flow direction
- 2 extent of filling nozzle location area
- 3 connecting part with groove
- 4 adapters mounting thread area
- 5 normal attachment point
- 6 vehicle filling unit mounting area (not to scale)
- 7 movement limit of lever for nozzle with protruding device
- 8 filling unit well (where fitted)
- 9 point of impact (see S.3.2.2)
- 10 grip area

Dimensions

- L 82 mm minimum
- D_1 \varnothing 54 mm maximum
- D_2 \varnothing 60 mm maximum

Figure S.6 — Critical dimensions of the connected light vehicle Euro filling unit

Annex T
(normative)

Gas tube(s)

T.1 General provisions

The gas tube may be replaced by a gas hose if this hose fulfils the requirement of Annex L.

Gas tubes, other than non-metallic gas tubes, shall be secured such that they shall not be subjected to vibration or stresses.

Gas hoses and non-metallic gas tubes shall be secured such that they shall not be subjected to stresses.

At the fixing point the gas tube or hose shall be fitted with a protective material.

Gas tubes or hoses shall not be located at jacking points.

At passages the gas tubes or hoses, whether or not fitted with a protective sleeve, shall be fitted with protective material.

T.2 Gas tubes of seamless type made of either copper or stainless steel or steel with corrosion-resistant coating

If seamless copper is used the tube shall be protected by a rubber or plastic sleeve.

The outer diameter of Class 1 gas tubes made of copper shall not exceed 12 mm with a wall thickness of at least 0,8 mm, gas tubes of Class 1 from steel and stainless steel shall not exceed 25 mm with, for gas services, an appropriate wall thickness.

Gas tubes of seamless type made of materials other than copper, stainless steel or steel with corrosion-resistant coating shall comply with the applicable tests according to the provisions of T.2 of this annex.

T.3 Gas tube(s) of non-seamless type, gas tube(s) made of materials other than copper, stainless steel, and steel with corrosion-resistant coating, and their couplings

T.3.1 Design criteria

Component classification class 0,1,2 or 2A

Maximum allowable pressure

Parts of Class 0: as declared by the manufacturer

Parts of Class 1: 3 000 kPa

Parts of Class 2: 450 kPa

Parts of Class 2A: 120 kPa

Maximum design temperature 120 °C

For temperatures exceeding the above-mentioned values, special tests conditions are applicable.

T.3.2 General design rules

The couplings shall be compatible with the gas tube.

Specific care shall be taken against galvanic corrosion.

Stainless steel gas tube shall only be used in combination with stainless steel couplings.

Only straight longitudinal welding (in the direction of the tube itself) is permitted in gas tubes of non-seamless type.

T.3.3 Applicable tests

T.3.3.1 Class 0/1 gas tube(s)

The gas tube(s) of class 0/1 shall be subject to the tests in Table T.1.

Table T.1 — Applicable tests for gas tube(s) of class 0/1

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts
Resistance to dry heat	7.10	Only for non-metallic parts
Ozone ageing	7.11	Only for non-metallic parts

T.3.3.2 Class 2/2A gas tube(s)

The gas tube(s) of class 2/2A shall be subject to the tests in Table T.2.

Table T.2 — Applicable tests for gas tube(s) of class 2/2A

Test	Clause	Test conditions
Overpressure	7.2	
External leak	7.3	
LPG compatibility	7.8	Only for non-metallic parts
Corrosion resistance	7.9	Only for metallic parts

T.3.4 Specific design rules

T.3.4.1 Endurance test

The gas tube and its coupling(s) shall be tested for an endurance test consisting out of 100 000 cycles.

One cycle consists of pressure ramp from 15 % maximum allowable pressure up to maximum allowable pressure. After the endurance test, the gas tube and its coupling(s) need to comply with the external leak test of 7.3 and with the overpressure test according to 7.2.

T.3.4.2 Bending test on the gas tube

Test the gas tube according to the following procedure and acceptance criteria:

- a) select a mandrel with an external diameter from Table T.3;
- b) bend the gas tube over this mandrel once, forming a “U” shape;
- c) close the ends of the gas tube and subject it to the overpressure test.

Table T.3 — Mandrel selection

External diameter	Mandrel diameter
≤ 8 mm	3 times the external gas tube diameter
> 8 mm	5 times the external gas tube diameter

At the completion of the overpressure test, the gas tube shall be tested according to the external leak test of 7.3.

T.3.4.3 Excess torque resistance

A coupling designed to be connected directly to threaded fittings shall be capable of withstanding, without deformation, breakage or leakage, a turning effort of 150 % of the rated installation value delivered by the manufacturer, 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 the turning effort, then remove the component and examine it for deformation and breakage;
- c) perform a leakage test according to 7.3;
- d) perform an overpressure test according to 7.2.

T.3.4.4 Vibration test

Vibrate the gas tube and its coupling(s) according to the procedure described in 7.7.

After this test the gas tube and its coupling(s) need to comply with requirements of the external leak test of 7.3 and with the overpressure test according to 7.2.

T.3.4.5 Pull-off

Test the gas tube and its coupling(s) according to the following procedure and acceptance criteria.

Secure the subject specimen in an appropriate test fixture, then statically apply a tensile load along the gas tube axis at a maximum rate of 250 N/min until the gas tube separates from the coupling(s).

The force (F), in Newton, required to pull apart the gas tube from its coupling(s) shall be that calculated as:

$$F = (\pi d^2 P) / 10$$

where

- d internal diameter, (mm);
- P maximum allowable pressure, (bar).

T.3.4.6 Brass material compatibility

All gas tubes and its couplings having brass components shall be subjected to the brass material compatibility test according to 7.9.1.3.

After this test the gas tube and its coupling(s) need to comply with the leak tightness test of 7.3 and with the overpressure test according to 7.2.

Annex U (normative)

Interconnected LPG systems

U.1 Specific provisions for components of interconnected LPG-systems

U.1.1 Remotely controlled shut-off valve

A remotely controlled shut-off valve, when intended to be fitted as a component of an interconnected LPG-system, shall be submitted, during approval, to an endurance test with a number of cycles equal to 20 000.

The valve shall bear a marking with the following data clearly legible and indelible:

- a) the wording "ICS"; and
- b) the approval mark.

U.1.2 Non return valve

U.1.2.1 General

When a non-return valve is intended to be fitted as a component of an interconnected LPG-system it shall be submitted, during approval, to an endurance test according to the procedure laid down below.

The valve shall bear a marking with the following data clearly legible and indelible:

- a) the wording "ICS"; and
- b) the approval mark.

U.1.2.2 Endurance test for non-return valves in interconnected LPG systems

The non-return valve shall be able to withstand 20 000 cycles of operation and 24 h of chatter flow when tested according to the following procedure:

- a) connect the valve to a test fixture and apply a pressure to the valve's inlet equal to pressure of 3 000 kPa or of maximum allowable pressure in accordance with the classification pressure of the valve, then vent pressure from its outlet. Lower the pressure on the valve's outlet side to between 0 and a maximum of 0,5 times the above value prior to the next cycle;
- b) following 20 000 cycles of operation, subject the valve to 24 h of chatter flow at a flow rate that causes the most chatter.

After this test, the non-return valve shall comply with the applicable external leak test requirements in 7.3.

Failure in any sense during the procedure shall constitute a failure of the non-return valve.

All parts shall remain in position and function properly after this test.

Following this test, the check valve shall comply with the overpressure test in 7.2.

U.1.3 Electronic Control Unit (ECU)

When the ECU is intended to be fitted as a component of an interconnected LPG-system it shall inhibit, by controlling the fuel selection system, the vehicle operation in petrol mode after each switch-over operation to LPG mode until a volume of liquid fuel equivalent to that flown into the LPG container during such an operation is consumed.

Notwithstanding this, the ECU may permit the switch over to petrol mode if a fault in the LPG-system determines the inoperability of the system. Such a fault shall be clearly indicated to the driver.

In case of the inoperability of the LPG-system, a remotely controlled shut-off valve, complying with the requirements set out in this annex, shall be installed along the fuel line in order to prevent any flow of petrol into the LPG container after switching-over to petrol mode.

The maximum volume of liquid fuel that flows during a switch-over operation shall not exceed 0,4 l and the minimum volume of the container shall not be lower than 20 l.

To verify compliance with the requirements of this annex, the ECU shall be tested as follows:

- a) install the LPG-system on a vehicle;
- b) set the fuel selection system in LPG mode;
- c) warm up the engine until all temperatures of cooling and lubrication means and the pressure of lubrication means have reached equilibrium;
- d) let the engine run at the lowest idling speed;
- e) switch over from LPG mode to petrol mode and vice versa;
- f) set the fuel selection system in petrol mode.

The criteria adopted for the interpretation of the test is as follows:

- petrol mode is disabled until a volume of liquid fuel equal to 0,4 l is consumed;
- such consumption shall be calculated by a test bench measuring device;
- it may be calculated making use of the fuel flow signals of the LPG ECU read out by means of an appropriate scan tool, if the reliability of such signals has been previously verified.

The test shall be repeated also at the highest idling speed.

To measure the volume of liquid fuel that flows during the switch-over operations, the following test shall be carried out:

- g) install the LPG-system other than the container on a vehicle;
- h) place the container on a weighing system and fill up the LPG container;
- i) after having pressurized the LPG-system up to the normal operating conditions, record the reading of the weighing system (W_1);
- j) disable the ECU feature described above;
- k) switch-over from LPG to petrol and vice versa for at least 10 times;
- l) record the reading of the weighing system (W_2).

The volume of petrol flown per switch-over operation shall be calculated as follows:

$$V_{sw} = (W_2 - W_1) / SW / D_{petrol}$$

where

- W_1 first reading of weighing system;
 W_2 second reading of weighing system;
 SW number of switch-over operations from LPG to petrol mode and vice versa during the test;
 D_{petrol} 743 kg/m³.

The weighing system shall have the following:

- m) a precision of $\pm 0,02$ % of full scale or better;
- n) a resolution of 20 g;
- o) an accuracy of ± 2 % of the reading or $\pm 0,3$ % of full scale, whichever is better.

The ECU shall bear a marking with the following data clearly legible and indelible:

- p) the wording "ICS";
- q) the value of 0,4 l;
- r) the approval mark.

U.1.4 Provisions on the compatibility of metallic and non-metallic components and parts with petrol

Non-metallic components or parts which can come into contact with petrol shall not show excessive volume change or loss of weight.

Resistance to petrol according to ISO 1817 with the following conditions:

- a) medium: petrol (E10)¹;
- b) temperature: 23 °C (tolerance according to ISO 1817);
- c) immersion period: 72 h.

Maximum change in volume 20 %.

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

Metallic components or parts which may come into contact with petrol shall have a permanent resistance against petrol. Metallic parts shall permanently be protected against corrosion (e.g. coating, surface finish, material mix) and fulfil the corrosion resistance requirements set out in 7.9 of this document.

¹ See Annex 10 to UN Regulation No. 83.

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- [6] EN ISO 11114-2, *Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 2: Non-metallic materials (ISO 11114-2)*
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