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Road vehicles — Compressed natural gas (CNG) fuel systems —

Part 1: Safety requirements

Véhicules routiers — Systèmes d'alimentation en gaz naturel comprimé (GNC) —

Partie 1: Exigences de sécurité

Reference number
ISO 15501-1:2001(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15501 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15501-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 25, *Road vehicles using natural gas*.

ISO 15501 consists of the following parts, under the general title *Road vehicles — Compressed natural gas (CNG) fuel systems*:

— *Part 1: Safety requirements*

— *Part 2: Test methods*

Annexes A and B of this part of ISO 15501 are for information only.

Introduction

For the purposes of ISO 15501, all fuel system components in contact with natural gas have been considered suitable for natural gas as defined in ISO 15403.

When applying this part of ISO 15501, it is to be understood that a safety device to prevent overfilling the vehicle's fuel system is part of the refuelling station. The pressure gauge has not been considered as a safety component.

When necessary, technical solutions regarding functional requirements are given in this part of ISO 15501, as in annex A.

This part of ISO 15501 refers only to a service pressure of 20 MPa [200 bar[1)]]. Other service pressures and applications are under consideration for a future edition.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

Road vehicles — Compressed natural gas (CNG) fuel systems —

Part 1:
Safety requirements

1 Scope

This part of ISO 15501 specifies the minimum safety requirements applicable for the functionality of CNG on-board fuel systems intended for use on the types of motor vehicles as defined in ISO 3833. This part of ISO 15501 is applicable to vehicles using compressed natural gas in accordance with ISO 15403, including bi-fuel, original-production and converted vehicles.

All matters relating to the skills of installers and converters have been excluded from this part of ISO 15501.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15501. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15501 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes*

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 11439, *Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles*

ISO 14469:—[1)], *Road vehicles — Compressed natural gas (CNG) refuelling connector*

ISO 15403, *Natural gas — Designation of the quality of natural gas for use as a compressed fuel for vehicles*

ISO 15500 (all parts), *Road vehicles — Compressed natural gas (CNG) fuel system components*

ISO 15501-2, *Road vehicles — Compressed natural gas (CNG) fuel systems — Part 2: Test methods*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas*

3 Terms and definitions

For the purposes of this part of ISO 15501, the terms and definitions given in ISO 15500-1 and the following apply.

3.1
service pressure
settled pressure of vehicle fuel system of 20 MPa (200 bar) at a uniform natural gas temperature of 15 °C

1) To be published.

3.2
CNG on-board fuel system
compressed natural gas fuel system comprising cylinder, or cylinders, mounting, refuelling receptacle or more than one of each of these, according to ISO 14469, and the components described in ISO 15500-3 to ISO 15500-19

3.3
main shut-off valve
automatic valve designed to isolate a high-pressure source

4 Requirements

4.1 Design

4.1.1 General

The CNG on-board fuel system components shall comply with ISO 11439, ISO 14469 and ISO 15500, as applicable.

The high-pressure system, specified in ISO 15500-1, shall be designed on the basis of the service pressure.

For bi-fuel vehicles, provision shall be made to avoid accelerated deterioration of the non-CNG fuel system as a result of sustained operation on natural gas. Such measures shall be as recommended by the original vehicle manufacturer (e.g. fuel hoses).

All fuel system components shall fulfil the following conditions.

a) They shall withstand the environmental temperatures and other environmental conditions safely during their operational life.

b) They shall be located with full regard for anticipated damage while the vehicle is being used safely. Such damage may be caused by the vehicle itself, by extraneous factors such as heat, road debris, automotive chemical splash (brake liquid, oil, petrol, cooling liquid, etc.) or rust.

c) They shall be fitted so that they are not the outermost, highest or lowest parts of the vehicle; otherwise they shall be protected.

d) They shall be fitted so as not to affect ground clearance, approach angle, ramp (break-over) angle or departure angles as defined by the vehicle manufacturer.

e) They shall be located so that they will not suffer corrosion damage by accumulation of water or cargo chemicals.

Both the gas cylinder valve and pressure relief device (PRD), an automatic shut-off valve that can be manually opened or closed in case of automated failure (see annex B), shall be located in a safe place or be suitably protected.

The CNG on-board fuel system shall include

— a main shut-off valve closed when the engine is not running on CNG, and

— a manual or manual override valve located on each gas cylinder.

The CNG on-board fuel system may include a device inside the gas cylinder or a functionally equivalent system to control gas leakage in the event of a rupture in the fuel supply system (see annex A).

The main shut-off valve shall only be open when

— CNG operation has been selected, either manually or automatically, and

— the engine is cranking or running.

Only automatic valves that are normally closed when deactivated shall be used in the CNG on-board fuel system.

4.1.2 Components

4.1.2.1 Receptacle

The receptacle shall be provided with a cap to prevent the entry of dust, fluid or other foreign matter. The cap shall be permanently attached to the vehicle.

The following data should be displayed near the receptacle (marking shall be permanent):

— type of fuel (i.e. “CNG” for compressed natural gas),

— expiry date for gas cylinders, and

— service pressure for the vehicle.

4.1.2.2 Gas cylinder

Gas cylinders shall be provided with cylinder valves and pressure-relief devices, and shall be mounted in accordance with 4.4.

To prevent heat damage, gas cylinders and appurtenances shall either use a heat shield or be located in relation to the exhaust system such that their skin temperature does not exceed the value specified by the vehicle or cylinder manufacturer.

All fibre-reinforced gas cylinders (types 2, 3, and 4 according to ISO 11439) shall be protected from ultra-violet radiation.

4.1.2.3 Pressure regulator

Components located downstream of the pressure regulator shall be protected from overpressurization due to regulator failure.

4.1.2.4 PRD and PRV

The PRD and the pressure relief valve (PRV) shall be protected from dirt and water ingress and the discharge of the devices shall be located as far as possible from sources of ignition and heat in the vehicle.

The PRD shall be triggered by excessive temperature, or temperature and pressure, venting gas to protect cylinder rupture.

The PRV shall be used to prevent overpressurization of the system downstream of the first stage of the pressure regulator or regulators. If multiple regulators are used it may be necessary to provide additional PRVs.

4.1.2.5 Pipework

Pipework shall be installed, if possible on the chassis, in such a way that no damage from intrinsic vibrations occurs (e.g. resonance with engine vibration) and there are no friction points. The intervals between two attachment points shall not exceed 1 m, and pipework installation and bending shall be in accordance with the pipe and fitting manufacturer's specification.

4.2 Refuelling

4.2.1 General

The piping, receptacle and all valves and fittings installed on board the natural gas vehicle should be selected to minimize the pressure drop along the lines, and hence minimize the filling time of the CNG on-board fuel system.

4.2.2 Receptacle location

The receptacle should be installed in a suitable on-board location that is easy to reach, allowing safe operation. The preferred location is on the side of the vehicle.

Receptacles installed inside the engine compartment shall be attached to the vehicle chassis or body. They shall be installed sufficiently distant from the battery and high tension circuit to prevent the possibility of accidental ignition.

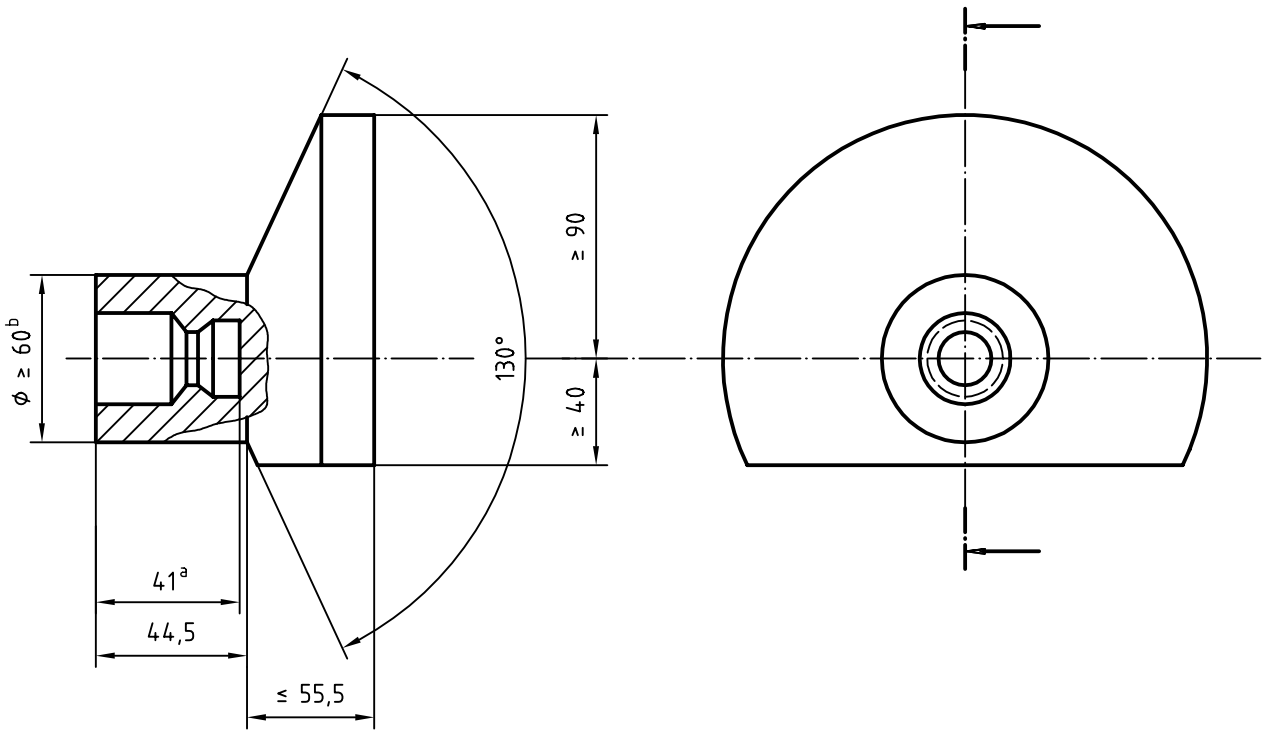
4.2.3 Receptacle mounting

The vehicle's CNG on-board fuel system shall be able to withstand a minimum of 670 N of loading on the receptacle in any direction without its gas tightness being affected (e.g. in the case of a refuelling hose breakaway).

4.2.4 Minimum receptacle clearance

The minimum receptacle clearance is shown in Figure 1.

Dimensions in millimetres



NOTE Depending on the vehicle design, the overall depth of the refuelling cavity need not be as large as is indicated here.

[a] Minimum length of the receptacle clear of provision for attachment of receptacle or protective cap.

[b] For minimum coupling clearance only. System designers should ensure that the dust- or pressure-tight cap operates freely in the provided space.

Figure 1 — Receptacle/nozzle interface envelope

4.3 Leakage control

4.3.1 Pressurized gas systems shall be designed so that they withstand, without leakage, the stresses that can be expected during operation.

After assembly, the vehicle's CNG on-board fuel system shall be tested for leakage.

4.3.2 The cylinder or parts of the gas system, or both, shall be mounted in a position which ensures that any leaking or venting gas from the fuel systems does not directly enter the driver or passenger compartment, boot or other spaces not sufficiently ventilated. Alternatively, it shall be ensured that any leaked gas will be directed safely to the atmosphere (see annex A).

4.3.3 Where a cylinder is located within the driver or passenger compartment or other insufficiently ventilated space, the valves, connections and pipework shall be enclosed in a gas-tight housing such that any gas leakage is vented and directed to the outside of the vehicle.

In case of fire, this requirement does not apply.

4.3.4 Any ventilation opening shall be positioned away from any openings into any vehicle compartment, away from any ignition source, and in a location where it is not susceptible to blockage.

4.3.5 Any enclosure containing a PRD shall be permeable to heat to allow the temperature of the PRD to rise to the temperature of the cylinder surroundings.

4.4 Mounting of the cylinder(s)

4.4.1 The cylinder or cylinders shall be securely attached to the vehicle to prevent slipping, rotating and dislodging. The installation shall be according to the cylinder manufacturer's instructions and ISO 11439.

4.4.2 Gas cylinder and attachments for mounting on the vehicle shall be constructed so that the mountings are not subject to failure by wear, corrosion (welding on cylinders is not permitted) or fatigue during the service life of the vehicle.

4.4.3 When tested in accordance with ISO 15501-2, the cylinder shall remain attached to the vehicle under the following accelerations, where g is the gravitational acceleration.

a) Road vehicle with a maximum authorized total mass (ISO M08), as defined in ISO 1176, of up to 3,5 t:
   - 20 g for the forward longitudinal acceleration;
   - 20 g for the backward longitudinal acceleration;
   - 8 g for the lateral acceleration in both directions;
   - 4,5 g for the upward vertical acceleration.

b) Road vehicle with a maximum authorized total mass (ISO M08), as defined in ISO 1176, of over 3,5 t:
   - 10 g for the forward longitudinal acceleration;
   - 10 g for the backward longitudinal acceleration;
   - 5 g for the lateral acceleration in both directions;
   - 4,5 g for the upward vertical acceleration.

4.5 Heat protection

Except for gas cylinders and appurtenances, which shall comply with 4.1.2.2, components shall be installed at least 100 mm from the exhaust system; otherwise heat shields shall be installed.

4.6 Minimizing risk of gas ignition

To prevent fire in a vehicle, the ignition sources shall be minimized.

Electric and electronic components in gas-tight housings shall be suitable for hazardous areas as defined in IEC 60079-10.

The location of electrical cables and mountings of CNG on-board fuel system components shall be designed to protect against the potential ignition of leaked gas.

4.7 Venting system

There is no best direction to release the gas through the PRD. The gas should be released in a dispersed manner. The dispersion method shall not restrict the venting capacity of any PRD.

5 Instructions for use

An instruction manual shall be provided including specific instructions regarding CNG operation and alerting the owner to the cylinder inspection or expiration date.

6 Marking

If other than the original equipment manufacturer (OEM), a label or plate identifying the installer of the CNG system with reference to this part of ISO 15501 shall be permanently attached to the vehicle.

Annex A
(informative)

Technical solutions to functional requirements

A.1 Prevention of hydrate and ice formation

As a guideline, in order to prevent hydrate and ice formation,

— the gas quality should be as specified in ISO 15403, and

— the high-pressure regulator should be heated.

A.2 Ventilation

Ventilation of the valves, connections and pipework may be achieved by either

a) placing the cylinder and its fittings in a durable enclosure sealed such that it is gas-tight to the compartment or space and provided with permanent ventilation, or

b) enclosing the neck of the cylinder and its fittings with a specially designed durable envelope that is gas-tight to the compartment and provided with permanent ventilation.

A.3 Control of gas escape in case of pipe fracture or rupture

There are three schools of thought in practice around the globe, covering actions that follow rupture of a CNG fuel system:

a) gas flow is completely shut off in each cylinder;

b) gas flow is limited by the use of a flow limiter;

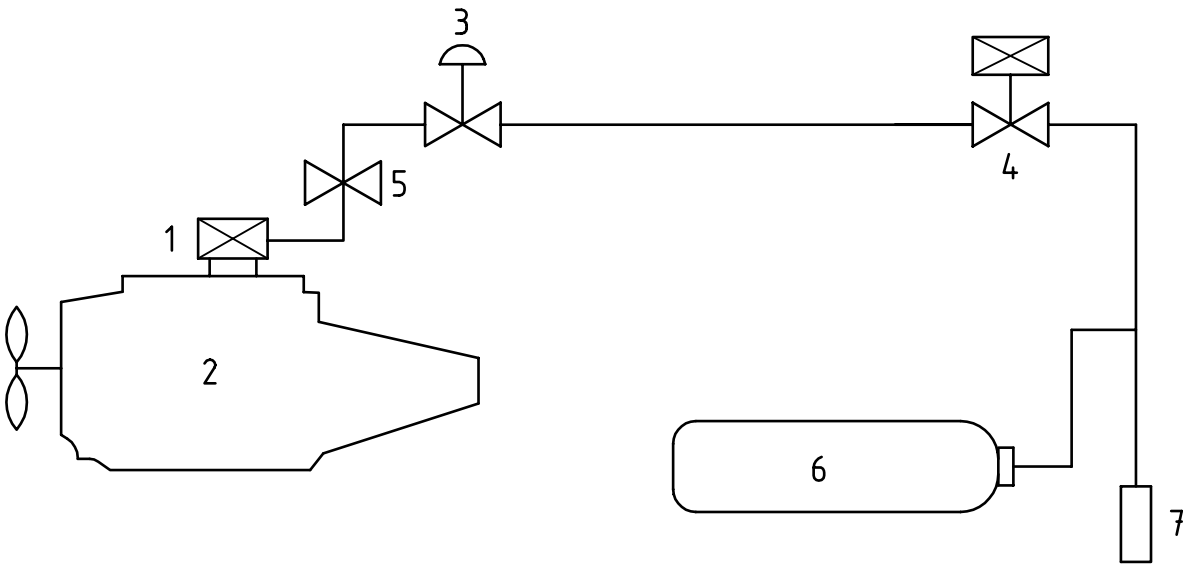
c) gas is allowed to escape without any restriction.

No method has been proven safer than another.

Annex B
(informative)

Compressed natural gas (CNG) on-board fuel systems

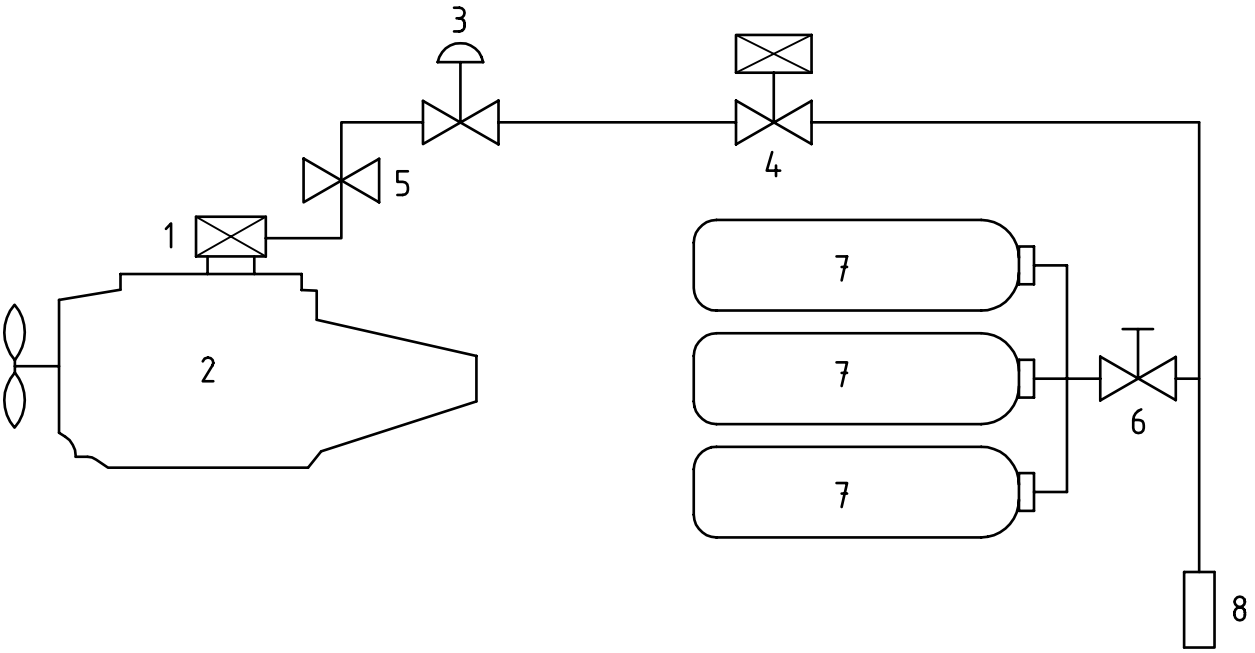
Examples of CNG on-board fuel systems are shown in Figure B.1 and Figure B.2.



Key

1 Gas/air mixer (or gas injector system)
2 Engine
3 Pressure regulator
4 Main shut-off valve
5 PRV (safety device to prevent overpressure)
6 Gas cylinder + cylinder valve + PRD
7 Refuelling receptacle

Figure B.1 — Single-cylinder system



Key

1 Gas/air mixer (or gas injection system)
2 Engine
3 Pressure regulator
4 Main shut-off valve
5 PRV (safety device to prevent overpressure)
6 Manual shut-off valve
7 Gas cylinder + cylinder valve + PRD
8 Refuelling receptacle

Figure B.2 — Multiple-cylinder system

ICS 43.060.40

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