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

Part 2: Test methods

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

Partie 2: Méthodes d'essai

Reference number
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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 15501-2 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*

Annex A of this part of ISO 15501 is for information only.

This corrected version of ISO 15501-2 incorporates a new Figure A.2 c).

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

Part 2:
Test methods

1 Scope

This part of ISO 15501 specifies the test methods for checking the minimum safety requirements specified in ISO 15501-1. It is applicable to the functionality of the fuel systems designed to operate on compressed natural gas of motor vehicles as defined in ISO 3833.

NOTE For tests of individual components, refer to the parts of ISO 15500.

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 898-1:1999, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*.

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

ISO 6487:2000, *Road vehicles — Measurement techniques in impact tests — Instrumentation*.

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

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

ISO 15501-1:2001, *Road vehicles — Compressed natural gas (CNG) fuel systems — Part 1: Safety requirements*.

3 Term and definition

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

3.1

notified body

government appointed body mandated to approve or disapprove

EXAMPLE Laboratories, universities and companies.

4 Test methods

4.1 Cylinder mounting strength tests

4.1.1 General

When a vehicle is equipped with several cylinders, they should preferably be tested as a unit.

When groups of cylinders are installed on a vehicle such that they are separately anchored to the original structure of the vehicle, then each separate group of cylinders may be tested individually.

When performing these tests, accessories and piping shall not contribute to reinforcing the cylinder mounting.

The requirements of ISO 15501-1:2001, 4.4.3, shall be verified by the test specified in 4.1.2, 4.1.3, 4.1.4 or 4.1.5 of this part of ISO 15501.

4.1.2 Inertia test

The cylinder or cylinders to be tested shall be mounted on the vehicle body or a part of the vehicle body, according to the specifications of the original equipment manufacturer (OEM) or after-market converter.

The vehicle body or part of the vehicle body shall be firmly anchored to the test trolley. The method used for anchoring the vehicle body to the test trolley shall not result in reinforcement of the cylinder anchorages or the part of the vehicle structure participating in anchoring the cylinder or cylinders. Testing performed with a trolley shall geometrically match original vehicle conditions.

The test shall be carried out using the following procedure.

a) Fill the cylinder or cylinders with a mass corresponding to at least 90 % of the mass of natural gas capacity at 20 MPa [200 bar][1)] and 15 °C. The gas density for these conditions shall be considered to be equal to 0,2 kg/l.

b) Measure the trolley deceleration with data channels of channel frequency class (CFC) 60 corresponding to the characteristics given in ISO 6487:2000.

c) Maintain the value of the deceleration as defined in ISO 15501-1:2001, 4.4.3, for at least 30 ms.

4.1.3 Static test

This test may be carried out on a vehicle body or on a part of a vehicle body.

The cylinder or cylinders to be tested shall be mounted on the vehicle body or on part of the vehicle body, according to OEM or after-market converter specifications.

The method used for anchoring the vehicle body or the part of the vehicle body in this test shall not:

— submit the anchorages and anchorage area (300 mm diameter circle) to abnormal stresses and/or deformation;

— result in reinforcement of the cylinder or cylinders or cylinder anchorages, or the part of the vehicle structure participating in anchoring the cylinder or cylinders.

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

The traction force is defined by the following formula:

$$F = (M_c + 0{,}9\,\rho V)a$$

where

F is the traction force, in newtons,

M_c is the mass of empty cylinder(s), in kilograms,

a is the acceleration as defined in ISO 15501-1:2001, 4.4.3,

V is the volume of the cylinder(s) in litres,

ρ is the density of CNG at 20 MPa (200 bar), 15 °C in kilograms per litre; it shall be considered equal to 0,2 kg/l.

The test shall be carried out using the following procedure.

a) Apply the traction force to the cylinder or cylinders' centre of gravity in the specified directions within 0,2 s.

b) Hold the specified traction force for at least 0,2 s.

c) Release the traction force.

4.1.4 Alternative method

If a vehicle crash test is performed according to international or equivalent regulations, the requirements of ISO 15501-1:2001, 4.4.3 are considered to have been met.

4.1.5 Acceptance criteria

4.1.5.1 By testing

At the conclusion of either of these tests, the cylinder or cylinders shall:

— remain attached to the vehicle body or part of the vehicle body;

— not interfere with the seat structure.

4.1.5.2 By calculation

Appropriate calculations shall be carried out, depending on the individual technical parameters. The method of calculation shall be approved by a notified body.

4.1.5.3 By engineering experience (steel cylinders)

For details of a practical means of compliance for steel cylinders (type 1 in accordance with ISO 11439:2000), determined as a result of calculations and substantiated by experience over time, see annex A.

4.2 Leak test

This test may be conducted at ambient temperature. It shall be performed on each vehicle after conversion.

a) Fill the vehicle fuelling system upstream of the first-stage regulator with an appropriate gas at 1 MPa (10 bar).

b) Check all components (valves, fittings) with a gas detector, foam-producing liquid or any other equivalent method. No leak shall be detected during five minutes.

Perform this test again with the system upstream of the first regulator at 20 MPa (200 bar).

If the cylinder and its valve have already been leak tested, the leak test shall be performed with the cylinder valve closed.

Stop the test if any leakage occurs during the filling from 1 MPa (10 bar) to 20 MPa (200 bar). Where a leak is detected, it shall be rectified by first relieving any pressure, then resealing. The system shall then be re-tested.

4.3 Functional test

4.3.1 Main shut-off valve test

The purpose of this test is to ensure that the main shut-off valve is in the closed position when

— the ignition key is off,

— the engine stalls,

— cranking on fuel other than CNG, or

— the engine is not running on CNG.

Any appropriate method may be used to ensure test results.

4.3.2 Receptacle clearance test

Ensure that free space around the receptacle conforms to ISO 15501-1:2001, 4.2.4.

4.4 Receptacle mounting tests

This test can be performed at ambient temperature either on a vehicle, or as a bench test using a CNG fuel system equivalent in geometry and anchoring to the vehicle. In either case, connect the nozzle to the receptacle and pressurize the CNG fuel system to service pressure.

The gas tightness of the CNG fuel system shall not be affected after

a) a 670 N pull is applied along the longitudinal axis of the receptacle, and

b) a moment of 200 N · m is applied in a worst case manner.

Following the above test, the gas tightness of CNG fuelling system shall be checked with an appropriate leak testing method.

Annex A
(informative)

Engineering experience for the mounting of steel cylinders

A.1 Single cylinder

a) There shall be at least four points of attachment to the vehicle structure, the distance between which shall be sufficient to ensure the stability of the cylinder.

b) Where the cylinder is anchored to sheet metal, the sheet metal shall be reinforced at each attachment point with metal plates of areas of no less than 3 600 mm^2 and a thickness of no less than 2,5 mm. Any such reinforcement plates shall be contoured to the shape of the sheet metal or chassis rail. It is preferred that a round washer be used, but where a square plate is fitted the corners shall be radiused to at least 0,5 mm and the bolt hole shall be positioned in the centre of the plate/washer. Where the bolt hole is not central in the plate, the nearest edge shall be bent to form an L-section for stiffening.

   Flat areas, even if ribbed, can be unsuitable for mountings without substantial reinforcement, because of flexing and fatigue. Anchoring should be to structural members where possible.

c) The mounting method shall not significantly weaken the vehicle structure.

d) Where anchorage bolts pass through a hollow section, a spacer tube shall be provided to prevent collapse of that section under load.

e) All fasteners shall have a diameter of no less than that shown in Table A.1 and shall comply with property class 8.8 in accordance with ISO 898-1:1999.

f) Where clamping bands are used, at least two steel bands shall be provided, the dimensions of which shall be no less than those shown in Table A.1. However, in the case of multiple cylinders mounted together, Table A.1 does not apply.

   To prevent the possibility of external corrosion where clamping bands are used, a non-moisture-retaining hard rubber or equivalent material shall be provided on the inner side of the bands. Similar protection shall be provided if the cylinder rests against other metal objects.

g) Where parts are joined (e.g. by welding a stud to a band), the strength of the joint shall be not less than the strength of either component.

h) Where the attachment is by means of clamping bands, there shall be a positive means of resisting longitudinal end loads on the cylinder due to the vehicle impact. The friction grip of the clamping bands is not normally an acceptable means of endwise retention unless the clamping bands can be demonstrated to meet the requirement of ISO 15501-1:2001, 4.4.3. An acceptable form of retention is to secure a 200 mm length of 50 × 50 structural steel angle to the vehicle at each end of the cylinder. Each length of steel angle shall be at right angles to the longitudinal axis of the cylinder with one leg vertical and fitted so as to provide a gap of 7 mm ± 3 mm to the end of the cylinder. The other leg of each angle shall be secured to the vehicle by at least two 10 mm diameter bolts. Where suitable body or structural members of the vehicle construction are available and these components are capable of withstanding the required loading, they may be used, provided the 7 mm ± 3 mm gap is maintained.

NOTE The attachment of a cylinder to the roof of the vehicle, and particularly to the gutters, is generally considered to be of inadequate strength, and unsatisfactory for a number of other reasons, and is specifically banned in some jurisdictions. Such installations require specific approval, which is usually given only for special vehicles, and take into account such aspects as vehicle speed, cylinder protection mounting strength, and vehicle handling characteristics.

A.2 Multiple cylinders

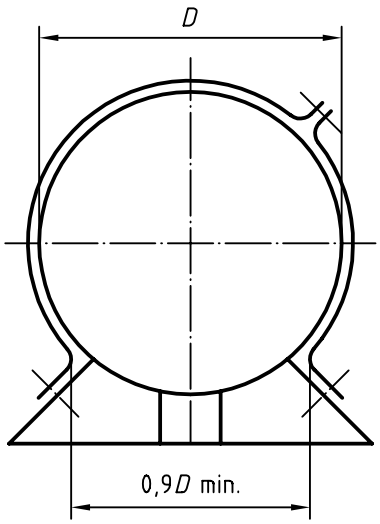
For installations with more than one cylinder, a specific design may be required for the mounting attachment.

Table A.1 — Dimensions of attachment

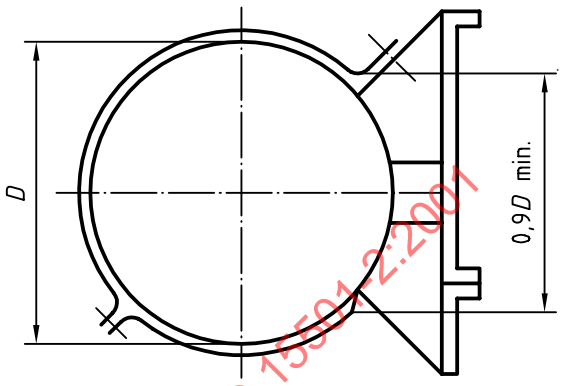
Cylinder capacity L		Band dimensions (minimum nominal size)	Bolt or stud diameter for band or flange mountings (minimum nominal size)
Over	Up to and including	mm	mm
0	100	30 × 3	10
100	150	50 × 6	12
150	—	Approved by a notified body	

A.3 Cylinder mountings

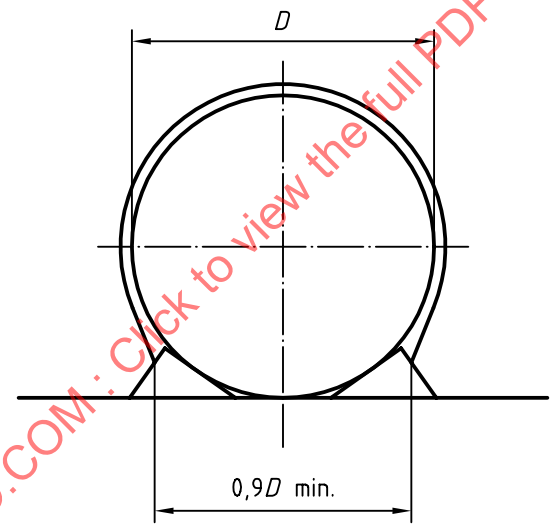
Figure A.1 shows examples of typical preferred arrangements, while Figure A.2 shows unacceptable arrangements.



a)



b)



c)

Figure A.1 — Typical preferred arrangements