INTERNATIONAL STANDARD

ISO 15500-9

Second edition
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Road vehicles — Compressed natural gas (CNG) fuel system components —

Part 9: Pressure regulator

Véhicules routiers — Composants des systèmes de combustible gaz naturel comprimé (GNC) —

Partie 9: Régulateur de pression

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15500-9 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 25, *Vehicles using gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 15500-9:2001), which has been technically revised.

ISO 15500 consists of the following parts, under the general title *Road vehicles — Compressed natural gas (CNG) fuel system components*:

— *Part 1: General requirements and definitions*

— *Part 2: Performance and general test methods*

— *Part 3: Check valve*

— *Part 4: Manual valve*

— *Part 5: Manual cylinder valve*

— *Part 6: Automatic valve*

— *Part 7: Gas injector*

— *Part 8: Pressure indicator*

— *Part 9: Pressure regulator*

— *Part 10: Gas-flow adjuster*

— *Part 11: Gas/air mixer*

— *Part 12: Pressure relief valve (PRV)*

— *Part 13: Pressure relief device (PRD)*

— *Part 14: Excess flow valve*

— *Part 15: Gas-tight housing and ventilation hose*

— *Part 16: Rigid fuel line in stainless steel*

— *Part 17: Flexible fuel line*

— *Part 18: Filter*

— *Part 19: Fittings*

— *Part 20: Rigid fuel line in material other than stainless steel*

Introduction

For the purposes of this part of ISO 15500, all fuel system components in contact with natural gas have been considered suitable for natural gas as defined in ISO 15403. However, it is recognized that miscellaneous components not specifically covered herein can be examined to meet the criteria of this part of ISO 15500 and tested according to the appropriate functional tests.

All references to pressure in this part of ISO 15500 are considered to be gauge pressures unless otherwise specified.

This part of ISO 15500 is based on a service pressure for natural gas used as fuel of 20 MPa [200 bar[1)]] settled at 15 °C. Other service pressures can be accommodated by adjusting the pressure by the appropriate factor (ratio). For example, a 25 MPa (250 bar) service pressure system will require pressures to be multiplied by 1,25.

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

Road vehicles — Compressed natural gas (CNG) fuel system components —

Part 9:
Pressure regulator

1 Scope

This part of ISO 15500 specifies tests and requirements for the pressure regulator, a compressed natural gas (CNG) fuel system component intended for use on the types of motor vehicles defined in ISO 3833.

This part of ISO 15500 is applicable to vehicles (mono-fuel, bi-fuel or dual-fuel applications) using natural gas in accordance with ISO 15403.

It is not applicable to the following:

a) liquefied natural gas (LNG) fuel system components located upstream of, and including, the vaporizer;

b) fuel containers;

c) stationary gas engines;

d) container-mounting hardware;

e) electronic fuel management;

f) refuelling receptacles.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15500-1, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 1: General requirements and definitions*

ISO 15500-2, *Road vehicles — Compressed natural gas (CNG) fuel system components — Part 2: Performance and general test methods*

3 Terms and definitions

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

3.1
lock-up pressure
stabilized outlet pressure of the regulator at 0 (zero) flow

4 Marking

Marking of the component shall provide sufficient information to allow the following to be traced:

a) the manufacturer's or agent's name, trademark or symbol;

b) the model designation (part number);

c) the working pressure or working pressure and temperature range;

d) the maximum outlet pressure.

The following additional markings are recommended:

— the direction of flow (when necessary for correct installation);

— the type of fuel;

— electrical ratings (if applicable);

— the symbol of the certification agency;

— the type approval number;

— the serial number or date code;

— reference to this part of ISO 15500.

NOTE This information can be provided by a suitable identification code on at least one part of the component when it consists of more than one part.

5 Construction and assembly

The pressure regulator shall comply with the applicable provisions of ISO 15500-1 and ISO 15500-2, and with the tests specified in Clause 6 of this part of ISO 15500.

The components downstream of the pressure regulator shall be protected from exposure to full upstream pressure. The pressure relief valve used for this purpose shall reset after relieving.

A pressure relief valve may be integral to the pressure regulator.

The pressure regulator shall have a factory-set maximum outlet pressure. The maximum outlet pressure rating and the inlet working pressure rating shall be marked on the regulator.

6 Tests

6.1 Applicability

The tests required to be carried out are indicated in Table 1.

Table 1 — Applicable tests

Test	Applicable	Test procedure as required by ISO 15500-2	Specific test requirements of this part of ISO 15500
Hydrostatic strength	X	X	X (see 6.2)
Leakage (external)	X	X	X (see 6.3)
Excess torque resistance	X	X	
Bending moment	X	X	
Continued operation	X	X	X (see 6.4)
Corrosion resistance	X	X	
Oxygen ageing	X	X	
Electrical over-voltages	X	X	
Non-metallic material immersion	X	X	
Vibration resistance	X	X	
Brass material compatibility	X	X	
Insulation resistance	X		X (see 6.5)
Minimum opening voltage	X		X (see 6.6)
Pressure impulse	X		X (see 6.7)
Water jacket freezing	X		X (see 6.8)

6.2 Hydrostatic strength

6.2.1 Test the pressure regulator according to the procedure for testing hydrostatic strength specified in ISO 15500-2.

6.2.2 Test the inlet of the first stage at a pressure of 2,5 times the working pressure.

6.2.3 The chambers downstream of the inlet valve to the pressure regulator shall be tested according to the following procedure.

With the inlet to the chamber in the open position and all the outlets plugged:

— if the chamber has a pressure relief valve, the chamber shall be tested at 2,5 times the relief valve's set pressure, with the relief valve removed and the opening plugged;

— if there is no relief valve, test the chamber to upstream working pressure.

6.2.4 Test the outlet chamber, port and all outlet fittings at 2,5 times the working pressure, or 0,4 MPa (4 bar), whichever is greater.

6.3 External leakage

Test the pressure regulator at the temperatures and pressures given in Table 2.

Table 2 — Test temperatures and pressures

Temperature °C	**Stage**	**Pressure** MPa [bar] (Factor × working pressure)	
		First test	Second Test
−40 or −20	Inlet to 1	1	0,025
20	Inlet to 1	0,025	1,5
120	Inlet to 1	0,05	
−40 or −20	Chambers downstream of inlet to 1	1	0,025
20		0,025	1,5
120		0,05	

6.4 Continued operation

The pressure regulator shall be able to withstand 50 000 cycles without any failure when tested according to the following procedure. Where the stages of pressure regulation are separate, the working pressure in a) to f) is considered to be the working pressure of the upstream stage.

a) Recycle the regulator for 95 % of the total number of cycles at room temperature and at the working pressure. Each cycle shall consist of flow until stable outlet pressure has been obtained, after which the gas flow shall be shut off by a downstream valve within 1 s, until the downstream lock-up pressure has stabilized. Stabilized outlet pressures are defined as set pressure ±15 % for at least 5 s. The regulator shall comply with 6.3 at room temperature at intervals of 20 %, 40 %, 60 %, 80 % and 100 % of room temperature cycles.

b) Cycle the inlet pressure of the regulator for 1 % of the total number of cycles at room temperature from 100 % to 50 % of the working pressure. The duration of each cycle shall be no less than 10 s. The regulator shall comply with 6.3 at room temperature at the completion of this test.

c) Repeat the cycling procedure of a) at 120 °C at the working pressure for 1 % of the total number of cycles.

d) Repeat the cycling procedure of b) at 120 °C at the working pressure for 1 % of the total number of cycles. The regulator shall comply with 6.3 at 120 °C at the completion of this test.

e) Repeat the cycling procedure of a) at −40 °C or −20 °C, as applicable and 50 % of working pressure for 1 % of the total number of cycles.

f) Repeat the cycling procedure of b) at −40 °C or −20 °C, as applicable and 50 % of working pressure for 1 % of the total number of cycles. The regulator shall comply with 6.3 at −40 °C or −20 °C, as applicable at the completion of this test.

g) At the completion of the cycles, the lock-up pressure downstream of the regulator shall not exceed the lock-up pressure specified by the manufacturer.

Leakage tests mentioned in a) through e) above are optional but the leakage test after f) is mandatory.

6.5 Insulation resistance

The insulation resistance test is designed to check for a potential failure of the insulation between the two-pin coil assembly and the pressure regulator casing.

Apply DC 1 000 V between one of the connector pins and the housing of the pressure regulator for at least 2 s. The minimum allowable resistance shall be 240 kΩ.

6.6 Minimum opening voltage

The minimum opening voltage at room temperature shall be ≤ 8 V for a 12 V system and ≤ 16 V for a 24 V system. The component shall be pressurized at 0,75 times working pressure during the test.

6.7 Pressure impulse

6.7.1 Internal impulse

Conduct the following steps for the internal impulse test:

a) Subject the pressure regulator with its first stage valve locked in the open position to a sudden application of its working pressure at its inlet. The pressure regulator shall retain or release the pressure without any permanent deformation.

b) The lock-up pressure downstream of the regulator shall not exceed the lock-up pressure specified by the manufacturer.

This test was included in order to evaluate the performance of the components that may suffer from the effects of an instantaneous increase in pressure. In normal service, this may happen for example, when filling gas in an empty system or when a solenoid valve opens the flow of gas to an empty fuel line. Previous tests have revealed that certain designs cannot cope with these instantaneous pulses and the components tend to bend or jam.

6.7.2 External impulse

The pressure regulator shall withstand 100 inlet pressure pulses, as follows.

a) If the regulator has an integrated solenoid valve, it shall be opened by application of the rated voltage.

b) The outlet of the regulator shall be vented until the inlet fuel line is at atmospheric pressure and then closed.

c) Working pressure shall be instantaneously applied to the regulator inlet.

The pressure regulator shall contain or vent the pressure without any permanent deformation. The pressure regulator shall meet the requirements of the external leakage in accordance with 6.3, and the lock-up pressure shall not exceed the manufacturer's rated lock-up pressure.

The internal impulse test in 6.7.1 tests the reaction of the regulator under a pressure pulse that enters into the first stage chamber, for example if the pressure regulator has no gas in it, the inlet valve is open and the cylinder valve opens instantaneously or the system is connected to a filling dispenser. The external impulse test in this subclause tests the resistance of the inlet valve to pulses on the high pressure side, for example, a pressure regulator with normal working pressure inside but with no pressure in the fuel line and there is a sudden opening of the cylinder valve filled with service pressure.

6.8 Water jacket freezing

Conduct the following steps for the water jacket freezing test:

a) Attach 1 m sections of coolant hose to the coolant inlet and outlet of the regulator or water jacket. Fill the regulator or water jacket, which normally contains an antifreeze solution, with water, to normal capacity and expose it at −40 °C ± 2 °C or −20 °C ± 2 °C, as applicable, for 24 h.

b) Following the freezing conditioning, and after exposing the assembly to 20 °C ± 2 °C for a minimum of 24 h, conduct an external leakage test at room temperature according to 6.3.

A separate sample may be used for this test.