INTERNATIONAL STANDARD

ISO 15500-13

First edition
2001-04-15

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

Part 13: Pressure relief device (PRD)

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

Partie 13: Dispositifs de limitation de pression

Reference number
ISO 15500-13:2001(E)

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Printed in Switzerland

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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 15500 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15500-13 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 25, *Road vehicles using natural gas*.

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*

— *Part 17: Flexible fuel line*

— *Part 18: Filter*

— *Part 19: Fittings*

Annex A forms a normative part of this part of ISO 15500. Annex B is for information only.

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

Part 13: Pressure relief device (PRD)

1 Scope

This part of ISO 15500 specifies tests and requirements for the pressure relief device (PRD), a compressed natural gas 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 using natural gas in accordance with ISO 15403 (mono-fuel, bi-fuel or dual-fuel applications). 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.

NOTE 1 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.

NOTE 2 All references to pressure in this part of ISO 15500 are to be considered gauge pressures unless otherwise specified.

NOTE 3 This part of ISO 15500 is based upon a service pressure for natural gas as a 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.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15500. 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 15500 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.

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

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

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

3.1
combination relief device
PRD activated by a combination of high temperature and pressure acting together

3.2
fusible material
metal, alloy, or other material capable of being melted

3.3
rupture disc
operating part of a PRD which, when installed in the device, is designed to burst at a pre-determined pressure to permit discharge of the cylinder

3.4
thermally activated relief device
PRD activated by high temperature and generally containing fusible material

3.5
yield temperature
temperature at which the fusible material becomes sufficiently soft to activate the device and to permit discharge of the cylinder

4 Marking

If a stand-alone component, marking shall provide sufficient information to allow the following to be traced:

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

b) the fusible material yield temperature or PRD activation temperature (see annex A), and the rupture disc pressure rating, as appropriate.

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

5.1 The PRD 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.

5.2 The PRD shall be suitable for the cylinder type and size used. The CNG cylinder and PRD system shall have been tested according to ISO 11439 to ensure suitability.

6 Tests

6.1 Applicability

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

Table 1 — Tests applicable

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	X	X	X (see 6.3)
Excess torque resistance	X	X	
Bending moment	X[a]	X	X (see 6.4)
Continued operation	X	X	X (see 6.5)
Corrosion resistance	X	X	
Oxygen ageing	X	X	
Electrical overvoltages			
Non-metallic synthetic immersion	X	X	
Vibration resistance	X	X	
Brass material compatibility	X	X	
Accelerated life	X		X (see 6.6)
Benchtop activation	X		X (see 6.7)
Thermal cycling	X		X (see 6.8)
Condensate corrosion resistance	X		X (see 6.9)
Flow capacity	X		X (see 6.10)

[a] This test is to confirm proper design and construction of stand-alone, externally threaded PRD designs and is not required if the PRD is internally imbedded in the valve body.

6.2 Hydrostatic strength

6.2.1 Housing

The manufacturer shall either physically test the housing or prove its strength by calculation. The test shall be performed according to the procedure given in ISO 15500-2 using a pressure of 80 MPa (800 bar) at 20 °C ± 5 °C.

6.2.2 Fusible material

6.2.2.1 Test procedure

Test the fusible material in the PRD with water at 30 MPa (300 bar) and 20 °C ± 5 °C for 30 min using the following procedure.

a) Randomly select three test specimens. For combination relief devices, the burst disc shall not be removed. During the test, the fusible material shall not begin to extrude out of the PRD.

b) Increase the pressure at a rate of 0,5 MPa/s (5 bar/s) to 60 MPa (600 bar), or to the pressure at which the fusible material starts to extrude.

6.2.2.2 Requirement

If the extrusion of the fusible material begins at less than 45 MPa (450 bar), the device is considered to have failed the test.

6.3 Leakage

Follow the procedure for testing leakage given in ISO 15500-2, using the test temperatures and pressures given in Table 2, below. The PRD shall be either bubble-free or have a leakage rate < 2 cm^3/h (normal conditions).

Table 2 — Test temperatures and pressures

Temperature °C	**Pressure** MPa [bar]
– 40	15 [150]
82	26 [260]

6.4 Bending moment

The purpose of this test is to confirm proper design and construction of stand-alone, externally threaded PRD designs. Test the PRD using the corresponding procedure given in ISO 15500-2.

6.5 Continued operation

6.5.1 Test procedure

a) Randomly select five test specimens.

b) Cycle the PRD according to Table 3, with water at between 10 % and 130 % of the service pressure, at a maximum cyclic rate of 10 cycles per minute and a temperature of 82 °C ± 2 °C.

Table 3 — Test temperatures and cycles

Temperature °C	**Cycles**
82	2 000
57	18 000

6.5.2 Requirements

6.5.2.1 Following the test there shall be no extrusion of the fusible material from the PRD.

6.5.2.2 At the completion of the test, the PRD shall comply with the requirements of 6.3 and 6.7.

6.6 Accelerated Life

6.6.1 General

Fusible materials can creep and flow within the operating temperature range of natural gas vehicle PRDs. Accelerated life testing is performed to verify that the rate of creep is sufficiently low so that the device can perform reliably for at least one year at 82 °C and for at least 20 years at 57 °C. Accelerated life testing shall be performed on new PRD designs or designs in which the fusible material melt temperature or device activation mechanism is modified. For devices not using activation materials that can creep, testing and analysis shall be performed to verify that the device will perform reliably for at least one year at 82 °C and at least 20 years at 57 °C.

6.6.2 Test procedure

a) Place the test specimens in an oven or liquid bath, holding the specimens' temperature to within ± 1 °C throughout the test.

b) Elevate the pressure on the PRD inlet to 130 % of the service pressure and hold this constant to within ± 0,7 MPa (7 bar) until activation. The pressure supply may be located outside the controlled temperature oven or bath. Limit the volume of liquid or gas to prevent damage to the test apparatus upon activation and venting. Each device may be pressurized individually or through a manifold system. If a manifold system is used, each pressure connection shall include a check valve to prevent pressure depletion of the system if one specimen fails.

6.6.3 Long-term temperature

It is assumed that the time-to-activation, t, of fusible alloys is a rate process governed by the power-law relationship of the formula:

$$t = A \cdot T^{B}$$

where

T is temperature, and

A, B are constants dependent upon the fusible alloy and PRD design.

The calculated time-to-activation for the PRD shall be greater than one year at 82 °C and at least 20 years at 57 °C, and shall exceed 500 hours, long-term test temperature.

Mathematical manipulation results in the following requirement for long-term test temperature:

$$T_{\mathrm{L}} = T(0{,}057)^{0{,}34[\log(T/T_{\mathrm{f}})]}$$

where

T_{L} is the long-term test temperature, in degrees Celsius;

T_{f} is the fusible material yield temperature, in degrees Celsius;

T = 82 °C;

log is base 10.

6.6.4 Requirements

6.6.4.1 Three PRDs shall be tested at the fusible material yield temperature to verify that they activate in less than 10 h.

6.6.4.2 Five PRDs shall be tested at their long-term test temperature. The time-to-activation for long-term test devices shall exceed 500 h.

6.7 Benchtop activation

6.7.1 General

6.7.1.1 The purpose of this test is to demonstrate that a PRD will activate consistently throughout its life.

6.7.1.2 Test two PRDs without subjecting them to other tests in order to establish a baseline time for activation. PRDs subjected to the tests of 6.5 and 6.9 shall activate within the time limits defined in 6.7.2 or 6.7.3, as applicable.

6.7.1.3 Test thermally activated relief devices in accordance with 6.7.2. Combination relief devices, activated by a combination of high pressures and temperatures acting together, shall be tested in accordance with 6.7.3.

6.7.2 Thermally activated relief devices

6.7.2.1 Test setup

The test setup shall consist of either an oven or chimney capable of maintaining a gas temperature at 600 °C ± 10 °C in the area of the oven or chimney into which the PRD is inserted for testing. The PRD shall not be exposed directly to flame.

6.7.2.2 Test procedure

a) Pressurize the PRD to 25 % of service pressure. The temperature shall remain within the acceptable range for 2 min prior to running the test.

b) Insert the PRD in the oven or chimney and record the time-to-activation, t.

6.7.2.3 Requirements

The PRDs subjected to the tests of 6.5, 6.8, 6.9, and the corrosion resistance and vibration resistance tests of ISO 15500-2, shall activate to meet the following requirements where t, in minutes, is the time-to-activation of the PRDs not subjected to those tests:

$\leqslant 5 \cdot t$

$\leqslant t + 4$ min

6.7.3 Combination relief devices

6.7.3.1 Test procedure

a) Place the PRD in an oven heated to a temperature 10 °C above the yield temperature of the fusible material.

b) Activate the PRD by pressurizing until the rupture disc bursts.

6.7.3.2 Requirement

The PRD subjected to the tests of 6.5, 6.8, 6.9, and the corrosion resistance and vibration resistance tests of ISO 15500-2, shall activate at a pressure > 75 % and < 105 % of the activation pressure of a PRD not subjected to any previous testing.

6.8 Thermal cycling

6.8.1 Test procedure

Thermally cycle the PRD between – 40 °C and 82 °C, as follows.

a) Place a depressurized PRD in a fluid bath maintained at – 40 °C or lower for a period of 2 h or more. Then transfer the device to a fluid bath maintained at 82 °C or higher within 5 min.

b) Leave the depressurized PRD in the fluid bath maintained at 82 °C or higher for a period of 2 h or more. Then transfer the device to the fluid bath maintained at – 40 °C or lower within 5 min.

c) Repeat steps a) and b) until a total of 15 thermal cycles have been achieved.

d) With the PRD conditioned for a period of 2 h or more in the – 40 °C fluid bath, cycle the PRD between no more than 10 % and no less than 100 % of the service pressure for a total of 100 cycles.

6.8.2 Requirement

At the completion of the test, the PRD shall meet all the requirements of 6.3 and 6.7.

6.9 Condensate corrosion resistance

6.9.1 Test procedure

a) Seal the outlet port of the PRD.

b) Fill the PRD with the test solution given in 6.9.2 and soak the device for 100 h at 21 °C.

c) Empty the solution from the PRD and reseal the outlet port, then heat the device for an additional 100 h at 82 °C.

At the end of this test, the PRD shall meet all the requirements of 6.3 and 6.7.

6.9.2 Test solution

The test solution, by volume percentage, consists of

— 84,8 % Stoddard solvent,

— 10,0 % benzene,

— 2,5 % fryquel no. 15 or no. 20 compressor oil,

— 1,5 % water,

— 1,0 % methanol, and

— 0,2 % mercaptan.

6.10 Flow capacity

6.10.1 General

6.10.1.1 Three random samples of the PRD shall be tested for flow capacity. Each device tested shall be caused to operate by temperature or a combination of temperature and pressure.

6.10.1.2 After activation, and without cleaning, removal of parts or reconditioning, each PRD shall be subjected to an actual flow test wherein the amount of air released by the device is measured. The rated flow capacity of the device shall be the average flow capacity of the three samples, provided the individual flow capacities fall within 10 % of the highest flow capacity recorded.

6.10.2 Test procedure

a) Conduct flow testing with air at 0,8 MPa (8 bar) to 0,9 MPa (9 bar).

b) Measure the temperature.

c) Correct the calculation of flow rate to 0,7 MPa (7 bar) absolute and 15 °C.

The PRD shall be tested to establish its flow capacity in m^3/h (normal conditions) of natural gas flow with an accuracy of ± 10%. One acceptable method is to measure the temperature and pressure of a known volume of compressed air or gas, both before and after conducting a flow test, and measure the time during flow.

7 Production batch inspection and acceptance testing

The PRD manufacturer shall institute a production batch inspection and acceptance testing program that ensures consistent safety performance of the product.

EXAMPLE ANSI/IAS PRD1.