

Draft Indian Standard

ROAD VEHICLES – COMPRESSED NATURAL GAS (CNG) FUEL SYSTEM COMPONENTS – PERFORMANCE AND GENERAL TEST METHODS

Foreword:

To be added by BIS

1.0 SCOPE:

1.1 This standard specifies performance and general test methods for Compressed Natural Gas (CNG) onboard fuel system components, intended for use on the motor vehicles defined in IS 14272 (Part 1), two wheelers and construction equipment vehicles (CEV).

1.1.1 This standard is applicable to CNG fuel system components intended to use on vehicles using compressed natural gas in accordance with IS 15320 (mono-fuel or bi-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; and
- d) CNG fuel systems components for the propulsion of marine craft.

1.1.2 This standard is based upon a service pressure for compressed natural gas as a fuel at 20 MPa (200 bar) settled at 15°C. Other service pressures could 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. All references to pressure are to be considered gauge pressures unless otherwise specified.

2.0 REFERENCES:

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

IS No.	Title
3400	Methods of test for vulcanized rubbers;
Part 4: 1987	Accelerated ageing (second revision)
Part 6): 2005 / ISO 1817:1999	Rubbers, vulcanized – Determination of the effect of liquids (second revision)
9844 :1981	Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by neutral salt spray test.
14272 (Part 1):1995	Automotive Vehicles – Types – Terminology : Part I Three and four wheelers
15320 :2003 / ISO 15403 : 2000	Natural Gas - Designation of the quality of natural for use as a compressed fuel for vehicles
15710 :2006	Road vehicles - compressed natural gas (CNG) fuel system components – General requirements and definitions

3 TERMS AND DEFINITIONS:

For the purpose of this standard, the terms and definitions as given in IS 15710 shall apply.

4. GENERAL:

4.1 Components shall comply with the tests specified in their relevant specifications, as well as the applicable tests specified in this standard. Because of the peculiarities of some components, the list of tests given in this standard (see Clause 5 to 18) is not exhaustive. Where additional tests are required, their provisions are given in another, relevant standard.

4.2 Unless otherwise specified, all tests shall be conducted using dry air or nitrogen. Test shall be performed by qualified personnel and appropriate safety measures shall be taken'. The dew point of the test gas at the test pressure shall be at the temperature at which there is no icing, or hydrate or liquid formation.

Unless otherwise specified, all pressure shall have a maximum tolerance of $\pm 5\%$.

Unless otherwise specified, all temperature shall have a maximum tolerance of $\pm 5\%$.

Unless otherwise specified, all dimension shall have a maximum tolerance of $\pm 5\%$.

5 HYDROSTATIC STRENGTH:

A component shall not rupture when subjected to the following test procedure: Plug the outlet opening of the component and have the valve seats or internal blocks assume the open position. Apply, with a test fluid, the hydrostatic pressure specified in their relevant specification to the inlet of the component for a period of at least 3 min. The hydrostatic pressure shall then be increased at a rate of less than or equal to 1.4 Mpa/s until component failure. The hydrostatic pressure at failure shall be recorded. The failure pressure of previously tested components shall be no less than 80% of the failure pressure of the virgin component.

The samples used in this test shall not be used for any other testing.

6 Leakage:

6.1 General

6.1.1 Prior to conditioning, purge the component or device with nitrogen and then seal it to about at 30 percent of working pressure using nitrogen, dry air or natural gas.

6.1.2 Conduct all tests while the device is continuously exposed to the specified test temperatures. The device shall either be bubble-free or have a leakage rate less than 20 N cm³ /h (normal) using following test method. If components are subjected to more than one working pressure, the test may be conducted in subsequent steps.

6.2 External leakage:

6.2.1 Plug each device outlet with the appropriate mating connection and apply the test pressure to the inlet.

6.2.2 Apply pressurized air, nitrogen, or natural gas to the inlet of the test device.

6.2.3 At all test temperatures, immerse the components in a suitable test medium for 2 min tolerance to time '0□□30 □s' or use a helium vacuum test (global accumulation method)

or other equivalent method.

6.2.4 If there are no bubbles for the specified time period, the sample passes the test. If bubbles are detected measure the leakage rate using an appropriate method. The leakage rate should not be more than that specified in 6.1.2.

6.3 Internal Leakage:

6.3.1 The internal leakage test is applicable only to devices having a closed position. The aim of this test is to check the pressure tightness of the closed system.

6.3.2 Connect the inlet or outlet (as applicable) of the device, with the appropriate mating connection, while leaving the opposite connection or connections open.

6.3.3 Apply the test pressure to the inlet or outlet (as applicable) of the device using air, nitrogen or natural gas as the test fluid.

6.3.4 At all applicable test temperatures mentioned in 6.4, immerse the component in a suitable test medium for 2 min □0□□30 □s or used any other equivalent method.

6.3.5 If there are no bubbles for the specified time period, the sample passes the test. If bubbles are detected, measure the leakage rate using an appropriate method; the leakage rate should not be more than that specified in Clause 6.1.2.

6.4 Test conditions

6.4.1 The device shall be conditioned at a low temperature of $-20\text{ }^{\circ}\text{C}$ ($+0^{\circ}\text{C}$ -5°C), as applicable, and pressurized at 75 percent and 2.5 percent of the working pressure.

6.4.2 The device shall be conditioned at a room temperature of $27^{\circ} \pm 5^{\circ}\text{C}$ and pressurized at 2.5 percent and 150 percent of the working pressure.

6.4.3 The device shall be conditioned at a high temperature of $85\text{ }^{\circ}\text{C}$ (-0°C $+5^{\circ}\text{C}$) or $120\text{ }^{\circ}\text{C}$ (-0°C $+5^{\circ}\text{C}$), as applicable, and Pressurized at 5 percent and 150 percent of the working pressure.

7 EXCESS TORQUE RESISTANCE:

A component designed to be connected directly to threaded fittings shall be capable of withstanding, without deformation, breakage or leakage, a torque effort of 150 percent of the rated installation value, accordance with 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 not less than 15 min, release it, then remove the component and examine it for deformation and breakage.
- c) Subject the component to the leakage test specified in Clause 6.
- d) Subject the component to the hydrostatic strength test specified in Clause 5.

8 BENDING MOMENT:

A component shall be capable of operation without cracking, breaking, or leaking when tested according to the following procedure.

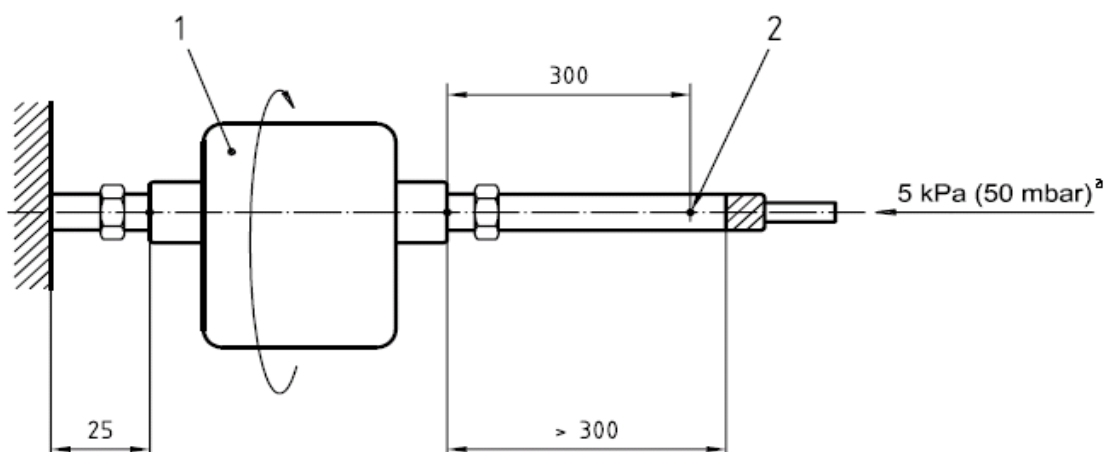
- a) Assemble the connections of the component, ensuring that they are leak-tight, to one or several appropriate mating connection(s) representative of the design. After assembly, the length of the inlet tubing shall be greater than 300 mm (see Figure 1).
- b) The outlet connection shall be rigidly supported at a distance of 25 mm from the component outlet, except in the following cases:
 - 1) if the component has an integral mounting means independent of the inlet and outlet connections, the component shall be mounted using the integral mounting means specified by the manufacturer;
 - 2) if the component is intended to be mounted by either the integral mounting means or the component outlet, the mounting means that produces the most severe test condition shall be used.
- c) Check this assembly for leaks prior to subjecting it to d).
- d) With the component in the closed position, pressurize the system to 5kPa (50 mbar) and apply a force in accordance to Table 1, 300 mm from the inlet, maintaining it for 15 min. Without removing the force, check the component for leakage in accordance with the test method given in clause 6, at room temperature.

NOTE: Depending on how this test is performed, raising the load to compensate buoyancy could be necessary.

- e) Conduct procedure (d) four times, rotating the component 90° around the horizontal axis between each test. Between tests, open and close (if applicable) the component three times with the bending moment removed.
- f) At the completion of the above tests, remove the component and examine it for deformation; then subject it to the leakage test according to Clause 6 and the hydrostatic strength test specified in Clause 5.

Outside diameter of tubing	Force N
6	3,4
8	9,0
≥ 12	17,0

Table 1 – Bending moment test force



Key

- 1 Component
- 2 Force point
- a 4 x 90° rotation.

Figure 1 — Bending moment

9 Continued operation

9.1 General

For details on test methods pertaining to particular components, see the respective parts of ISO 15500. The method specified in this clause is general in nature and also applies to miscellaneous components.

Other components (those for which specific requirements are not specified) shall be subjected to the following continuous operation test for a total number of cycles to be determined by the testing agency. The determination of the total number of cycles shall be based on 15 000 fill cycles and/or 50 000 duty cycles.

9.2 Test methods

9.2.1 Test procedure

The component shall be installed as indicated and cycled using dry air, nitrogen or natural gas, under all the appropriate loads.

Connect the component securely, using a suitable fitting, to a pressurized source of dry air, nitrogen or natural gas, and subject it to the number of cycles specified in ISO 15500-3 or parts corresponding to specific component, as applicable. A cycle shall consist of one full operation and reset within an appropriate period as determined by the testing agency.

On completion of the cycling, the component shall be subjected to the hydrostatic strength test, as specified in Clause 5.

During the off-cycle, the downstream pressure of the test fixture shall be lowered to a maximum of 50 percent of the test pressure.

Unless otherwise specified, the test pressure shall be 100 percent of the working pressure.

Unless otherwise specified, the conditions of 9.2.2, 9.2.3 and 9.2.4 shall apply.

9.2.2 Room temperature cycling

Operate the component through 96 percent of the total cycles at room temperature and at working pressure. On completion of the room temperature cycles, the component shall comply with the requirements of Clause 6.

This test may be interrupted, if desired, at 20 percent intervals for leakage testing.

9.2.3 High-temperature cycling

Operate the component through 2 percent of the total cycles at the appropriate maximum temperature specified in 4.4 of IS 15710 at working pressure. On completion of the high-temperature cycles, the component shall comply with the requirements of Clause 6 at the appropriate maximum temperature.

9.2.4 Low-temperature cycling

Operate the component through 2 percent of the total cycles at the appropriate minimum temperature specified in 4.4 of IS 15710 at 100 percent of the working pressure up to a maximum of 20 MPa. On completion of the low-temperature cycles, the component shall comply with the requirements of Clause 6 at the appropriate minimum temperature.

Immediately following the continued operation tests and leakage testing, perform the hydrostatic strength test in accordance with Clause 5.

10 CORROSION RESISTANCE:

10.1 All components shall perform safely and in compliance with 6 following exposure to salt spray according to the following test method. AISI series 300 austenitic stainless steels, or equivalent austenitic stainless steels, are exempted from corrosion resistance testing.

10.2 With the component supported in its normal installed position, expose it for 144 h to a salt spray (fog) test, as specified in IS 9844. If the component is expected to operate, unprotected, in vehicle underbody service conditions, then it shall be exposed for 500 h to the salt spray (fog) test.

10.3 Maintain the temperature within the fog chamber between 33 °C and 36 °C.

10.4 The saline solution shall consist of 5 percent sodium chloride and 95 percent distilled water, by weight.

10.5 Immediately following the corrosion test, rinse the sample and gently clean it of salt deposits; then subject it to the according to 6.

10.6 Immediately following the corrosion resistance test and leakage test, subject the sample to the hydrostatic strength test according to Clause 5.

11 OXYGEN AGEING:

All synthetic or non-metallic parts of components that provide a fuel-containing seal for which a satisfactory declaration of properties is not submitted by the applicant shall not crack or show visible evidence of deterioration after oxygen ageing when tested according to the following procedure.

Subject representative samples to 96 h of exposure to oxygen at a temperature of 70 ± 5 °C at 2 MPa (20 bar), in accordance with IS 3400(part 4).

12 ELECTRICAL OVER-VOLTAGES:

All electrical components or devices containing electrical subcomponents shall withstand the application of 1,5 times the rated voltage ± 5 percent for periods of 3 min without failure. Failure to open is not considered an unsafe condition.

13 NON-METALLIC SYNTHETIC IMMERSION:

13.1 Non-metallic synthetic material used in a component shall be subjected by the test agency to the tests described in 13.2 and 13.3, except where the applicant submits declaration of results of tests carried out on the material provided by the manufacturer.

13.2 A part made of Non-metallic synthetic material' in contact with natural gas shall not show excessive change in volume or weight when tested accordance with the following procedure.

a) Prepare, measure and weigh one or more representative samples of each non-metallic material used in a component, then immerse the sample or samples at room temperature in natural gas, at a pressure equal to its working pressure, but not less than 100 kPa, for a minimum of 70 h.

b) Immediately following this period of immersion, rapidly reduce the test pressure to atmospheric pressure without causing shredding or disintegration.

No tested sample within 1h shall exhibit swelling greater than 25 % or shrinkage greater than 1 %. The weight change shall not exceed 10 %.

13.3 Non-metallic synthetic material used in a component that is likely to be exposed to ester-based or alpha olefin-based synthetic compressor oils, including non-synthetic compressor oils, shall not show excessive change in volume or weight when tested in accordance with IS 3400 (Part 6) or the following procedure.

c) Prepare, measure and weigh representative sample or samples of each non-metallic synthetic material used in a component, then immerse the sample or samples at room temperature in holders, each containing one of the test fluids, for a minimum of 70 hours.

d) Following this period of immersion, remove and measure the test samples.

No sample shall exhibit swelling greater than 25% or shrinkage greater than 1%. The weight change shall not exceed 10 %.

13.4 Non-metallic part in contact with CNG shall not show excessive greater volume change or loss of weight.

13.4.1 Test the resistance to n-pentane according to ISO 1817 with the following conditions:

- a) Medium: n-pentane;
- b) Temperature: 23°C (tolerance according to ISO 1817);
- c) Immersion period : 72 h.

13.4.2: Requirements:

Maximum change in volume 20%;

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

14 Vibration resistance

Components with moving parts shall remain undamaged and shall continue to operate and meet the requirements of their leakage tests and hydrostatic strength test after the vibration test has been carried out in accordance with the following test procedure.

Vibrate the component for 30 min, pressurized to its working pressure with dry air, nitrogen or natural gas, and sealed at both ends, along each of the three orthogonal axes at the most severe resonant frequency determined as follows:

- by an acceleration of 1,5 g;
- within a sinusoidal frequency range of 10 Hz to 500 Hz;
- with a sweep time of 10 min.

If the resonance frequency is not found in this range, the test shall be conducted at 500 Hz.

On completion of the test, the component shall not show any indication of fatigue or component damage, and shall comply with the leakage test specified in Clause 6 and the hydrostatic strength test specified in Clause 5.

15 BRASS MATERIAL COMPATIBILITY:

All fuel-containing brass components or subcomponents for which a satisfactory declaration of properties is not submitted by the applicant shall be tested according to the following procedure (component manufacturers able to provide documentation attesting to the field-worthiness of their products are exempted from this requirement).

- a) Subject each test sample to the physical stresses normally imposed on, or within, a part as a result of assembly with other components. Apply these stresses to the sample prior to the test, and maintain them during it. Samples with thread, intended to be used for installing the product in the field, shall have the threads engaged and tightened to the torque specified in the instruction manual of the sample. Poly-tetrafluoro ethylene

(PTFE) tape or pipe compounds shall not be used on the threads.

- b) Degrease three samples and continuously expose them for 10d at a set position to a moist, ammonia-air mixture maintained in a glass chamber of approximately 30 liter capacity and with a glass cover. Maintain approximately 600 cm³ of aqueous ammonia, with a relative density (specific gravity) of 0,94, at the bottom of the glass chamber, below the samples. Position the samples 40 mm above the aqueous ammonia solution, supported by an inert tray. Maintain the moist ammonia-air mixture in the chamber at atmospheric pressure and at a temperature of 34 °C ± 2 °C.

After being subjected to the conditions of this procedure, samples shall show no evidence of cracking or de-lamination when examined at 25 x magnification.

16 Ozone ageing for vulcanized or thermoplastic rubbers:-

16.1 The test shall be in compliance with ISO 1431-1

The Test piece, which shall be stressed to 20% elongation, shall be exposed to air at 40°C with an ozone concentration of 50 parts per hundred million during 72 hours.

16.2 No cracking of the test piece is allowed. (After being subjected to the conditions of this procedure, samples shall show no evidence of cracking when examined at a magnification of 25X.)

17 Resistance to dry heat for vulcanized or thermoplastic rubbers:-

The test shall be done in compliance with ISO 188.

The test piece shall be exposed to air at a temperature equal to the maximum operating temperature (85°C or 120°C as applicable) for 168 hours.

The allowable changes in tensile strength shall not exceed +25 percent.

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

- a) Maximum increase 10%;
- b) Maximum decrease 30%.

18 Automotive fluid exposure

18.1 General

External portions of components shall be able to withstand exposure to the following fluids without mechanical degradation. Resistance shall be determined by the test in 18.2 except when the manufacturing can demonstrate by other means that the material is resistance to these fluids

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18.2 Test Method

The external surfaces of the component shall be exposed to the following test. The inlet and outlet connections of the component shall be connected or capped in accordance with the component manufacturers installation instructions. The test shall be performed at ambient temperature. The component shall be exposed by spraying the exterior of the component 24 times at one hour intervals. The test shall either be performed over 24 straight hours or during a maximum of three consecutive days (e.g. 8 times a day over three days)

Alternatively, the component may be immersed in the solution for a period of 24 hours. In the immersion method, the fluid shall be replenished as needed to ensure complete immersion for the duration of the test.

An individual test shall be performed with each of the three fluids specified in 18.3. One component may be used for all three exposures sequentially.

18.3 Fluids:

The following fluids shall be used for testing:

- a) Sulfuric acid: 19% solution by volume in water;
- b) Ethanol/ gasoline: 5/95 % concentration of E5 fuel meeting the requirements of ASTM D 4814;
- c) Windshield washer fluid: 50% by volume solution of methanol and water.

18.4 Pass criteria

After exposure to each chemical; the component shall be wiped off and rinsed with water and examined.

The component shall not show signs of mechanical degradation that could impair the function of the components such as cracking, softening, or swelling. Cosmetic changes such as pitting or staining are not considered failure. At the conclusion of all exposure, the components(s) shall meet the leakage requirements of clause 6 and hydrostatic strength requirements of clause 5.

NOTE:- Replace the “CNG” with “CNG / Bio- CNG” wherever it specified. Also, Bio- CNG shall confirm all requirements which are specified for CNG.