III
PROVISIONAL STANDARD GE N° 1-117

Technical provisional standard for components designed to operate with compressed natural gas (CNG) in vehicle carburetion systems and operation requirements.

GE Nr. 1-117

PROVISIONAL TECHNICAL STANDARD FOR COMPONENTS DESIGNED TO OPERATE WITH CNG IN VEHICLE CARBURETION SYSTEMS AND OPERATION REQUIREMENTS

PART I
CONSTRUCTION

1.1. SCOPE

1.1.1. This standard applies to the construction and performance of CNG system components for providing motive power to new or used motor vehicles that require internal combustion engine.

1.1.2. These standards do not apply to systems of steady engines and LNG components.

1.2. GENERAL

1.2.1. To the effects of this Standard, Natural Gas is mainly comprised of methane and compresses up to 200 bar (pressure gauge) for its use in vessels installed in motor vehicles; and up to 250 bar for storage and plant refueling tanks. The equipment of the corresponding systems shall be designed to operate at the indicated pressures.

1.2.2. A CNG carburetion system for vehicles includes interconnected and assembled components allowing the following functions:

a) A fuel selector allowing the use of the selected fuel (bi- fuel system)
b) CNG storage cylinders
c) CNG supply line
d) Connections to refuel CNG
e) Gas flow adjuster, when required
f) CNG pressure gauge and dial for its reading
g) Pressure regulator
h) Gas-air mixer
i) Overpressure relief

1.2.3. CNG components may perform more than one function but shall in all cases operate according to the functions assigned to each component, fulfilling each function individually.

1.2.4. Each system component shall be constructed such as to comply with resistance, operability and safety requirements.

The components must be well fixed and must not show signs of distortion, bend, rupture or other damages when assembled for carrying out the tests or any other operation, in compliance with these standards.

1.2.5. Each component shall be designed so that incorrect assembly is not possible and shall be secured to its parts avoiding displacements when handled under normal operation and use conditions.

1.2.6. Materials used shall be those suitable for NG and operation conditions

1.2.7. The threads of any component for coupling in a high pressure area which are different to the ones of the cylinder, must comply with ANSI B 2.2 Standard and those corresponding to CNG cylinders must comply with ANSI B.57.1 Standard.

1.2.8. A trumpet-type connection component must comply with SAE.J.514 Standard

1.2.9. All the system components subject to CNG cylinder pressure must be designed to withstand a working pressure not lower than 200 bar (pressure gauge)

1.2.10. The components must operate safely within a range of -40°C and 120°C and CNG cylinders within a range of -40°C to 50°C.

1.2.11. The sections of electrical cables shall be adequate to the current running through them.

1.2.12. The components connected to electrical conductors must have their openings constructed such as to avoid abrasion between them.

1.3. **INLET OPENING FOR CNG SYSTEM FUELING**

1.3.1. The inlet connection for filling cylinders must be designed with a cap or plug for preventing dirt and liquid from getting in, and

a) Shall be able to house a standardized connector (see figure 1)
b) Will not allow system filling with the cap on
c) The vehicle engine will not ignite if it is not in place.

1.3.2. The fuel inlet must include mechanisms to depressurize the refueling connection so that the corresponding connector may be removed

1.3.3. The component installed in the system to facilitate refueling must comply with the pneumatic leak test and hydrostatic pressure resistance tests as set forth in items 1.2 and 1.3 in Part II of these Standards

1.4. PRESSURE MEASUREMENT AND READING

Pressure gauges shall be constructed such as to avoid the expulsion of their components if overpressure ruptures their elastic elements, joints or if an internal rupture occurs.

1.4.1. The pressure gauge dial shall be set to values that are twice those of operating pressure and at least, once or twice the pressure value at which the safety device disc bursts

1.4.2. Pressure gauges shall have a 1.4 mm maximum diameter opening for the inlet connection.

1.5. AUTOMATIC SHUT OFF VALVE

1.5.1. The automatic shut off valve must be designed such as to prevent NG flow into the engine once it has stopped rotating.

1.5.2. Joints, diaphragms and other non metallic parts shall be resistant to the atmosphere and fluids they may be exposed to, during normal service, such as oil, natural gas, gasoline and oxygen.

These components shall comply with the 1.14 test included in Part II of these Standards

1.6. MIXER

1.6.1. The mixers, carburetors and adaptors must be manufactured with adequate materials and meet the service conditions for which they are designed and indicated.

1.7. INSTRUCTION BOOKLETS

1.7.1. All the components manufactured for carburetion systems must include a booklet with instructions and indications in Spanish, which will facilitate the correct connection and assembly of the installation and help the CNG Equipment manufacturer to draft the Operation and Maintenance Manual.

1.8. MARKINGS

1.8.1. Each component must be correctly identified and used according to instructions and shall be marked as follows:

a) Automatic shut off valve

I Manufacturer's trade name or mark
II Type
III Working pressure in bar
IV Flow direction when required for its correct installation
V CNG
VI Voltage to operate
VII Approval number

b) Pressure gauge

I Manufacturer's trade name or mark
II Type
III Quality seal of the Certification Entity or approval data and applied Standard.

c) Pressure regulator

I Manufacturer's trade name or mark
II Type
III Maximum inlet pressure
IV Flow direction
V CNG
VI Approval number

d) Electronic units

I Manufacturer's trade name or mark
II Type
III Voltage and current
IV Polarity
V Approval number

e) Gas-air Mixer / Carburetor

I Manufacturer's name, trade name or symbol
II Type
III Maximum inlet pressure depending on whether it is designed for higher values than atmospheric ones.
IV CNG

V Approval number

f) Refueling connection device

I Manufacturer’s name, trade name or symbol
II Type
III Approval number

Note: Threads and joints included in GE N° 1-115 and GE N° 1-116 may be used for items 1.2.7 and 1.2.8.

PART II

COMPONENTS PERFORMANCE TEST

1.1. GENERAL

1.1.1. The tests shall be carried out at room temperature of 20 ± 5°C, except otherwise indicated

1.1.2. Components shall be subject to leakage tests according to item 1.2 to be performed before and after having complied with the tests set forth in items: 1.5. Corrosion resistance, 1.6 Vibration resistance, 1.8 Durability, 1.9 High temperature exposure, 1.10 Mercurous nitrate test and 1.11 Low temperature exposure.

1.1.3. Dielectric resistance test according to item 1.12 shall be carried out before and after having complied with the cycling test (see 1.8.2 and 1.8.3)

1.2. PNEUMATIC LEAK TEST

1.2.1. Components containing gas (tubing or piping are not included) must not show evidence of external leakages when exposed to a 1.5 pneumatic pressure at normal operation pressure applied to the inlet opening, when bypasses are opened and the outlet is plugged

This operation shall last one minute and in order to detect the leak, the part is immersed in a water container for inspection.

This verification is performed after the following conditioning and tests:

I The part is exposed during twenty four (24) hours to 120°C in a test room or enclosure and then, verified.
II The part is exposed during twenty four (24) hours to a 40°C temperature in a test room or enclosure and then, verified.
III Corrosion resistance test according to 1.5 and later, verification at room temperature.
IV Vibration resistance test according to 1.6 and later, verification at room temperature.
V The bronze part is exposed to a mercurous nitrate test according to 1.11 and then, verified at room temperature.

1.2.2. Valves and regulators designed to supply an outlet pressure lower than atmospheric pressure shall not show evidence of any leak through their seat when their inlet is connected to a pneumatic source of 1.5 normal operating pressure for one minute. In order to detect leaks, the part is

immersed in a water container for inspection. This inspection is not carried out until the following conditionings and tests have been performed:

I The part is exposed during twenty four (24) hours to -40°C in a test room or enclosure and then leak tested.
II The part is exposed during twenty four (24) hours to a 120°C in a test room or enclosure and then, verified.
III Corrosion resistance test according to 1.5 and later, verification at room temperature.
IV The brass part is exposed to a mercurous nitrate test according to 1.11 and then, verified at room temperature.
V See also item 1.8

1.3. HYDROSTATIC TEST

1.3.1. Except for pressure regulators (see 1.3.2), the assembly of components confining pressure gas (not including tubing or piping) must not rupture, fracture or show permanent distortion when tested as indicated below.

Tests must be performed at room temperature.

The outlet opening of the tested component must be plugged and its seat or inner structure must be set in an "open" position. The inlet shall be exposed to a hydrostatic pressure 2.5 times higher than the normal operating pressure of the component for 1 minute.

The test shall be repeated with its internal structure or the seat, as the case may be, in "shut-off" position.

1.3.2. The structure of a pressure regulator prepared to operate with positive pressure must not rupture, fracture or show permanent distortion when tested as indicated below:

Tests must be performed at room temperature.

The outlet opening of the regulator must be plugged. The inlet of the regulator chamber shall be exposed to a hydrostatic pressure which shall be twice the gas normal operating pressure for five (5) minutes.

The area of the regulator structure upstream the pressure reduction valve seat must not rupture, fracture or show permanent distortion.

Then the valve seat shall be set to open position and the regulator shall withstand twice the operating pressure of the chamber located downstream of the seat, or the upstream operating pressure, whichever the highest.

In the case of pressure regulators that contain more than one valve seat, the test is repeated with the valve seat in open position, with twice the pressure or the operating pressure of the chamber located downstream of the respective valve.

1.4. REGULATOR SHUT OFF PRESSURE

The shut-off pressure of a regulator designed to provide a higher pressure than the atmospheric one, must not be 120% higher than the initial pressure release, indicated by the manufacturer.

Method of test

The regulator must be connected at the outlet of a flow gage and with the adequate air supply, pressure and capacity. A callipered pressure gauge must be fitted to the testing equipment, upstream of the regulator, and the inlet pressure must be recorded. The piping connected to the regulator outlet consists of two (2) sections of 305 mm length each, joined by a regulator T-coupling and the material shall be as the one described in identification 40.

A pressure gauge (Bourdon, mercury or water column) is connected to the free section of the T-coupling, according to the outlet pressure of the regulator.

An automatic valve and a manual valve will be connected to the free end of the pipe. The valve shut-off must be regulated until it provides an air flow (240) two hundred and forty times the diameter of the regulator opening calculated in mm. multiplied by 0.04 coefficient (mm x 0.04) with the inlet pressure of the regulator at the working pressure specified by the manufacturer. The obtained value times 29 factor, expresses the air flow rate in liters/ hours.

The regulator initial pressure and outlet pressure must be read and recorded with this setting. Then the automatic valve is locked in the installation and the regulator outlet pressure shall not have varied so as to exceed 120% of initial recorded pressure.

The test must be repeated with a regulator inlet pressure maintained at half the design value, specified by the manufacturer.

1.5. CORROSION RESISTANCE

The gas-air system fittings must not show evidence of significant corrosion, leaks in the protective coating and must be in conditions to operate safely after being exposed to Salt Spray Fog testing according to:

Method of test

Components shall be connected and supported as really installed and shall be exposed during (240) two hundred and forty hours to a Salt Spray Fog testing according to the indications of Standard A.S.T.M.B. 117. The temperature in the fog chamber shall be maintained between 33° and 38°C. The saline solution shall consist of a dilution of 20% sodium chloride (Cl Na) in 80% of distilled water, measured in weight.

1.6. VIBRATION RESISTANCE

The components of the carburetion system will not be damaged and may continue operating safely, after being exposed to vibration according to the following:

Method of test

A representative sample of each component must be mounted, as specified by the manufacturer, on a frame simulating the part of the vehicle in which it will be installed. The assembly must be placed on a vibratory platform capable of producing vertical reciprocal movements. The parts shall be continuously vibrated for sixty (60) minutes at variable frequencies, from 10-55-10 Hz through a linear movement cycle, with a displacement of 1 ± 0.1 mm, for two (2) minutes.

In case resonance is detected, the operation shall continue at the same frequency for two hours. If resonance is not detected, vibration shall be maintained for two hours at a frequency of 55 Hz.

1.7. OXYGEN AGEING

Components manufactured with synthetic rubber must not crack or show visible evidence of deterioration when exposed to oxygen aging according to the following:

Method of test

Representative samples of components manufactured with synthetic rubber must be prepared to be tested:

a) Tensile strength according to A.S.T.M.D 412 method
b) Hardness, according to A.S.T.M.D 1415
c) Other samples must be exposed for ninety six (96) hours to oxygen at a temperature of seventy degrees (70°) and at a pressure of twenty (20) bars, according to standard A.S.T.M.D.572.

After the ageing period, some samples are tested at tensile strength and hardness is measured at others, following the techniques and procedures

indicated in a) and b) and the values resulting from the tensile strength tests must not be lower than 70% of those found in the raw sample. Hardness must not have varied ± when compared to the original sample.

1.8. DURABILITY

1.8.1. A regulator must operate safely without showing signs of deterioration after their valves have completed (100.000) one hundred thousand opening and closing cycles, according to the following:

Method of test

A regulator that will be subject to cycling test shall be set at the operating pressure and flow indicated for the outlet normal pressure.

The regulator inlet shall then be connected to a source of pressurized dry air or nitrogen and maintained at operating pressure. The testing machine shall ensure intermittent operation of the regulation mechanism, during which outlet pressure from the accessory must be increased up to its closing pressure and shall then, decay up to atmospheric value. The aim is to achieve maximum modulation of regulation mechanisms.

The testing machine shall be designed such as to ensure 100,000 cycles in the mechanisms, in no more than 30 minutes and no less than 20 minutes, and the number of cycles must be determined by a counter related to the pressure control system or by any other similar means. The amount of cycles upstream of the valve must be calculated (in case there is more than one valve).

Once these 100,000 cycles have been completed, the regulators shall not show evidence of deterioration, may continue operating safely and shall show no leaks when tested according to item 1.2 at room temperature.

1.8.2. Solenoid shut-off valves shall perform safely after 100,000 cycles of opening and closing in accordance to the following:

Method of test

The inlet opening of the valve shall be connected to a CNG source and to the operating pressure. The test shall be conducted at normal voltage. The valve closes and opens one full cycle within a period of not less than five (5) seconds and continues until the valve has been subjected to 100,000 cycles. At the end of those tests, the valve shall operate safely and the leak test shall be performed according to item 1.2, at room temperature.

1.8.3. Switches or other components with moving parts must withstand 100,000 cycles according to the following:

Method of test

Cycles must be performed at normal operating pressure and voltage. The component must be operated by means of its active parts on a machine for 100,000 cycles at a rhythm of 10 cycles/ minute, or higher, if the accessory manufacturer indicates it; however, it shall never exceed the 20 cycles/ minute.

Once these 100,000 cycles have been completed, the component must continue operating safely and shall show no leaks when tested according to 1.2, and shall show no evidence of deterioration when the dielectric resistance test is performed according to item 1.12.

Mixers containing moving parts must undergo 100,000 operation cycles, at 21°C, 2000 cycles at -40°C and 2000 cycles at a temperature of 120ºC without showing evidence of flaws.

1.9. LOW TEMPERATURE OPERATION

Components must maintain their characteristics and operate safely when exposed to -40°C, according to the following:

Method of test

Each component shall be placed in a chamber at -40°C during a 24 hour period. If a component preserves its antifreeze characteristics, it is leakage tested according to item 1.2, and its capability of performing safely shall be verified.

Note: Components which normally contain antifreeze solutions shall be filled with the corresponding products to the capacity indicated by the manufacturer before being tested.

1.10. HIGH TEMPERATURE OPERATION

Components must maintain their characteristics and operate safely, when exposed to 120°C, according to the following:

Method of test

Each component shall be placed in a thermal chamber at 120°C during a 24 hour period. If a component preserves its thermal characteristics, it shall be leakage tested according to item 1.2, and its capability of performing safely shall be verified.

1.11. Mercurous nitrate immersion test (NO_3 Hg). A brass component in contact with CNG shall withstand without cracking, the following mercurous nitrate test:

Method of test

The components will be used assembled as if they were ready for use in the system. When coupled to tubes or pipes, they will be adjusted with normal torque values and each sample will be immersed for fifty (50) minutes in an aqueous mercurous nitrate solution containing (100) one hundred grams of NO_3 Hg and thirteen (13) milliliters of nitric acid (NO_3H) per liter of solution. Following the immersion, the accessories must be leakage tested according to item 1.2 at room temperature.

1.12. DIELECTRICAL STRENGTH

Electrical components must withstand during one (1) minute, without rupturing, a voltage of 524 V ac. applied between the current transporting parts and its cover case according to the following:

Method of test

The electrical components with selector switches and other controls in "open" position shall be subject to gradual and uniform increasing actions starting from 0 and reaching 524 V or until a rupture is produced, using a transformer which outlet may be regulated from zero at the previously indicated value.

1.13. ABNORMAL ELECTRIC VOLTAGES

Electrical components must be able to operate normally in spite of being exposed to abnormal electrical voltages.

Method of test

Each component shall be exposed to at least (50) fifty cycles at each of the following voltages: 85% and 110% of the normal operating voltage and shall perform correctly without showing any sign of burns or pitting in the selectors' electric contacts.

1.14. NON-METALLIC SYNTHETIC IMMERSION TEST

A non metallic synthetic material in contact with CNG shall not show excessive volume change or loss of weight when tested in accordance with the following:

Method of test

A representative sample of each non-metallic synthetic material shall be prepared, measured and weighed, then immersed in n-hexane for seventy (70) hours. The sample shall not exhibit swelling greater than 23%, nor shrinkage greater than 1%. The weight loss shall not exceed 10%

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Note: This standard has been adapted from CGA preliminary Standard 3.12.1981 Compressed natural gas fuel system components for use on Highway vehicles.
For the certification tests of national manufacture components, Gas del Estado may admit the application of other standards from technologically developed countries with experience in the use of CNG.

The CNG Fuel System Manufacturer or CNG Fuel System Supplier must submit the corresponding technical documentation to evidence approval feasibility.
In case of approval, the tests and values indicated shall replace the ones required in Standard GE N° 1-115 for each component involved.