NAG – E 407

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Motorcycles Compressed Natural Gas (CNG) Fuel System Technical Specification

Approved by Resolution ENARGAS Nr. 2947/04



ENTE NACIONAL REGULADOR DEL GAS



NAG-E 407

MOTORCYCLES COMPRESSED NATURAL GAS FUEL SYSTEM TECHNICAL SPECIFICATION

TABLE OF CONTENTS

1	AIM
2	SCOPE
3	DEFINITIONS AND ABBREVIATIONS
4	GENERAL ASPECTS
5	APPLICABLE AND REFERENCE DOCUMENTS
6	QUALIFYING DOCUMENTATION
7	CNG CYLINDERS9
8	COMPONENTS OF CNG CYLINDERS9
9	INSTALLATION OF CNG CYLINDERS
10	GAS CONDUITS (TUBING, PIPING OR HOSES)
11	FUEL SYSTEM INSTALLATION14
12	CARBURETION SYSTEM COMPONENTS15
13	TASKS TO BE PERFORMED



NAG-E-407 TECHNICAL SPECIFICATION MOTORCYCLES COMPRESSED NATURAL GAS FUEL SYSTEM

1 **AIM**

Regulation of the minimum technical and safety requirements for the installation, qualification, use and control of CNG fuel systems on natural gas propelled motorcycles.

2 Scope

This document shall only apply to motorcycles with four-stroke engines so that they can use gasoline or natural gas alternatively.

3 Definitions and abbreviations

For the purpose of this document, the following terms mean:

ENARGAS: Ente Nacional Regulador del Gas.

CNG Fuel System (Fuel System): CNG fuel system Supplier's equipment approved by a Certification Organization for its installation on CNG propelled motorcycles and made up of the following components, previously approved by a Certification Organization:

a) cylinders

b) cylinder fastening devices;

c) manual valves to be installed at the cylinder outlets, including their safety systems;

d) high pressure gas conduits, their connectors and fastening devices;

e) pressure regulator and its fastening device;



f) CNG fuel valve and its fastening device;

g) low pressure gas conduit;

h) mixer;

i) solenoid valve;

j) fuel selector switch and its electrical connections; and

k) pressure gauge.

CNG: Compressed natural gas.

Motorcycle (the definition included in Law 24.449, Traffic and Road Safety, is adopted): Two-wheeled vehicle with an engine traction cylinder capacity exceeding 50 cm³ and that can generate speeds higher than 50 km/h.

CO: See Certification Organization.

Certification Organization: Entity accredited by the ENARGAS, according to Resolution ENARGAS Nr. 138/95 or one superseding it in the future.

PEC: see CNG fuel system supplier.

CNG fuel system supplier: Physical or legal person registered as such in the RMH (Registry of Qualifying Licenses) jointly responsible with its Technical Representative of:

- a) assembling the CNG fuel system to be used on motorcycles and submitting it for approval through a Certification Organization;
- b) qualifying the operation and issuing the corresponding documentation according to the regulations in force; and
- c) training and controlling the Installation Workshops it qualified.



RMH: ENARGAS Registry of Qualifying Licenses, according to Resolution ENARGAS Nr. 139/95, its amendments or related standards.

RTTdM: Installation workshop technical representative.

SICGNC: CNG centralized IT-system.

TdM: Installation Workshop qualified by a PEC.

4 General Aspects

- **4.1** This document supplements the regulatory outline which governs the activity related to the use of compressed natural gas (CNG). In case of conflict, the criteria of this document shall prevail.
- **4.2** Likewise, it will supplement the national, provincial or municipal legislation regarding motorcycles.
- **4.3** Inspection of CNG fuel system installation shall be performed every six months.

Cylinder inspection shall be performed according to the stipulations of the regulations in force.

- **4.4** CNG fuel system components and their installation shall be in accordance with ENARGAS recognized standards.
- **4.5** This document will govern the prototype approval through a Certification Organization (CO) and the subsequent production control with reference to the approved prototype, for each motorcycle make and model. A record of photographs and documents supporting the necessary controls and testing will be kept by the CO to ensure compliance of these Technical Specification requirements.



- **4.6** CNG containers approved by an ENARGAS recognized CO, shall be fixed to the motorcycle without changing its strength, structural integrity, stability or driving features. They will be suitable for filling at qualified CNG filling stations and they will not be movable.
- **4.7** Requirements to be complied with during components assembly and mounting, tests and inspections to be performed on the system and on the motorcycle and the feature enabling the identification of this type of motor vehicles fitted with CNG equipment shall be approved by a CO. The prototype approval certificate shall be issued by the CO and delivered to the requesting CNG Fuel system Supplier (PEC) for each motorcycle make and model, once requirements are satisfactorily complied with.
- **4.8** The original system for liquid fuel shall be retrofitted with the CNG fuel system so that the motorcycle may operate adequately alternating use of gasoline or natural gas, regulated at the required value according to the design of the dosing device to be used.
- **4.9** Pressure gauge will indicate the working pressure which shall not exceed 200 bar M at 21 °C +1/-0 °C.
- **4.10** CNG fuel system components for motor vehicles approved by a CO may be used, provided they are useful for the intended specific functions and their installation does not jeopardize the motorcycle structural integrity, stability or driving features.
- 4.11 Procedures for conversion, inspection, modification, dismounting, withdrawal or reinstallation of CNG fuel systems on motorcycles shall comply with the stipulations of Resolutions ENARGAS Nr. 139/95, 2603/02 and 2768/02 or those amending or superseding them in the future.



4.12 Mandatory CNG fuel system identification sticker will be visibly affixed at the top of the liquid fuel tank or at any place determined by ENARGAS in the future.

5 Applicable and reference documents

NAG-415 (former GE-N1-115 1984):

Regulations. Definitions and terminology. Specifications and procedures. Technical documentation to be complied with by all registered categories of manufacturers and importers.

NAG-416 (former GE-N1-116 1984):

Minimum technical and safety standards and specifications for on-board CNG fuel system installation and testing.

NAG-417 (former GE-N1-117 1984):

Standard for components designed to operate with compressed natural gas in vehicles carburetion systems and operation requirements.

Resolution ENARGAS Nr. 139/95:

Guidelines to be followed by individuals and legal entities involved in the CNG system, in order to guarantee quality, efficiency and safety.

Resolution ENARGAS Nr. 2603/02:

Substitutes the procedure of Resolution ENARGAS Nr. 139/95, manuals and safety recommendations for the use of motor vehicles using CNG in their propulsion system.

Resolution ENARGAS Nr. 2768/02:



New design and location of the identification stickers and definition of the purpose of the external identification label.

ASME B 31.3:

"Chemical plant and petroleum refinery piping".

ASTM D 2000 (SAE J200):

"Classification system for rubber products in automotive applications".

ISO 15500-17 :

"Road vehicles- Compressed natural gas (CNG) fuel system components- Part 17 Flexible fuel line".

6 Qualifying documentation

- 6.1 The installation qualifying technical documentation shall follow the same criterion and format used for the other motor vehicles.
- 6.2 The same CNG fuel system Technical sheet form defined in Document Nr. 3, ANNEX I, Resolution ENARGAS Nr. 2603/02 shall be used, and the item "Others" of the identification field shall be ticked, specifying in the observations field that the converted vehicle is a motorcycle.
- 6.3 The identification credential of the CNG fuel system installed in the vehicle (Yellow card) will be the one stated in Document Nr. 3, Annex I, Resolution ENARGAS Nr. 2768/02 and at the back, in the field "I do hereby certify that the information provided and the installed conversion equipment comply with standards GE-N1-115/116/117", it will be added that the conversion equipment also complies with the present document.



- 6.4 The CNG fuel system identification sticker (sticker) shall be the one indicated in Document Nr. 1, Annex I, Resolution ENARGAS Nr. 2768/02.
- 6.5 Means for ensuring traceability and follow-up through the database generated by ENARGAS SICGNC shall be used.

7 CNG cylinders

CNG cylinders to be installed shall:

- a) Operate at a standard pressure of 200 bar M.
- b) Be duly approved by a CO.
- c) Not be modified or altered once installed.

8 Components of CNG cylinders

- 8.1 **Pressure relief safety device:** Every CNG steel cylinder shall have a combined safety device: pressure burst disc of 340 +0/–34 bar and fusible plug to melt at nominal 100 °C \pm 4°C, in the cylinder manual valve with a separate channeling to a safe zone.
- 8.2 **Check valve:** The cylinder filling system of the motorcycle must be fitted with a check valve in order to avoid the gas flow returning from the cylinder to the filling connection.
- 8.3 **Excess flow valve:** The cylinder must be fitted with an excess flow valve, installed as the cylinder first outlet fitting, to avoid natural gas leakage in case of rupture in the high pressure zone.



8.4 **Material compatibility:** Fittings directly mounted on the cylinders must be electrochemically compatible with the CNG cylinder material.

9 Installation of CNG cylinders

- 9.1 A CNG cylinder must be installed taking into consideration the following:
 - a) It shall be permanently installed and adequately fixed to avoid detachment, displacement, slippage or rotation.
 - b) It will not project beyond the motorcycle limits at its installation height.
 - c) Its installation shall avoid unnecessary stresses on the container or its fittings.
 - d) The installed cylinder position will enable perfect visibility of its serial number and homologation code. If it is impossible to view simultaneously both numbers, the serial number will be preferred.
 - e) The fastening device components assembly shall be treated as a unit designed for the permanent installation of cylinders so as to avoid displacement and prevent direct contact with the motorcycle while it is attached to it. As far as possible, the fastening device shall contribute to avoid cylinder's theft.
 - f) Fastening straps, fitting bolts, elastomers used as protective joint and anchorages perform different functions, thus requiring special attention. Cradles, fastening straps and other metal components, except bolts, shall be made of commercial quality structural steel with a minimum tensile strength of 340 MPa.



 g) Cylinder fastening device and its anchorages shall comply with the stipulations of the regulations in force and shall be approved by a CO. They shall be designed for each motorcycle make and model.

To verify motorcycle structural integrity, which is prone to be affected by the installation of the fastening device and the mechanical protection, it must be ensured that these two protective devices are approved by the manufacturer, or the structure must be analyzed by a CO with the support of a specialist.

- h) For the purpose of the previous item, each fastening device model shall include the specification of the motorcycle make and model and the cylinders for which they are suitable.
- i) The fastening device installation manual must specify the design foreseen variables, including the cylinder diameter and length intervals for which it is suitable. When the device is used for more than one cylinder, the addition of all tares in the containers shall be considered during sizing and contact among them shall be avoided.
- j) The attachment of the fastening device to the motor vehicle chassis shall be carried out using bolts on anchorage points. Once the device and its anchorages are assembled and the cylinders are mounted, they shall withstand, at least, a load of:

1) Twenty times the weight of the full container, in the vehicle's axial direction, and



2) Eight times the weight of full container in any other direction.

- 9.2 The axle loads resulting from the motorcycle own weight plus the driver and passenger's weight and the CNG fuel system weight must not exceed the maximum load specified by the manufacturer.
- 9.3 Fastening straps shall be at least 20 mm wide and 2 mm thick. Types allowed shall have a section equivalent to 40 mm².
- 9.4 Non-corrosion resistant metal materials shall undergo a surface treatment such as painting, zincplating, chromepainting, etc.
- 9.5 Screws shall be of forged or redrawn steel of 500 MPa minimum tensile strength. Nuts shall be of forged or redrawn steel of 340 MPa minimum tensile strength.
- 9.6 Non-corrosion resistant screws, nuts and washers shall undergo a surface treatment such as zincplating, chromepainting or a similar one.
- 9.7 Materials different from the ones stated in 9.5 shall be considered, provided they have at least similar characteristics to four steel screws of a minimum diameter of 8 mm, quality 8.8, with their corresponding safety washers and nuts.
- 9.8 Fastening metal parts must be separated from the cylinder by elastomer strips permanently affixed to the cradles and hold down straps. Elastomer and metal may be joined by vulcanizing, sticking or any other method used to prevent elastomer displacement. No part of the cylinder shall be in contact with other metal parts.
- 9.9 Elastomer strips shall be sized such as to project at least 5 mm on each side of the metal supports. Minimum thickness shall be 1.5 mm.



9.10 The elastomer shall be of similar characteristics to those of products used in the motor vehicle industry, foreseen in standard ASTM D 2000 (SAE J 200), according to the minimum requirements of BG 705. It shall be non-hygroscopic, hydrocarbon resistant and its hardness shall be equal to or exceed Shore 70 A.

10 Gas conduits (tubing, piping or hoses)

10.1 They must be constructed to withstand a pressure of

 \checkmark 4 (four) times the working pressure when located upstream of the first regulation stage, or

 \checkmark 5 (five) times the working pressure when located downstream of the first regulation stage.

- 10.2 The material to be used shall be resistant to the chemical action of gas and to operating conditions. Piping or tubing shall comply with ASME B 31.3 standard or similar and hoses to ISO 15500-17 standard.
- 10.3 They must be of adequate size so as to provide the required gas flow according to the characteristics of the motorcycle in which the system is used.
- 10.4 Piping must be clean cut and free from debris resulting from threading, flakes or any other type of dirt or flaw.
- 10.5 Ends of piping and tubing must be carefully reamed.
- 10.6 Tubing for high pressure gas delivery and their fittings shall be safely mounted and secured to compensate vibrations, by means of nylon clamps or any other product of identical resistance and neutral reaction.



- 10.7 Tubing for high pressure gas delivery shall follow the shortest, most practical path between the cylinders and the dosing unit, compatible with their flexibility and must be protected against damages or ruptures caused by collisions, overstresses or friction wear. They must have the necessary amount of loops to compensate vibrations or displacement among the CNG fuel system components as a result of possible motorcycle deformations. Each loop shall have al least two (2) tubing turns and its diameter shall not be less than 70 mm.
- 10.8 Joints and connections: They shall fully comply with item 1.1.4.9 of NAG-416 Standard (former GE-N1-116).
- 10.9 The following is prohibited:
 - a) Connection of bushings and use of materials other than brass or steel.
 - b) Joints that contain a right and a left thread on the same part.
 - c) Bending of tubing resulting in its brittleness.
 - d) Repairs in the CNG delivery line. Flawed elements must be replaced in a TdM.

11 Fuel system installation

CNG fuel system shall be installed so that:

 a) valves, cylinder and its connections, regulator, pressure gauge and high pressure piping and its connections are protected from falls, impacts or contact with stationary objects, and in case any of these situations arise, loads will be transferred to the motorcycle chassis.



- b) high pressure piping shall be secured by fastening devices not causing abrasion or choking, or producing a galvanic couple. Fastening elements shall be positioned so as to guarantee piping safe location.
- c) its components shall be located:
 - at least 50 mm away from combustion gases delivery system,
 - as far as possible from heat sources, and
 - in such a way that they do not project beyond the motorcycle limits at their installation height.
- d) the gravity center is kept as low as possible;
- e) loads jeopardizing the motorcycle stability, structural integrity or maneuverability during an acceleration, brake or at a stable speed or when turning to the right, to the left or circulating along a straight line are not generated.
- f) it is protected from the electrostatic charge that might be generated when the vehicle is in motion.

12 Carburetion system components

12.1 Manual valves, fuel selectors, solenoid valves, check valves, inlet valves for refueling, automatic shut-off valves, pressure regulators and dosing units used as CNG carbureted system components must comply with the requirements specified in standard NAG 417 (former GE 1-117) or other subsequent standard approved by ENARGAS.



- **12.2** An automatic electric valve usually closed must be installed downstream the manual valve so as to prevent the flow of gas to the carburetor when the motor is idle or not associated to the ignition system.
- **12.3** Every fuel system installed shall be fitted with a pressure gauge indicating storage pressure, and complying with the requirements of NAG-417 (former GE-N1-117), or a similar one approved by a CO, placed in such a way that it remains visible during the refueling operation.
- **12.4** Fuel selection mode shall not jeopardize the general safety of the public or passengers' safety.
- 12.5 Components of the installed CNG fuel system must be protected against possible strikes resulting from a lateral roll-over of the motorcycle. Protective devices shall withstand at least, the stress caused by the lateral roll-over of the motorcycle loaded with the maximum allowable axle load specified by the manufacturer increased by 50%.

13 Tasks to be performed

- **13.1** By CNG fuel system suppliers
- 13.1.1 Getting the fuel system approval by a CO, based on the specifications of this document.
- 13.1.2 Tests stated in item 3.5.1 of Standard NAG 415 (former GE-N1-115).
- 13.1.3 Test CNG fuel system components and deliver them, duly packaged, to the TdM qualified by it.
- 13.1.4 Subject components of the low pressure section to a leak test at twice the regulated pressure.



- 13.1.5 Train TdM personnel and provide them the installation manual prepared as requested by the CO. This will give them the necessary knowledge to complete the installation of the fuel system in accordance with the requirements of the regulations in force.
- 13.1.6 Qualify the TdM and control, as frequently as necessary, assuring it has the required equipment for completing the installation of the fuel system in accordance with the standard, based on the training provided.
- 13.1.7 Record TdM training and verification of its equipment.
- 13.1.8 Develop a quality system as required by the CO ensuring compliance with the requirements of this document.
- **13.2** By Installation Workshops
- 13.2.1 Comply with the instructions given during training provided by PEC jointly with its RTTdM.
- 13.2.2 Verify gas-tightness of the connections and good fastening of the components.
- 13.2.3 Fill cylinders with CNG, previously scavenging the system's air with inert gas.
- 13.2.4 Perform all the necessary tests so that start-up and circulation with both fuels, switching and passage from one fuel to the other are done smoothly and without inconveniences.
- 13.2.5 Send each user, with receipt of acknowledgment, an "Instruction manual for using CNG on motorcycles" prepared according to the guidelines provided in Sub-annex I of Resolution ENARGAS Nr. 2603/02. Among other issues, the user will be informed that if the motorcycle is involved in an accident in which a component of the CNG fuel system or the



qualifying documentation is visibly or apparently damaged, he must take the vehicle to the TdM for its assessment.



Form for Proposals on the Technical Specification "Compressed Natural Gas Fuel Systems on Motorcycles"

Company:	Technical Representative:			
Address:		Zip Code:		
Phone:				
Page:	Point:	Paragraph:		
Queter				

Proposal:

Substantiation for proposal:



INSTRUCTIONS FOR FILLING-IN THE FORM FOR PROPOSALS

1. Complete in print letter (hand written or printed) with indelible ink.

2. In the space identified as "**Quote**", copy the text you propose to modify or else summarize it, as long as there are no doubts or ambiguities about the text it refers to.

3. In the space identified as "**Proposal**", indicate the exact wording to be inserted.

4. In the space identified as "**Substantiation for Proposal**", state the problem that will be resolved or improved by your recommendation. Give the specific reason for your proposal or include the technical bibliography on which it is grounded providing copies, if possible, or else describing the experience it is based on.

5. This Proposal must be submitted together with a note to: Gerencia de Distribución, ENTE NACIONAL REGULADOR DEL GAS (ENARGAS) Suipacha 636 4° Piso TE 325-2500, Ciudad de Buenos Aires.