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ANSI NGV 3.1-2014 • CSA 12.3-2014

Fuel system components for compressed natural gas powered vehicles



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Fuel system components for compressed natural gas powered vehicles



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Preface

This is the third edition of ANSI NGV 3.1 • CSA 12.3, *Fuel system components for compressed natural gas powered vehicles*. It supersedes the previous editions published in 2012 and 1995.

This Standard was prepared by the NGV 3/HGV 3 Technical Subcommittee on Standards for Fuel System Components for Compressed Natural Gas and Hydrogen Powered Vehicles, under the jurisdiction of the Joint Automotive Technical Committee and the Technical Committee on Natural Gas Powered Vehicles and Fuelling, and had been formally approved by the Technical Committee(s), American National Standards Institute, and the Interprovincial Gas Advisory Council.

Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
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 - c) *where possible, phrase the request in such a way that a specific “yes” or “no” answer will address the issue.*

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at standardsactivities.csa.ca.

History of the development of NGV 3.1 • CSA 12.3

Note: *This history is informative and is not part of the standard.*

In 1984 there was a growing need in the U.S. natural gas vehicle industry for guidelines pertaining to the assembly of aftermarket equipment installed on motor vehicles in order to operate alternatively on either gasoline or natural gas. The American Gas Association Laboratories (AGAL), in response to this need developed an A.G.A. Requirement for Natural Gas Vehicle (CNG) Conversion Kits, No. 1-85. This requirement was intended to help promote the safe development and installation of NGV conversion systems by manufacturers and installers. The first draft of A.G.A. Requirement No. 1-85 was developed during 1984 and 1985, with the final version dated August 20, 1985.

At the time of its issuance, A.G.A. No. 1-85 was in compliance with NGV equipment and fueling stations specifications published by the National Fire Protection Association (NFPA) under its Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems, NFPA 52. The first edition of NFPA 52 was issued in 1984. A second edition was issued in 1988.

In 1988 a group of U.S. gas utilities formed the Natural Gas Vehicle (NGV) Coalition (the Coalition) to promote widespread use of compressed natural gas as a transport fuel. The Coalition organized committees to address technical, marketing and legislative issues which would affect the future expansion of a U.S. transportation industry fueled by natural gas.

The Coalition recognized that an important consideration in the successful commercialization of natural gas as a vehicle fuel was the issue of codes and standards (or the lack of codes and standards, or harmonized codes and standards) pertaining to both fuel stations and vehicle fuel systems. The Coalition's Technology Committee was established to achieve the goal of an organized family of coordinated codes, standards and regulations addressing natural gas vehicles and fueling stations. To help achieve this goal, the Technology Committee established the Standards and Standardization Subcommittee.

Subsequently, the third edition of NFPA 52 was published in 1992. This edition incorporated many changes developed and recommended by the NGV Coalition's task groups.

During August 1992, an NGV Conversion Equipment Task Group was established to coordinate with the AGAL for requirements for compressed NGV conversion kits. The task group agreed the phrase "NGV fuel system" should replace "NGV conversion kits." (An NGV fuel system is comprised of all major components required to supply, manage, and/or control fuel flow, enabling a vehicle to operate on natural gas.) The task group continued to meet during August, October and December 1992 to promulgate the development of a standard to cover both dedicated and bi-fuel natural gas systems for light and medium duty vehicles.

A standard for NGV fuel system components existed in Canada, National Standard of Canada CAN/CGA 12.3 Fuel System Components for Natural Gas Powered Vehicles. The genesis for this Canadian document was the Amendment to the 1982 CGA B149.1 Natural Gas Installation Code which added to the Code provisions for Natural Gas for Vehicles (NGV) fuel system components on highway vehicles, as well as coverage of NGV refueling stations. Subsequently, these NGV aspects evolved into stand-alone Canadian documents, one being the CAN/CGA-12.3 which was first published in February 1991.

In order to further common goals for North American harmonization, the task group and the Canadian Gas Association (CGA) NGV Steering Committee on Natural Gas Powered Vehicles, initiated formation of a joint activity involving the CGA Steering Committee's Subcommittee on

Fuel System Components for Natural Gas Powered Vehicles and the Coalitions NGV Conversion Equipment Task Group.

On February 17, 1993, the first joint meeting of the NGV Conversion Equipment Task Group and the CGA 12.3 Standards Subcommittee on Fuel System Components for Natural Gas Powered Vehicles was held. As a result the U.S. Task Group and Canadian Subcommittee agreed to establish the Joint NGVC/CGA Subcommittee on Natural Gas Vehicle Conversion Equipment, to develop harmonized requirements for a North American Bi-National standard. The newly established subcommittee agreed to proceed with harmonization of the Canadian Standard for Fuel System Components for Natural Gas Powered Vehicles, CAN/CGA-12.3, which was first published in February 1991, and A.G.A. requirement 1-85. In light of the different approaches in Canada and the U.S. (i.e., systems vs. components), the joint subcommittee agreed that separate harmonized standards be developed for both complete fuel systems and individual system components. Two joint working groups were established to draft the standards requirements for NGV conversion fuel system components and NGV conversion fuel systems, for consideration and final approval by the joint subcommittee.

A standard was prepared by the Joint U.S./Canadian Conversion Component Working Group during several meetings over a period of two years and involved four drafts.

At its July 1994 meeting, the Joint NGVC/CGA Conversion Equipment Subcommittee reviewed and modified the fourth draft of the proposed harmonized standard and voted affirmatively to initiate an ANSI Canvass Ballot and Canadian Public Review and Comment to initiate national recognition and approval of the standard.

During August 1994 the A.G.A. Laboratories and Canadian Gas Association initiated a 60 day ANSI Canvass Ballot and Canadian Public Review and Comment of proposed AGA NGV3.1/CGA 12.3 - Draft 5. At its November 29, 1994 meeting, the joint subcommittee considered and resolved all comments and criticism's received during public review, and accepted several minor editorial modifications of the draft.

The first edition of the harmonized U.S./Canadian Standard for Fuel System Components for Natural Gas Powered Vehicles, was approved by the American National Standards Institute, Inc. on May 10, 1995, the CGA NGV Standards Steering Committee on Natural Gas Vehicles and Fuelling on April 17, 1995, and by the Canadian Interprovincial Gas Advisory Council (IGAC) on June 16, 1995.

In 2007, in response to industry requests, the standard was revised and rewritten in its entirety, and was published as the second edition of ANSI NGV 3.1 • CSA 12.3.

The second edition of the Standard for Fuel System Components for Compressed Natural Gas Powered Vehicles was approved by the American National Standards Institute, Inc. on February 14, 2012 and by the Harmonized Joint Automotive Technical Committee on March 25, 2010.

This, the third edition of the Standard for Fuel system components for compressed natural gas powered vehicles was approved by the American National Standards Institute, Inc. on February 25, 2014, the Joint Automotive Technical Committee on February 20, 2014, the Technical Committee on Natural Gas Powered Vehicles and Fuelling on January 24, 2014, and by the Canadian Interprovincial Gas Advisory Council (IGAC) on February 27, 2014.

Previous editions of this standard, approved by the American National Standards Institute and the Joint Automotive Technical Committee are as follows:

ANSI/AGA NGV3.1/CGA 12.3-1995

ANSI NGV3.1-2012 • CSA 12.3-2012

The following identifies the designation and the year of the harmonized standard:

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ANSI NGV 3.1-2014 • CSA 12.3-2014

Fuel system components for compressed natural gas powered vehicles

1 Scope

1.1

This Standard establishes requirements for newly produced compressed natural gas fuel system components, intended for use on natural gas powered vehicles, as listed in Table 1, below:

Table 1
Fuel system components
(See Clauses 1.1 and 1.5.)

Check valve
Manual valve
Manual container valve
Automatic valve
Gas injector
Pressure indicator
Pressure regulator
Gas flow adjuster
Gas/air mixer
Pressure relief valve
Pressure relief device
Excess flow valve
Gas tight housing and ventilation hoses
Rigid fuel line
Flexible fuel line, hoses and assemblies
Filter
Fittings
Discharge line closures

1.2

This Standard applies to devices that have a service pressure of either 16 500 kPa (2 400 psi), 20 700 kPa (3 000 psi), or 24 800 kPa (3 600 psi), hereinafter referred to in this Standard as the following:

“P24” - 16 500 kPa (2 400 psi)

“P30” - 20 700 kPa (3 000 psi)

“P36” - 24 800 kPa (3 600 psi)

The Standard also applies to components downstream of the first stage of pressure reduction with a working pressure designated by the manufacturer in kPa (psi).

1.3

The construction of the noted components whether specifically covered by the various provisions of this Standard or not, is to be in accordance with reasonable concepts of safety, performance and durability.

1.4

All specifications as to construction set forth herein are to be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

1.5

This Standard emphasizes the pressure containment, performance and safety characteristics of components listed in Table 1.

1.6

It is recognized that other components not specifically covered herein can be examined to meet the criteria of this Standard and tested according to the appropriate functional needs.

1.7

This Standard does not apply to the following:

- a) natural gas fuel system components incorporated during the manufacture of motor vehicles originally manufactured in compliance with the *Federal Motor Vehicle Safety Standards (FMVSS) for Compressed Natural Gas Fueled Vehicles* and the *Canadian Motor Vehicle Safety Standard (CMVSS)*;
- b) fuel containers;
- c) stationary gas engines;
- d) container mounting hardware;
- e) electronic fuel management;
- f) fueling receptacles; or
- g) three way valves.

1.8

In the case of conflict between this Standard and Federal, Provincial, State or local requirements, the government requirements are to take precedence.

1.9

All references to “psi” throughout this Standard are to be considered gauge pressures, unless otherwise specified.

1.10

This Standard contains SI (metric) units corresponding to the yard/pound quantities, the purpose being to allow the Standard to be used in SI (metric) units. IEEE/ASTM SI 10, *American National Standard for Metric Practice*, or ISO 80000-1:2009 Quantities and units - Part 1: General, is used as a guide in making metric conversion from yard/pound quantities.) If a value for a measurement and a corresponding value in other units are stated, the first stated value is to be regarded as the requirement. The given corresponding value may be approximate. If a value for a measurement and a corresponding value in other units, are both specified as a quoted marking requirement, the first stated unit, or both are to be provided.

1.11

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user shall satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

ANSI PRD 1-2013

Pressure relief devices for natural gas vehicle fuel containers

ANSI NGV 2-2007 (R2012)

Compressed Natural Gas Vehicle Fuel Containers

ASTM International

A269-10

Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

A632-04 (R2009)

Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small – Diameter)

B117-11

Standard Practice for Operating Salt Spray (Fog) Apparatus

D471-12

Standard Test Method for Rubber Property – Effect of Liquids

D572-04 (R2010)

Standard Test Method for Rubber-Deterioration by Heat and Oxygen

D573-04 (R2010)

Standard Test Method for Rubber – Deterioration in an Air Oven

D638-10

Standard Test Method for Tensile Properties of Plastics

D1149-99

Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment

D1193-06 (R2011)

Standard Specification for Reagent Water

D4895-10

Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion

G154-12a

Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

IEEE/ASTM SI 10-2010

American National Standard for Metric Practice

CGSB (Canadian General Standards Board)

CGSB 3.513

Standard for Natural Gas for Vehicles

ISO (International Organization for Standardization)

1431-1:2007

Rubber, vulcanized or thermoplastic—Resistance to ozone cracking—Part 1: Static and dynamic strain testing

4080:2009

Rubber and plastics hoses and hose assemblies – Determination of permeability to gas

6270-2:2005

Paints and varnishes—Determination of resistance to humidity—Part 2: Procedure for exposing test specimens in condensation-water atmospheres

9001:2008

Quality Management Systems - Requirements by an accredited registrar

TS 16949:2009

Quality management systems – particular requirements for the application of ISO 9001:2008 for automotive production and relevant service parts organizations

80000-1:2009

Quantities and units - Part 1: General

SAE International

J343-2012

Test and Test Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies

J1616-1994

Recommended Practice for Compressed Natural Gas Vehicle Fuel

March 2014

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J1673-2012

High Voltage Automotive Wiring Assembly Design

J1742-2010

Connections for High Voltage On-Board Road Vehicle Electrical Wiring Harnesses-Test Methods and General Performance Requirements

3 Definitions

The following definitions shall apply in this Standard:

Compressed natural gas (CNG) — natural gas which has been compressed and stored for use as a vehicle fuel meeting the gas composition requirements specified in Clause 4.5 of ANSI NGV 3.1 • CSA 12.3.

Duty cycle — one complete operation of the component such as pressurization and depressurization or on and off as applicable.

Injector duty cycle — the operating frequency of an injector as specified by the manufacturer.

Filter — component containing a screen or media that is intended to remove foreign debris from the gas stream.

Fitting — connector used to join sections of pipe, tube, hose, or components.

Flexible fuel line — non rigid tubing or hose through which natural gas flows.

Gas/air mixer — device for mixing the gaseous fuel and the intake air for the engine. This does not include fuel injectors.

Gas flow adjuster — a gas flow restricting device, installed downstream of a pressure regulator, controlling gas flow to the engine, either at a fixed setting or in relation to overall engine fuel demand. This does not include fuel injectors or devices that respond to individual cylinder firing events.

Gas injector — solenoid operating valve used to control flow into the engine or associated intake that is activated with each engine cylinder cycle.

Direct gas injector — a gas injector that introduces fuel directly into the combustion chamber.

Intake gas injector — a gas injector that introduces fuel upstream of the combustion chamber.

Gas tight housing — enclosure meant to capture leakage from pressure-retaining components.

Leakage:

External leakage — leakage from any pressure-retaining chamber to atmosphere, or to any chamber venting to atmosphere.

Internal leakage — leakage from one pressure-retaining chamber to another, where both are intended to contain pressure during normal operation.

Lockup pressure — the stabilized pressure at the outlet of a pressure regulator at zero flow.

Ncc (normal cubic centimeter) — dry gas that occupies a volume of 1 cm³ at a temperature of 273.15 K (0 °C) and an absolute pressure of 101.325 kPa (1 atm).

Period — time elapsed between the beginning of one cycle and the beginning of the next cycle.

Pressure:

Burst pressure — pressure that causes structural failure of the component and consequential fluid loss through the component envelope, not including gaskets or seals. The highest pressure during a burst test.

Hydrostatic pressure — the hydraulic pressure to which a component is subjected during testing.

Opening pressure (cracking pressure) — the pressure at which a closure device initially opens to allow flow out of the device.

Service pressure — the settled pressure at a uniform gas temperature of 21 °C (70°F). Service pressure shall only be used for components that are upstream of the first stage of pressure reduction.

Set pressure — pressure at which a pressure relief valve is intended to open.

Working pressure — maximum pressure that a component can be expected to experience in actual service. Working pressure shall only be used for components that are downstream of the first stage of pressure reduction.

Pressure indicator — device that indicates gas pressure.

Pressure regulator — device used to control the delivery pressure of gaseous fuel to the engine.

Pressure relief device (PRD) — a device that, when activated under specified performance conditions is used to vent the container contents.

Pressure relief valve (PRV) — a reclosing device that opens to relieve pressure at a pre-determined upstream pressure.

Discharge line (vent line) — exhaust plumbing from pressure relief devices or pressure relief valves or other devices venting gas.

Discharge line closure — a device used to keep contamination out of a relief line while still permitting escape of gas from the line to atmosphere.

Repeated use discharge line closure — a discharge line closure intended to relieve multiple venting events.

Rigid fuel line — tubing that has been designed not to flex in normal operation and through which fuel flows.

Single use relief line closure — a relief line closure principally intended to relieve gas from a single pressure relief device (PRD) or pressure relief valve (PRV) event.

Valve — a component by which the flow of a fluid can be controlled.

Automatic container valve — automatic valve rigidly fixed to the container which controls the flow of gas to the fuel system.

Automatic valve — an on/off valve for controlling flow of gas that is not manually operated.

Check valve — mechanical valve that allows gas to flow in only one direction.

Excess flow valve — a valve intended to automatically shut-off or limit flow when a prescribed flow rate through the valve is exceeded.

External excess flow valve — excess flow valve installed outside the container or container valve.

Flow-limiter type excess flow valve — excess flow valve that limits flow when activated.

Internal excess flow valve — excess flow valve installed inside the container or container valve.

Manual container valve — manual valve intended to be rigidly mounted to fuel containers.

Manual valve — a hand operated device for controlling the flow of gas.

Service valve — a valve intended for use only during maintenance or repair, requiring tools to operate.

Shut-off type excess flow valve — excess flow valve that stops flow when activated.

Ventilation hose — hose meant to capture or deliver to outside the vehicle leakage from gas tight housings.

Ventilation passages — portions of pressure-retaining components meant to capture and direct gas leakage from the pressure-retaining seals of that component.

Venting device — a device intended to vent pressure to atmosphere under certain conditions. Typically includes (but not limited to) pressure relief valves and pressure relief devices (PRDs).

Vent line closures — see definition for Relief line closure.

4 Construction and assembly

4.1 General

4.1.1

Components shall be made of materials suitable for use with compressed natural gas. Resistance to chloride stress corrosion cracking shall be taken under consideration if selecting stainless steel materials. Resistance to sustained load cracking shall be taken under consideration if selecting aluminum materials. Resistance to galvanic corrosion shall be taken under consideration when joining components containing dissimilar materials.

4.1.2

All threads shall comply with a recognized international or national Standard.

4.1.3

Components in the engine compartment shall be suitable for service within a temperature range of -40 °C to 120 °C (-40°F to 248°F). All other components shall be suitable for service within a temperature range of -40 °C to 85 °C (-40°F to 185°F).

4.2 Electrical equipment and wiring

4.2.1

Any openings through which electrical wiring components are routed shall be equipped with means to prevent chafing and abrasion of the wire insulation.

4.2.2

Electrical equipment and circuit wiring in a component shall be in accordance with SAE J1742 and SAE J1673.

4.2.3

Materials used for electrical construction shall be suitable for their particular application. When determining the acceptability of an electrical insulating material, consideration shall be given to its mechanical strength, dielectric strength, heat-resistant properties, the degree to which it is enclosed or protected, and any other features influencing fire and accident hazards.

4.3 Component literature

4.3.1

Manufacturers of components for compressed natural gas powered vehicles shall provide literature for their components. This literature shall provide information to guide the installer in making a proper installation. The literature shall also require that intermediate assemblers transmit the component warnings and literature to the installer. The manufacturer shall provide duplicate literature in response to requests, including service parts. The literature shall be published in the predominant language(s) of the destination country. Critical parts of the component literature shall be worded in the imperative.

Component literature shall include at least the following:

- a) service pressure and specification for CNG use as indicated by “P24”, “P30”, or “P36” for components upstream of the first stage of pressure reduction, or working pressure for components downstream of the first stage of pressure reduction;
- b) gasses for which the component is intended to be used;
- c) operating temperature limits;
- d) mounting limitations with regards to corrosion resistance, including whether the component is suitable for underbody, exterior, or interior locations;
- e) flow ratings of connections if required for safety, such as flow requirements into and out of relief valves;
- f) requirements for warning labels that might be required as part of the installation;
- g) parts that require periodic replacement shall be identified;
- h) manufacturer's or representative's contact information; and
- i) other information as required by specific component sections.

4.3.2

Component literature shall also include, as appropriate:

- a) installation instructions, including torques;
- b) installation orientation requirements;
- c) service procedures; and
- d) recommendations for service access.