



Compressed Natural Gas (CNG) Check Valve Component Technical Specification (CTS)

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This document provides the standard technical requirements for the Compressed Natural Gas (CNG) Check Valve herein referred to as the check valve. The functions, performance, and design constraints for the check valve are defined in this standard or referenced to an industry standard.

1.2 Applicability. The check valve is a functional vehicle component that prevents the back flow of CNG from the container to the filling receptacle when the container valve is energized and open to provide fuel feed to the powertrain. This standard applies only to Bi-fuel or Dedicated (i.e., Mono-fuel or Mono-Fuel plus) CNG vehicles.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ANSI NGV 3.1	ISO 15500	SAE J1344	SAE J2044
ISO 14469-1	NFPA52	SAE J1645	UN R110

2.2 GM Standards/Specifications.

GMW3059	GMW14264	GMW15272	GMW16331
GMW3116	GMW14333	GMW15311	GMW16807
GMW3172	GMW14334	GMW15357	GMW16955
GMW14089	GMW14573	GMW15570	GMW17758
GMW14234	GMW14872	GMW15862	GMW17759

2.3 Additional References.

- CG5518: Compressed Natural Gas (CNG) Check Valve SOR Appendix G3 Validation Cross Reference Index (VCRI) Template
- Global Legal Database
- GM1927 Supplier Quality Statement of Requirements
- GM Part Number 9986467

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The check valve is located between the fuel receptacle and the fuel container. It prevents return flow of CNG from the container to the filling connection. The check valve is typically located adjacent to the container valve. The check valve content is illustrated in Figure 1.

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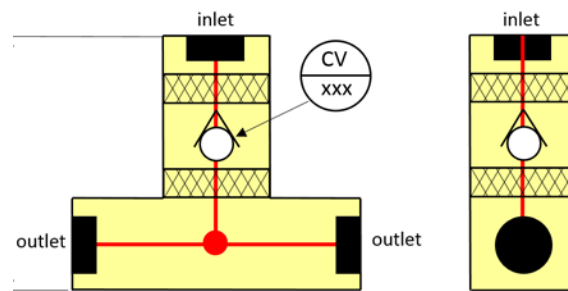


Figure 1: CNG Check Valve (Dual Outlet Shown, Single Outlet Also Available)

3.1.1 Appearance.

3.1.2 Content.

3.1.2.1 Physical Content.

- The check valve consists of the following:
- Check valve within a housing.
 - One (1) gas inlet interface.
 - One (1) or two (2) gas outlet interfaces.
 - Two (2) gas filters in the inlet interface, one (1) upstream and one (1) downstream of the check valve.

3.1.2.2 Functional Content. The primary function of the check valve is to prevent the return flow of CNG from the container to the filling connection. The secondary function of the check valve is to avoid relatively large particle contamination of the fuel system.

3.1.3 Ambient Environment.

3.1.3.1 See requirements stated in GMW17759 including, but not limited to; ambient and extreme operating conditions, solar and ultraviolet radiation, fuel storage system operating pressures, fueling cycle temperatures and pressures (including fill and fast fill), non-operating pressure and temperature, fuel contamination, road splash, and car wash and vehicle submersion.

3.1.3.2 Corrosion. CNG fuel subsystem components shall have no degradation of performance throughout the corrosion and durability target life, when exposed to the severe corrosive environments (e.g., Coastal areas or regions with high road salt usage).

3.1.4 Interfaces.

Specific interface requirements to the check valve are described in 3.1.4.1.

3.1.4.1 Component to Other Components/Subsystems.

3.1.4.1.1 Gas Inlet Interface. The check valve shall have an interface that connects to an 8 mm (outer diameter) steel pipe male end form, per SAE J2044. The check valve shall have the correspondingly designed female end form that will connect to this male pipe end form and meet the requirements of this specification. The dimensions of the female end form are shown in Appendix A, Figure A1.

3.1.4.1.2 Gas Outlet Interface. The check valve shall have one (1) outlet or an integrated "T" fitting allowing for two (2) outlet interfaces. These outlets shall be connected to 6 mm (outer diameter) steel pipes, per SAE J2044. The check valve shall have the correspondingly designed female end form that will connect to this male end form and meet the requirements of this specification. The dimensions of this female end form are shown in Appendix A, Figure A1.

3.1.4.1.3 Crashworthiness. The check valve shall not create any leak that causes the system to fail crashworthiness requirements. The check valve shall be designed to prevent disconnection and damage to adjacent components.

3.1.5 Usage Definition.

3.1.5.1 The check valve shall meet all other vehicle level usage requirements, per GMW17759, as tested at a subsystem level and partial system per GMW17758.

3.1.5.2 Real Refueling Cycles. The CNG fuel storage system testing shall have 1650 filling cycles per service life. Of the 1650 cycles, 1000 full filling cycles shall be tested from < 2 MPa to a temperature compensated

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service pressure, and 650 filling cycles shall be tested with different elevated storage system pressures according to Table 1.

Table 1: Refueling Cycle Fill Properties

Storage System Pressure Range	% Total Cycles	Cycles
Empty to full	61%	1000
25% to full	14%	225
50% to full	14%	225
75% to full	12%	200

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 The check valve shall meet all operational performance requirements, without loss of function or degradation when subjected to at least the number of CNG filling cycles defined in 3.1.5.

The check valve shall meet specific durability requirements according to the applicable regional standards (UN R110, ANSI NGV 3.1 or National Fire Protection Association (NFPA52)). Special vehicle, operational, or ambient conditions may be identified in the performance requirements paragraphs.

Note: All fuel flow measurement testing, unless otherwise specified, shall use a qualified calibration gas. The supplier shall define the test gas used, and provide correlation to the actual gaseous fuel. The test gas temperature for all CNG fuel flow measurements shall be measured at the CNG fuel component inlet. The CNG fuel component temperatures at the start of all fuel flow measurements shall be stabilized and documented. Any changes in either test gas or component temperature shall be monitored and documented throughout the test and the data shall be used in the fuel correlation calculation.

3.2.1.2 External Leakage (100% Methane, 0 °C). The check valve leakage shall not exceed $5 \text{ mbar} \times \text{l/s} \times 10.5 \text{ mbar} \times \text{l/s}$ over total service life at the region specific operating pressure.

3.2.1.3 Shutoff Function Leak Requirement. The check valve shall be capable of providing a bubble tight seal (see 6.1 for definition) to the ambient over the requested durability cycles and the defined operating ambient temperature range and the expected CNG temperatures, as defined in this specification and GMW17759.

3.2.1.4 Minimum Fill Rate. The check valve shall meet CNG Subsystem minimum fill requirements testing, per GMW17759 namely, the CNG fuel subsystem and hence the check valve shall accept fuel from a NGV 1 or UN R110 approved fill nozzle at ambient temperatures of -40 °C to 50 °C (-40 °F to 122 °F) with an initial container pressure of 0.5 MPa (73 psi) and a final container pressure of 24.8 MPa (3600 psi) compensated for ambient temperature of 21 °C (70 °F) with an average fast fill rate of $\geq 6.0 \text{ GGE/minute}$ for North America and a final container pressure of 20 MPa compensated for ambient temperature of 15 °C with an average fast fill rate of $\geq 10 \text{ kg/minute}$ for UN R110 regions. Other regions may require country specific fill rates. Refer to the Program Specific Documents.

The requirement shall be tested at a CNG fill station with a three (3) bank system capable of a storage pressure of 30 MPa (4350 psi). The measurement shall be conducted via the pressure reading of the high pressure sensor in the CNG storage system during the fill. Final fuel density, multiplied by the nominal storage volume, divided by the refueling time shall reveal a mass flow equal or exceeding the requirements in this paragraph. This test shall be performed with the system and the filling station at -40 °C, -30 °C, 20 °C, and 50 °C.

Higher moisture content in the CNG may affect check valve functionality during fast fill, as the significant temperature drop associated with fast fill may freeze the check valve in the open position. This is more prevalent in North America than in Europe due to different CNG quality. This condition shall be comprehended and minimized or eliminated in the design of the check valve design. This condition is more prevalent in the receptacle integrated check valve.

3.2.1.5 Opening pressure. The opening pressure shall be $< 50 \text{ kPa}$.

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3.2.1.6 Check Valve Durability. The fuel check valve shall comply with durability specifications defined in ISO 14469, with the exception that 15 000 durability cycles shall be performed and at 125% of service pressure.

3.2.1.7 Refueling Cycle Thermal Impact. All components of the CNG fuel subsystem subjected to the CNG gas flow during refueling shall be subjected to 300 cycles of -40 °C to 100 °C to -40 °C (-40 °F to 212 °F to -40 °F) per the profile outlined in Table 2.

3.2.1.7.1 The components shall be powered and monitored for incidents during this test, however, all components shall meet the performance requirements following testing. This test is to validate the functional integrity of the CNG subsystem components under conditions of exposure to sudden temperature changes as could occur in extreme environmental conditions.

3.2.1.7.2 Test specimen components should be monitored for the following potential effects of thermal shock:

- Binding or slackening of moving parts.
- Mechanical failures due to rapid water or frost formation.
- Differential contraction or expansion of dissimilar materials.
- Deformation or fracture of components.
- Cracking of surface coatings.
- Leaking of pressure fittings/connections.

Table 2: Thermal Shock Test Requirements

Initial Temperature		Final Temperature		Duration of Exposure in minutes ^{Note 2}
in °C	in °F	in °C	in °F	
-40	-40	-40	-40	60
-40	-40	100	212	Note 1
100	212	100	212	60
100	212	-40	-40	Note 1

Note 1: Transitions moving abruptly to the next environment: 30 s maximum, or until component temperature stabilizes, whichever comes first.

Note 2: Or until component temperature stabilizes, whichever comes first.

3.2.1.8 Refueling Durability. The check valve shall meet subsystem refueling durability requirements specified in GMW17759.

3.2.1.9 Noise. The check valve connection to adjacent components shall minimize transmission of noise.

3.2.1.10 Electrostatic Discharge (ESD). The check valve shall not create ESD related failures in adjacent or downstream components.

3.2.1.11 Corrosion. The interfaces between components must satisfy the default functional corrosion requirements defined in GMW15272 and GMW14872, unless otherwise defined in the Vehicle Technical Specification (VTS) Representative paragraphs relative to corrosion.

3.2.1.12 Refueling Noise. During refueling, the check valve shall not generate objectionable noise at the refueling operator's ear level. The check valve shall not generate audible vibration or whistling noises during refueling, as defined in 3.2.1.4, leading to a minimum subjective rating smaller than 7.0 for the check valve, per GMW14264.

The noise level at the operator's ear location due to the refueling procedure shall be < 70 dB (A) arithmetically averaged sound pressure values between left and right ear utilizing a 50th percentile customer in a nominal position and stance, or:

$$\sqrt{0.5((dBL)^2 + (dBR)^2)}$$

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