



Type 1 CNG Fuel Container Assembly

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 specification establishes the requirements for a Type 1 Compressed Natural Gas (CNG) Fuel Container Assembly. The functions, performance, reliability, and validation requirements of the CNG Fuel Container Assembly are defined in this document or a reference is made to another applicable document.

1.2 Applicability. This specification applies only to Bi-fuel or dedicated (Mono-Fuel, Mono-Fuel Plus) CNG vehicles. It includes requirements for both complete and incomplete vehicles (i.e., cab chassis).

1.3 Remarks. The CNG Fuel Container Assembly is part of a functional assembly for receiving and storing CNG, as well as delivering the fuel to the fuel delivery system during use of the vehicle by the vehicle operator. The CNG Fuel Container Assembly shall carry out its function while meeting specific requirements of the customer and other interfaces. Mandated safety and emission standards and company objectives shall be met.

2 References

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

2.1 External Standards/Specifications.

ANSI NGV 2	CSA B51	ISO 11439	SAE J1344
ANSI NGV 3.1	FMVSS 303	ISO 11439	SAE J1616
Article 57	FMVSS 304	ISO 16232	SAE J1645
CMVSS 301	ISO 1431-1	NFPA 52	UN R110

Note: In addition to the documents listed in 2.1, program specific documents may apply to this specification and the supplier shall verify conformance to the standards and regulations listed in GMW17759, if applicable. Region specific standards and regulations shall be fulfilled as noted in GMW17759 for the region of sale.

2.2 GM Standards/Specifications.

GMW3059	GMW14101 (ID)	GMW14872	GMW15862
GMW3097	GMW14333	GMW15272	GMW16600
GMW3116	GMW14573	GMW15282	GMW17759
GMW3172	GMW14729	GMW15357	
GMW8738 (ID)	GMW14829	GMW15487	
GMW14089	GMW14854 (ID)	GMW15570	

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References

CG5101 (ID)

GM1927 Supplier Quality Statement of Requirements

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The CNG Fuel Container Assembly is a subassembly within CNG Fuel Storage Subsystem. It includes the container shut off valve and additional safety devices, such as thermal triggered pressure relief devices and/or pressure triggered pressure relief devices. The container assembly interfaces with CNG fill, regulator supply piping, and electrical wiring, and may interface with vent piping and an excess flow valve. In addition, the container assembly interfaces with the vehicle structure for mounting purposes. (e.g., strap mounting integration).

3.1.1 Appearance. The appearance of the CNG Fuel Container Assembly shall be consistent with the look of the original vehicle where visible to the customer. Colors of the CNG Fuel Container Assembly shall blend in with the rest of the vehicle. Bright colors shall be avoided except to aid in service identification, or if required by local regulation.

3.1.2 Content. The required physical and functional content for the CNG Fuel Container Assembly is identified in 3.1.2.1 thru 3.1.2.2.

3.1.2.1 Physical Content. The Type 1 CNG Fuel Container Assembly consists of:

- Steel tank with one (1) or two (2) threaded tank openings.
- Outer protective coating.
- Label(s).
- Container valve assembly.
- Valve protectors or helmets (optional).
- Container Relief Plug with secondary Temperature and/or Pressure Triggered Pressure Relief (optional).

3.1.2.2 Functional Content. The CNG Fuel Container Assembly shall:

- Receive fuel for storing up to the designed storage capacity.
- Store fuel in a safe, leak-free manner, as defined in 3.2.
- Support the controlled release of the stored fuel quantity down to the defined unusable content.
- Manage temperature variations due to fueling and defueling operations.
- Support mounting of the container to the vehicle structure.
- Support total release of the stored fuel quantity down to atmosphere in case of overheating or over-pressurization.
- Meet all corrosion requirements as defined in 3.2.1.4.

3.1.3 Ambient Environment.

3.1.3.1 Normal Operating Environment. The CNG Fuel Container Assembly shall meet 100% of the performance requirements specified in 3.2 of this document throughout its service life for all normal operating conditions stated herein. See Table 1 and Table 2.

Table 1: Ambient Temperature

Region	Minimum Temp	Maximum Temp
Worldwide Default	-48 °C (-55 °F)	52 °C (125 °F)
Russia (Siberia)	-51 °C (-60 °F)	Not applicable
Middle East	Not applicable	55 °C (130 °F)

Table 2: Normal Operating Environment

Underbody Air Temperature	-40 °C to 90 °C
Underhood Air Temperature	-40 °C to 180 °C
Trunk and Vehicle Interior Temperature (i.e., vans)	-40 °C to 77 °C
Relative Humidity	2% to 100%
Barometric Pressure ^{Note 1}	56.9 kPa to 106.3 kPa
Precipitation	≤ 4.6 mm/minute
Electromagnetic	Refer to GMW3097
Ozone	≤ 0.40 ppm

Note: Powertrain Integration Fuel Storage and Handling components shall be able to meet, or exceed, the minimum, continuous, and excursion temperature limits specified in 3.1.3.2.

Note 1: Regional requirements may require a lower barometric pressure due to their elevation. See the program specific document for clarification.

The constant maximum CNG temperatures inside the storage containers are limited to 57 °C (North America, 135 °F; NGV2) or 65 °C (United Nations (UN) R110). The CNG fuel storage container surface shall withstand a maximum temperature of 82 °C, according to the major standards maximum allowed CNG container surface temperatures. (UN R110 and ANSI NGV 3.1) Exceeding these temperatures, per Table 2, will be considered an excursion temperature occurrence.

3.1.3.2 Extreme Operating Environment. The excursion duration shall not increase the CNG temperature inside the storage container to more than the allowed continuous CNG temperature limits (see 3.1.3). Since there is a deviation of the maximum ambient temperature in the standards and the GM internal maximum temperature requirement of 82 °C, program dependent temperature requirements exceeding the applicable standards due to package position, must be evaluated, documented and applied in validation testing. To keep the surface and CNG temperatures within the regulatory requirements, additional measures (i.e., shielding) maybe needed.

3.1.3.3 Non-Operating Storage Environment. The CNG Fuel Container Assembly shall meet 100% of the normal performance requirements specified in 3.2 when returned to the operating environment defined in 3.1.3.1 after exposure to the following conditions.

Storage Temperature (empty tank): -48 °C to 82 °C (-54 °F to 180 °F).

3.1.3.4 Total Solar Radiation. Total solar radiation is defined as wavelengths between 295 nm and 2800 nm. The CNG Fuel Container Assembly shall meet all operating performance requirements, without loss of function or degradation of service life, under the operating environment defined in 3.1.3.1 after exposure to Solar Radiation. If the parts of the system are sensitive to Solar Radiation, they shall be protected.

3.1.3.5 Ultraviolet Radiation. Ultraviolet radiation is defined as wavelengths between 295 nm and 385 nm. The CNG fuel subsystem shall meet all operating performance requirements, without loss of function or degradation of service life, under the operating environment defined in 3.1.3.1 after exposure to Ultraviolet Radiation. If the parts of the system are sensitive to Ultraviolet Radiation they shall be protected.

3.1.3.6 Fuel Storage System Operating Pressures. The CNG Fuel Container Assembly shall be capable of operation with gauge pressures ranging from 0 MPa (0 psi) to a maximum of 125% service pressure or 31.0 MPa (4500 psi) for United States and Canada and maximum of 125% service pressure or 26 MPa for all other regions.

3.1.3.7 Corrosion. CNG Fuel Container Assembly 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). Suitable materials shall be used throughout the fuel subsystem to prevent galvanic corrosion. The CNG vehicle will be tested (by GM) for vehicle durability, per GMW8738. Layered corrosion, stress corrosion cracking and pitting corrosion of CNG Container Assembly shall not occur.

3.1.3.8 Environmental Intrusion Guidelines.

Note: These requirements will be tested by GM at the vehicle level.

3.1.3.8.1 Snow/Ice. The CNG Fuel Container Assembly shall experience exposure to snow and ice without degradation of performance.

3.1.3.8.2 Road Splash. The CNG Fuel Container Assembly shall experience periodic splash by water-based fluids from the road surface without degradation of performance.

3.1.3.8.3 Underhood/Underbody/Truck Bed Car Wash. The CNG Fuel Container Assembly shall experience periodic exposure to car wash spray (including soap spray) without degradation of performance.

3.1.3.9 Contamination. Appendix A, Table A1 identifies the potential contaminants which the CNG Fuel Container Assembly must withstand prolonged exposure to or be located, packaged, or protected from to assure no degradation from its design function. Appendix A, Table A2 identifies additional potential contaminants, which also need to be considered. The assembly shall be designed to meet all requirements from GMW16600.

3.1.3.9.1 Container Assembly Interior Cleanliness. The container shall be provided such that any interior particles shall meet the following:

- Maximum particle size distributions per component in the inner area (at delivery): < 350 µm.
- maximum permitted remaining contamination: 100 mg/m².

ISO 16232 shall be used to confirm these results. Outer component areas must be particle free, with an unaided visual check.

3.1.3.9.2 Test Fuels. The CNG Fuel Container Assembly shall be designed to support the specific regional CNG fuel composition and quality, as defined in UN R110 and ANSI NGV 2. Performance and quality of the container shall not be affected due to incompatibility between the container assembly and the CNG fuel.

3.1.3.10 Impact. The CNG Fuel Container Assembly shall meet all operational performance requirements, without loss of function or degradation of service life, when exposed to manufacturing installation equipment and all vehicle regulatory crashworthiness requirements. The results of the program specific simulation analysis will be converted into design requirements for the impact resistance of the components, as well as component impact test requirements (e.g., fall tower or sled tests) to assess the suitable component resistance. Finally, the total CNG Storage System shall be exposed to the standard fuel system vehicle crash tests.

3.1.4 Interfaces.

3.1.4.1 Component to Component. The CNG Fuel Container Assembly shall meet performance requirements in 3.2 if the container valve is removed from and/or reinstalled at least ten (10) times to the container during the CNG Fuel Container Assembly service life.

The CNG Fuel Container Assembly shall meet performance requirements in 3.2 if the Container Relief Plug is removed from and/or reinstalled at least ten (10) times to the container during the CNG Fuel Container Assembly service life.

The CNG Fuel Container Assembly shall meet performance requirements in 3.2 if the container valve helmets are removed from and/or reinstalled to the container during the CNG Fuel Container Assembly service life. Mounting of the helmets to the tank shall not affect the performance requirements in 3.2. Mounting details are provided by program specific documents.

3.1.4.2 Fuel Container – Valve interface. The valve container interface and Container Relief Plug with secondary Temperature and/or Pressure Triggered Pressure Relief shall have the interfaces as shown in Table 3. For specific part requirements see Program Specific Documents.

Table 3: Valve to Container Thread Interface

Valve type	Interface
External	M30×3.5 (1-1/8"-12 UNF) thread with radial sealing except the following: - China: M25×2 thread with axial sealing - India and South America: 3/4"-14 NPT
Internal	M55X2 with radial sealing except the following: South America: 2"-12 NPT or 1 1/2"-11 1/2 NPT

For the European region, the interface shall be designed to show the commonly referred to term of the "Rattlesnake Effect."

The container thread design shall allow disengagement of the valve O-rings with the valve still engaged to the container threads while still bearing the force of full service pressure on the valve housing. This feature notifies the operator by a clearly audible hissing sound that there is remaining pressure in the container. A geometric example for this feature is provided in Appendix C, Figures C1 and C2.

3.1.4.3 CNG Fuel Container Assembly – Relief Plug (Pressure or Temperature activated Pressure Release Device (PRD)). The CNG Fuel Container Assembly if required, shall provide a threaded interface for the Container Relief Plug with optional secondary Temperature and/or Pressure Triggered Pressure Relief:

Table 4: Container Relief Plug to Container Thread Interface

Container Relief Plug (optional secondary PRD)	Interface
Europe and UN R110 countries (if used)	M30×3.5 (1-1/8" – 12 UNF-2A with double "O" ring sealing radially)
North America	M30×3.5 (1-1/8" – 12 UNF-2B or 2" - 12UN-2A)
South America	3/4" – 14 NPT

3.1.4.4 Fuel Container Assembly to Subsystem. The CNG Fuel Container Assembly shall meet the performance requirements in 3.2 if removed from and/or reinstalled in the container straps at least ten (10) times during the CNG Fuel Container Assembly service life.

3.1.4.5 Tightness. The CNG leak rate service pressure at any CNG Container Assembly interface or CNG Container Assembly to subsystem interface shall be bubble tight. This is defined as $< 5 \text{ mbar}^* \text{L/s} \times 10^{-5} \text{ mbar}^* \text{L/s}$, per interface, over total service life for exterior leakage with 100% Methane at 0 °C. Using a standard leak detection solution, $5 \text{ mbar}^* \text{L/s} \times 10^{-5} \text{ mbar}^* \text{L/s}$ equates to no bubbles in 3 minutes or < 0.2 Normal cubic centimeters per hour (Ncc/h), where Ncc/h is at 0 °C and 101.3 kPa.

3.1.4.6 CNG Fuel Container Assembly interface to vehicle – Assembly. The CNG Container Assembly shall include features to locate the tank to the vehicle during assembly. Location shall be within $\pm 5 \text{ mm}$ from nominal design position. This shall be accomplished by either providing angled surfaces to nest against a mating surface on the vehicle or by dedicated locating tabs/bolt holes.

3.1.4.7 CNG Container Assembly to vehicle – Dynamic. The CNG Container Assembly shall include features to minimize the dynamic movement of the container assembly against the vehicle mounting surface. This shall be accomplished by either providing angled surfaces to nest against a mating surface on the vehicle or by dedicated locating tabs/bolt holes. The maximum allowable movement during G-loading (six (6) directions) to be determined by Computer Aided Engineering (CAE) analysis based on component clearance and strap/bracket fatigue limits.

3.1.5 Usage Definition. The service life shall be per UN R110 and ANSI NGV 2.

3.1.6 Refueling Cycles. The CNG Fuel Container shall meet all performance requirements in 3.2 when exposed to the gas cycles in Table 5. A total of 1650 filling cycles per service life shall be tested at the CNG Subsystem level. Of these, 1000 full filling cycles shall be tested from < 2 MPa to temperature compensated service pressure and 650 filling cycles shall be tested with different elevated storage system pressures. See Table 5.

Table 5: Refueling Cycle Fill Properties

Storage System Pressure Range	% Total Cycles	Cycles
Empty to Full	61%	1000
¼ to Full	14%	225
½ to Full	14%	225
¾ to Full	12%	200

Note: These requirements are in addition to the cycle requirements of UN R110 and ANSI NGV 2.

3.1.7 Fuel Cycle Temperature and Pressures (“Fast Fill”). The CNG Fuel Container Assembly shall meet all the operating performance requirements listed in 3.1.7.1 thru 3.1.7.3 without loss of function or degradation of service life, under the operating environment defined in 3.1.3.1 after exposure to the typical temperature dynamics of a “fast fill” operation. The resulting temperature change shall be applied at all possible initial operating temperatures throughout the range of 3.1.3.1.

3.1.7.1 Definition of pressure ramps and temperature dynamics at fast-fill.

- First pressure pulse at Fuel System Interface (upstream of the receptacle): 18 MPa (at empty container divided by the remaining unusable fuel mass inside the container).
- Pressure pulse duration: 0.7 s.
- Number of pulses: 2.

3.1.7.2 Average Fueling Rate. Flow rates in North America are up to 6 Gasoline Gallons Equivalent (GGE)/minute, up to 10 kg/minute for other regions.

3.1.7.3 CNG Temperature Data During a Fast Fill (Minimum Temperatures of the Gas Inside Components During Refueling). The average gas temperature can drop by -40 °C from the start fill gas temperature. Note: Local minimum average gas temperature inside components can remain at this temperature for as long as 20 s.

3.2 Product Characteristics. The required product characteristics for the CNG Fuel Container Assembly are identified in several different categories in 3.2.1 thru 3.2.5.

3.2.1 Performance Requirements. The assembly shall be designed and meet all requirements from UN R110, ANSI NGV 2, Korea Automobile Management Act enforcement regulations Article 57, NFPA 52, CSA B51, CMVSS 301.2, FMVSS 303 and FMVSS 304, and ISO 11439 standards as required by the region of sale. GMW14101 will be conducted by GM and the CNG Container Assembly shall meet the test requirements.

3.2.1.1 Receive Fuel. The CNG Fuel Container Assembly shall accept all industry standard fast fills at all ambient temperatures, as defined in 3.1.3. Initial container pressure shall be 0.5 MPa (73 psi) and have a final container pressure of 24.8 MPa (3600 psi). Pressure shall compensate for an ambient temperature of 21 °C (70 °F) with an average fast fill rate of at least 6.0 GGE per minute for North America and a final tank pressure of 26 MPa with an average fast fill rate of at least 10 kg/minute for UN R110 regions. Other regions may require country specific fill rates. Refer to the program specific documents. Deviations from this paragraph shall be approved by the System Bill of Material (BOM) Family Owner (BFO).

3.2.1.2 Store Fuel. The CNG Fuel Container Assembly and interface(s) shall meet the leak requirements in 3.1.4.5 for the service life at pressures between minimum and maximum allowable working pressure of the container under the environmental conditions specified in 3.1.3.