Specification for Fuel Storage and Handling Subsystem

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.

This standard provides the technical requirements for the Fuel Subsystem. This standard must only be used when invoked by a program-specific technical specification. References to the program-specific technical specification are included in this standard where program-specific requirements are expected to exist.

Note: The program-specific technical specification CG933 may include additional program specific requirements that are not referenced in this standard and may supersede any requirements included in this standard. In the case of any conflicts between this standard and the program-specific technical specification, the program-specific technical specification takes precedence.

1.1 Purpose. This standard establishes the Chassis Fuel Storage and Handling Subsystem (hereinafter referred to as fuel subsystem) requirements for General Motors gasoline, ethanol and methanol flex-fuel, and diesel fueled vehicles. Gasoline vehicles are designed to operate on gasoline and all legal gasoline-based fuel blends approved for use in gasoline powered vehicles. Ethanol flex-fuel vehicles are designed to operate on any gasoline-ethanol blend from 0% to 85%, and 100% ethanol depending on the market. Methanol flex-fuel vehicles are designed to operate on any gasoline methanol blend from 0% to 85%. For the remainder of this standard, flex-fuel vehicles will be used generically to encompass both ethanol and methanol flex-fuel vehicles, unless otherwise noted. Diesel vehicles are designed to operate on diesel and all legal diesel-based fuel blends approved for use in diesel powered vehicles. The functions, performance, design constraints, and validation required of the subsystem are directly defined in this standard or a reference is made to another standard.

This standard is a generic fuel subsystem specification that serves as a template to be used for developing a fuel subsystem specification for a particular platform or vehicle. In this form, this standard provides information required for developing a specification for a particular application, with only application specific addition, deletion, and modification.

1.2 Applicability. This standard applies only to gasoline, ethanol flex-fuel, methanol flex-fuel, diesel fuel, conventional and hybrid vehicles. It includes requirements for both complete and incomplete vehicles and for specific applications, such as police and taxi use.

1.3 Remarks. The fuel subsystem is a functional subsystem supporting and part of the gasoline (E0-E100) and diesel systems that make up the Fuel/Diesel Exhaust Fluid (DEF) Quantity Indication, Fuel/DEF Delivery, Fuel/DEF Refill, and Fuel/DEF Containment Features. The fuel subsystem is necessary for receiving and storing fuel; sensing and displaying fuel quantity; conditioning (cleaning or heating) fuel; supplying fuel to the engine; and (for gasoline and ethanol flex-fuel only) managing both refueling vapor (North America only) and fuel vapor generated during use of the vehicle by the vehicle operator. The fuel subsystem is to carry out these functions while meeting specific requirements of the customer, the powertrain and other interfaces, mandated safety and emission standards, and company objectives.

Flex-fuel vehicles may be designed to run on ethanol, methanol, or both depending upon regionally available legal fuels. Reference the program specific requirements or the Vehicle Information System (VIS) to determine the appropriate validation fuels.

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2 References

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

2.1 External Standards/Specifications.

70/220/EEC	ASTM A269	GB 18352.3	SAE J285
70/221/EEC	ASTM D6158	GSO 40	SAE J1140
40 CFR Part 80	CCR Title 13, Section 1968.1	ISO 527-1/2	SAE J1645
40 CFR Part 86	CCR Title 13, Section 2290	ISO 1431-1	SAE J1960
49 CFR Part 172	CMVR 115	ISO 3167	SAE J2044
Article 62 (Korea)	CMVSS 301	ISO 9158	SAE J2587
ASTM A249M	EPA-AA-RSPD-IM-98-1	ISO 9159	TRIAS 15-J017-01
ASTM A262	FMVSS 301	KOBD MOE Notification 2006-161	UL 94

2.2 GM Standards/Specifications.

9985406	GMW14106	GMW14854 (ID)	GMW15695 (ID)
9985784	GMW14234	GMW14857	GMW15696
GM6130M	GMW14264	GMW14859 (ID)	GMW15826
GM9060P	GMW14507	GMW14880 (ID)	GMW15862
GM9080P	GMW14508	GMW14889	GMW15873
GM9676P	GMW14509 (ID)	GMW14890	GMW15983
GMW3059	GMW14510	GMW14911	GMW15986
GMW3091	GMW14547	GMW14914	GMW16240 (ID)
GMW3097	GMW14555	GMW15017	GMW16438
GMW7699	GMW14573	GMW15048	GMW16494
GMW8518	GMW14638	GMW15198 (ID)	GMW16600
GMW14081	GMW14839	GMW15272	GMW17334
GMW14089	GMW14841	GMW15667	GMW17820

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2.3 Additional References [Note 1].

- Assembly Drawings: AKK99213, AKM53766, AKX06162, AKX12746, AMN74899, ANB88666
- Best Practice 112732
- Best Practice ELEC86-S5128
- Best Practice FSH-1
- Best Practice FSH-11
- Best Practice FSH-125
- Best Practice FSH-185
- Bill of Process (BOP)
- California Air Resources Board mail out Number 92-10
- California Air Resources Board mail out Number 96-31
- California Evaporative Emission (EVAP) Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles [Note 2]
- California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles [Note 2]
- CG933 Appendix C of Statement of Requirements (SOR)

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- CG1752 Data Sheet
- CG1937 Appendix C of Statement of Requirements (SOR)
- CG3546 Data Sheet
- CG3547 Data Sheet
- CG3548 Data Sheet
- Chassis Fuel Global Subsystem Leadership Team (GSSLT) System Robustness Document
- Chassis Fuel System Evaporative Emission Interface Control Document
- Component Technical Specification (CTS)
- Evaporative Emissions (EVAP) Subsystem Technical Specification Benchmark document
- Federal Motor Carrier Safety Regulations (FMCSR)
- Fuel System Vehicle Partitioning and Product Structures (VPPS) Section 15:05
- General Motors Europe Model ABE 78559/002
- Global Ground Clearance Guidelines
- Global Legal Database
- GM1927-3 Supplier Quality Statement of Requirements found in SupplyPower
- GM Chart Number 10093203
- GM Chart Number 22514086
- GM Engineering Materials and Processes Standards
- GM Part Number 15708574
- GM Serviceability Design Guidelines
- GME Chart Number 09156280
- Hazardous Materials Transportation Act
- Inspection Maintenance (IM) 240
- Installation drawings (GME only)
- LUKOIL Oil Company, Moscow, Russia (www.lukoil.com)
- Master Process Documents (MPD)
- Owner's Manuals (GM, as applicable)
- Powertrain Fuels and Lubes Website URL: http://powertrain.gm.com/portal
- PPEI 8774, found at URL: https://gmweb.gm.com/sites/PTI_GSSLT/Pages/PPEI.aspx
- Process Control Plan
- Service Manuals (GM, as applicable)
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS)
- Vehicle Technical Specification (VTS)
- Vehicle Information System (VIS) Interface Control Document (ICD) Global Database

Note 1: References that are limited to internal distribution within General Motors shall not be distributed outside the company. Contact the GM Lead Engineer for further instructions.
Note 2: References with a year included with the document title or identifying number are not related to the publishing date.

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3 Requirements

3.1 System/Subsystem/Component/Part Definition. The fuel subsystem shall provide the capability to receive and store fuel, sense fuel quantity, condition fuel, supply fuel to the engine, return unused fuel to the storage tank (where applicable), and capture fuel vapor (for all gasoline and flex-fuel applications, and refueling vapors for North America only) and manage fuel vapor in terms of storage, control, and recovery.

3.1.1 Appearance. See Program Subsystem Technical Specification (SSTS) and Vehicle Technical Specification (VTS).

3.1.2 Content.

3.1.2.1 Physical Content. The fuel subsystem shall have the features listed in 3.1.2.1.1 through 3.1.2.1.8.

3.1.2.1.1 Provide high-quality fuel filling characteristics.

3.1.2.1.2 Provide accurate indication of the quantity of stored fuel.

3.1.2.1.3 Control noise, thermal effects, and odor.

3.1.2.1.4 Supply clean fuel to the engine in accordance with powertrain requirements.

3.1.2.1.5 Manage the generation, storage, and escape of fuel vapor in/from the fuel subsystem (gasoline and flex-fuel only).

3.1.2.1.6 Interface with the Vehicle's Structure, Powertrain, and Electrical System.

- GM Powertrain will provide the vehicle's interface hardware and/or requirements for fuel pressure regulation, return fuel control, vapor purge control, and vapor leak detection.
- The vehicle's electrical interface is to provide the wiring, interface connections, and electrical loads for all electrical hardware.
- The vehicle's body/chassis interfaces, including meeting packaging and fastening integrity requirements.

The template interface control document(s) shall be reviewed and completed prior to creation of a Statement of Requirements (SOR) to capture the agreed upon interface items with GM Powertrain. See the template interface control documents in the VIS Global Interface Control Document (ICD) database, Fuel System Vehicle Partitioning and Product Structures (VPPS).

3.1.2.1.7 The fuel subsystem shall meet all internal and external applicable performance objectives and regulations. The design and operation of the fuel subsystem shall be in accordance with the applicable governmental safety regulations and company safety objectives. The fuel subsystem shall also conform to the requirements for fuel system integrity during other rear and side impacts, fire resistance of non-metallic fuel storage tanks (if used), and corrosion resistance as defined in the VTS standard paragraphs.

3.1.2.1.8 The Fuel Subsystem shall Provide the Following Functions and Interactions:

- Customer: Receive fuel and function without noise or odor as measured using GMW14264 Subjective Rating Scale.
- Government: Meet all applicable regulations.
- Powertrain: Provide fuel at the required flow and pressure, and manage Powertrain induced pressure pulsations, heat rejections, return fuel (where applicable), and relative motion.
- Environment: Meet emission requirements, and be robust to environmental conditions such as heat, pressure, contaminants, etc.
- Body/Chassis: Meet vehicle packaging constraints while not inducing any vehicle noise.
- Electrical: Identify power requirements, receive power, and provide signaling.
- Company: Meet goals and business objectives.

3.1.2.2 Functional Content. The fuel subsystem shall provide the functions listed in 3.1.2.2.1 through 3.1.2.2.9.

3.1.2.2.1 The subsystem shall receive fuel for storing up to the designed-in storage capacity.

3.1.2.2.2 The subsystem shall capture fuel vapor (applies to gasoline and ethanol flex-fuel only, and includes refueling vapors for regions where Onboard Refueling Vapor Recovery (ORVR) is required, currently North America, China proposed for a future date).

3.1.2.2.3 The subsystem shall store fuel in a safe manner.

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3.1.2.2.4 The subsystem shall sense fuel level and provide a signal of stored fuel quantity.

3.1.2.2.5 The subsystem shall sense tank pressure and enable vapor leak detection with gasoline and flex-fuel applications in enhanced Evaporative Emissions (EVAP) regions only. Reference PPEI 8774 for enhanced EVAP and fuel subsystem interfaces.

3.1.2.2.6 The subsystem shall supply cleaned fuel to the engine upon demand according to the pressure and flow requirements of the powertrain, and return excess fuel back to the storage tank (where applicable).

3.1.2.2.7 The subsystem shall manage vapor by limiting the generation and escape of the fuel vapor, and by transporting and storing the vapor for a later purge and combustion by the powertrain (gasoline and flex-fuel only).

3.1.2.2.8 The subsystem shall manage heat buildup in the fuel.

3.1.2.2.9 The subsystem shall filter purge air.

3.1.3 Ambient Environment. The ambient environmental conditions that the subsystem may encounter during its life are defined in 3.1.3.1 through 3.1.3.6.

3.1.3.1 Operating Environment. The fuel subsystem shall satisfy performance requirements within the conditions referenced in Table 1 and Table 2.

Table 1: Ambient Temperature

Region	Minimum Temperature	Maximum Temperature
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: Operating Environment Note 1

Underbody	-40 °C to 90 °C
Underhood	-40 °C to 180 °C
Relative Humidity	2% to 100%
Barometric Pressure Note 2	56.9 kPa to 106.3 kPa
Precipitation	≤ 4.6 mm/minute
Grades	≤ 30%
Electromagnetic	Refer to GMW3097
Ozone	≤ 0.40 part per million (ppm)

Note 1: Powertrain Integration Fuel Storage and Handling components shall be able to meet, or exceed, the minimum, continuous, and excursion temperature limits specified in CG3548.
Note 2: Regional requirements may require a lower barometric pressure due to their elevation. See the program specific document for clarification.

3.1.3.2 Non-Operating Pressure and Temperature. The fuel subsystem shall meet all operating performance requirements without loss of function or degradation of service life under the following non-operating conditions:

- Transport by airplane at altitudes up to 13 700 m.
- Free air temperature of -48 °C to 93 °C.

3.1.3.3 Fuels. The fuels and/or fuel characteristics that must be successfully accommodated by the subsystem are identified in 3.1.3.3.1 through 3.1.3.3.3.

3.1.3.3.1 Test Fuels. The fuels are identified in CG3547 and encompass descriptions of legal fuels that are defined by Federal or Regional Regulations and Corporate requirements. These test fuels are defined in the GM Powertrain Fuels and Lubes Website and shall be purchased from an approved supplier.

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The fuels shown in CG3547 will be used as the global default fuels in the validation of the subsystem; however, each program shall review the global default fuels with Global Fuel Board (Powertrain Fuels and Lubes) to ensure the default fuels are representative of the program Notice of Decision (countries of sale).

Powertrain Fuels and Lubes Website URL: http://powertrain.gm.com/portal.

3.1.3.3.2 Component Test and Other Fuels. The fuels identified in CG3547 encompass the characteristics of additional fuels that may be experienced in vehicle use and/or during subsystem development and validation. Environmental and vehicle level test fuels are defined in the GM Powertrain Fuels and Lubes Website. Component test fuels are described in GMW14914, and shall be purchased from an approved supplier. These fuels should be considered in component design and analysis.

3.1.3.3.3 Fuel Quality. The subsystem shall accommodate fuels with an average particulate contaminant level as described in the Fuel Pump Module Component Technical Specification (CTS) Template GMW14081.

3.1.3.4 Contamination. Appendix A, Table A1 identifies the potential contaminants which the fuel subsystem must withstand prolonged exposure to or be protected from to ensure no degradation to its design function.

3.1.3.5 Corrosion. Performance ratings are to be to underbody requirements per GMW15272.

3.1.3.5.1 Zinc Chloride exposure shall be considered per GMW16600.

3.1.3.5.2 Calcium Chloride exposure shall be considered per GMW16600.

3.1.3.6 Ultraviolet Radiation. For incomplete vehicle applications (e.g., cab chassis, cutaway G van, etc.), the exposed materials shall retain 75% of the original properties for tensile strength (ISO 527-1/2) after 1500 kJ/m^2 of accelerated exposure using Xenon arc weathering apparatus as described in SAE J1960. Tensile bars shall be prepared using ISO 3167. This requirement does not apply to complete vehicle applications.

3.1.4 Interfaces. The fuel subsystem interfaces with several physical entities that will affect or constrain its functionality and design. These interfaces are described in 3.1.4.1 through 3.1.4.3.5.

3.1.4.1 External-to-Vehicle to Subsystem. Descriptions of the associated major interfaces are given in 3.1.4.1.1 through 3.1.4.1.3.

3.1.4.1.1 Refueling Station. The fuel subsystem shall interface with gasoline, flex-fuel and diesel station pumps during refueling. The design and operation of the subsystem must address and satisfy 3.1.4.1.1.1 and 3.1.4.1.1.2.

3.1.4.1.1.1 The fuel subsystem components are to be compatible with any physical interface created by fuel pump nozzle insertion in the fuel fill pipe assembly. This applies for nozzles defined by SAE J285, SAE J1140, ISO 9158, and ISO 9159.

3.1.4.1.1.2 The fuel subsystem shall not cause the automatic shutoff feature of the pump nozzle to be inoperative or prematurely activated.

3.1.4.1.2 Vehicle/Station Operator. The fuel subsystem and its operation, if affecting the interfaces with persons fueling the vehicle or adding gasoline treatments to the fuel tank, shall:

3.1.4.1.2.1 Accommodate common-practice operations such as pump-nozzle insertion and removal.

3.1.4.1.2.2 Maintain a user-friendly (e.g., acceptable levels of force, sound, and odor) interface with the fueling operator.

3.1.4.1.3 Ambient. Potential fuel subsystem interfaces with the vehicle ambient are:

- Air in the fuel subsystem will be vented to the atmosphere during the fill operation for non ORVR applications, and vented to the vapor canister for ORVR type applications.
- Ambient air will be ingested and used for purging stored vapor within the canister to the engine.
- Some vapor may enter the atmosphere at times due to vapor management inefficiency or capacity limits in extreme ambient and vehicle dynamic conditions.
- Some liquid fuel may spill onto the ground under/near the vehicle during refueling if there is an attempt to overfill (per GMW14508) the fuel tank.

3.1.4.2 Subsystem to Subsystem. Interfaces between the fuel subsystem and other vehicle subsystems, systems, and features may constrain or drive the design of the fuel subsystem and therefore must be addressed during fuel subsystem design and development. The fuel subsystem implementation and operation in the vehicle

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must also successfully accommodate the identified interfaces. The physical interface requirements are defined in 3.1.2.1.8 and detailed in the fuel subsystem interface control documents.

- Subsystem names correspond to VPPS identified categories.
- System names correspond to System Engineering definitions.
- Feature names correspond to System Engineering definitions.

3.1.4.2.1 Restricted Fuel Flow Condition. Other vehicle subsystems, systems, and features shall not be damaged by a sudden, abnormal reduction/loss of fuel flow.

3.1.4.2.2 Crashworthiness. The fuel subsystem shall not fail any crashworthiness requirements by interactions with other vehicle subsystems, systems, and/or features.

3.1.4.3 Component to Component. Generic component to component interface requirements for the fuel subsystem are identified in 3.1.4.3.1 through 3.1.4.3.5.

3.1.4.3.1 Crashworthiness. The fuel subsystem components shall not create any leak that causes the subsystem to fail crashworthiness requirements. Components shall be designed to prevent unintended disconnection and damage to adjacent components.

3.1.4.3.2 Noise. Component to component connections shall minimize transmission of fuel subsystem noise.

3.1.4.3.3 Electrostatic Discharge (ESD). Components shall not create ESD or ESD related damage in adjacent or downstream components.

3.1.4.3.4 Corrosion. The fuel subsystem, components and interfaces between components shall satisfy the default functional corrosion requirements (GMW15272) of a safety related system defined as 15 years, unless otherwise defined in the VTS representative paragraphs relative to corrosion.

3.1.4.3.5 Thermal Integrity. The fuel subsystem, components and interfaces between components shall satisfy the requirements and evaluations found in UL 94, the Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing and GMW14911 Thermal Integrity: Vehicle Auto-Ignition Sensitivity Review.

3.1.5 Usage Definition. Usage conditions that the fuel subsystem may encounter are captured in CG3546. Refer to applicable General Motors CTS and vehicle validation test procedures for specific component and subassembly durability requirements.

3.2 Product Characteristics.

3.2.1 Performance Requirements. The functional performance requirements for the fuel subsystem are specified in 3.2.1.1 through 3.2.1.15. All requirements apply for the conditions specified in 3.1.3 and 3.1.5, except where noted. Special vehicle, operational, or ambient conditions may be identified in the performance requirements paragraphs.

3.2.1.1 Receive Fuel. The fuel subsystem shall receive fuel for filling the tank according to 3.2.1.1.1 through 3.2.1.1.10.

3.2.1.1.1 Fill Nozzle Compatibility. The fuel subsystem shall allow fuel fill with vapor recovery (gasoline and flex-fuel only) and non-vapor recovery type service station nozzles, with and without retaining springs, per nozzles defined in 3.1.4.1.1.1.

3.2.1.1.2 Shutoff, Spit-back, and Well-over (Well-back). The fuel subsystem requirements related to nozzle automatic shutoff and fuel spit-back are given here and/or specified in GMW14508.

3.2.1.1.2.1 Fuel fill shall be accomplished without causing the automatic shutoff feature of the nozzle to fail under all customer fill conditions defined in GMW14508.

3.2.1.1.2.2 Nozzle premature shutoffs and fuel spit-back shall not exceed the allowable limits defined in GMW14508.

3.2.1.1.2.3 The fuel subsystem shall contain 7% to 10% vapor space when tested to customer fill capacities described by GN/GE/GK-1 of GMW14508. A design study shall show venting of the fuel tank vapor space on grade conditions for the targeted vapor space (reference GMW15017).

A minimum of 7% vapor space shall exist (without fuel expansion) when overfilled per condition GN/GE/GK-2 or DN/DE/DK-2 of GMW14508. A design study shall show that at least one (1) vent valve is open on level ground at 7% vapor space, and with the fuel expanded 4% (3% vapor space remaining).

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Note: For extended range electric vehicles, the fuel tank shall vent under all conditions and grades, with a stuffed tank and 4% expansion to prevent liquid from accumulating in the venting system and contaminating the canister. Particularly when the vehicle remains full for an extended period of time (all electric driving) and when considering the allowable vent valve leakage specifications.

3.2.1.1.2.4 Spit-back for vehicles shall meet the applicable requirements of the Environmental Protection Agency (EPA) defined in Federal document 40 CFR, Part 86 (GMNA only). The global GM in-house requirement is defined in GM customer fill procedure GMW14508 (customer satisfaction).

3.2.1.1.2.5 The fuel subsystem shall limit the fuel tank pressure to 16.9 kPa (g) (68 in of H_20) for condition GN-9 of GMW14508 such that no loss of function of the subsystem occurs. Reference 3.2.1.1.9.

3.2.1.1.2.6 The fuel subsystem shall not well-over or expel fuel after customer fill tests, defined in GMW14508, with an after filling soak time of 5 minutes and an open filler pipe (fuel cap off or capless doors open).

3.2.1.1.2.7 The fuel subsystem spit-back shall be assessed on vehicles sold in North America without ORVR according to GMW15696 (testing may be required on ORVR applications. Reference criteria in GMW14508 while testing for EPA spit-back with the non-vapor recovery nozzles).

3.2.1.1.3 Maximum Fill Rate. The fuel subsystem shall accept a maximum fill rate per condition GMW15198 and GMW14508 as referenced in the appropriate refueling table (gasoline, flex-fuel, or diesel application).

Note: Different requirements may apply for commercial vehicles under Federal Motor Vehicle Safety Standards (FMVSS) and or Federal Motor Carrier Safety Regulations (FMCSR).

3.2.1.1.4 Filling on Grades. The fuel subsystem shall encompass the capability to be filled at service stations with up to 6% grade (3.4 degrees) for any vehicle attitude.

3.2.1.1.5 Fill Access.

- For North America, the fuel subsystem shall meet the access zone and fill requirements of the California Air Resources Board (CARB) Specification for Fill Pipes and Openings of Motor Vehicle Fuel Tanks. The CARB zone is a legal requirement and details are specified in the Fuel Fill Pipe CTS GMW15667 and the CARB documents, reference GMW14859.
- General Motors Europe Model ABE 78559/002 contains an access zone to achieve customer satisfaction, and shall also be considered.

Note: The CARB access zone is built off the fuel fill pipe to cap interface, the latching point (internal threads), and the restrictor position. It should be recognized that study files built off one interface may not work for other interfaces; therefore, care should be taken to ensure math studies are correctly constructed.

3.2.1.1.6 Return Fuel. If required, the fuel subsystem shall accommodate the highest potential return/bypassed fuel flow (nominal pump flow +5 sigma process variation) at 14 V Direct Current (DC) without adverse effect on subsystem/vehicle performance.

3.2.1.1.7 Electrostatic Grounding. The fuel subsystem shall provide for grounding of electrostatic charge buildup during fuel fill per the Fuel Fill Pipe CTS GMW15667. Grounding is defined as an electrical attachment or bonding to the vehicle's ground plane as defined in the VTS.

3.2.1.1.8 Fill Nozzle Aspirator Pressure. To avoid fill nozzle shutoff mechanism disruption, pressure internal to the fill pipe at the end of the nozzle shall not exceed 80% of the fuel fill pipe Z height or 2.5 kPa (gage) (10 in H_2O) whichever is less, relative to atmosphere for the complete set of refueling conditions defined in GMW14508.

3.2.1.1.9 Tank Pressure.

3.2.1.1.9.1 Maximum Tank Pressure. A capability to discharge liquid fuel and/or vapor to vehicle surrounding environment during refueling shall be provided to limit gauge pressure within the fuel subsystem to 16.9 kPa (gage) (68 in H_20) for all conditions of GMW14508.

Note: During a failed nozzle, a varying pressure condition may require the test to be run longer than the time specified in GMW14508 GN-9/GW-9 to allow the tank pressure to stabilize. Canister loading shall be assessed at 10 s only.

3.2.1.1.10 Liquid Carryover. The maximum liquid fuel carryover to the vapor canister during refueling shall not exceed the amount defined in GMW14508. Reference the appropriate gasoline refueling table.

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3.2.1.2 Capture Refueling Vapor (ORVR Where Specified). The fuel subsystem shall capture fuel vapor during refueling according to 3.2.1.2.1 through 3.2.1.2.2. Ethanol flex-fuel vehicles shall demonstrate compliance using both certification fuel (as defined by CARB and EPA) and E10 fuel. The Fuel Global Subsystem Leadership Team (GSSLT) direction shall determine the regions and markets where this is necessary.

3.2.1.2.1 Refueling Vapor Emission (ORVR Applications Only). Total vapor emissions from the fuel subsystem during the Federal Test Procedure (FTP) refueling test defined in Federal document 40 CFR, Part 86 shall satisfy the following requirements in 3.2.1.2.1.1 and 3.2.1.2.1.2.

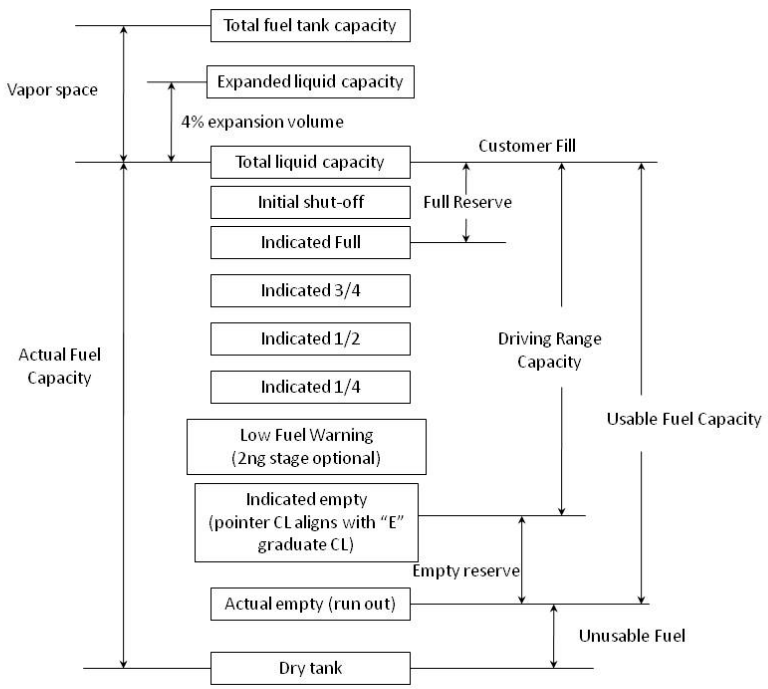
3.2.1.2.1.1 During a complete fuel tank refueling event, emissions from the fill head shall not exceed the EPA limit of 0.05 g/L (0.2 g/gal) of dispensed fuel, and should not exceed the GM goal of 0.03 g/L (0.1 g/gal) of dispensed fuel.

3.2.1.2.1.2 During a partial fuel tank refueling event under FTP conditions, (when adding 25% fill with manual shutoff) emissions shall not exceed 0.03 g/L (0.1 g/gal) of dispensed fuel.

3.2.1.2.2 Vapor Transported to the Canister (ORVR Applications Only). Under FTP refueling conditions, the (theoretical minimum) refueling vapor rate of 1.32g/L (5 g/gal) of dispensed fuel shall be considered in the design of the fuel subsystem.

3.2.1.3 Store Fuel. The fuel subsystem shall provide for fuel storage capacity and integrity according to 3.2.1.3.1 through 3.2.1.3.8.

3.2.1.3.1 Fuel Tank Capacity. Refer to GMW14106. The capacity definitions are illustrated in Figure 1.



Note: Driving Range Capacity is used in calculating the driving range (reference Best Practice 112732. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.). Advertised capacity is dependent upon regional practices (e.g., GME historically used driving range capacity as advertised volume, where GMNA is required by law to use Usable Fuel Capacity). CL = Centerline, E = Empty.

Caution: The VTS fuel capacity needs to be clearly understood and take into account regional advertised fuel capacity differences, to ensure correct fuel subsystem design imperatives. A VTS specified capacity shall be reviewed by the Design Engineer (DE) with the Program Team to ensure a clear understanding of the imperative.

Figure 1: Volume Definition

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3.2.1.3.2 Leak Integrity (Onboard Diagnostic Type Applications, North America, Korea, and India Only). The fuel subsystem shall not leak liquid fuel or vapor under the conditions defined in the "California Evaporative Emission Standards and Test Procedures (for 2001) and Subsequent Model Motor Vehicles", the "California Refueling Emission Standards and Test Procedures (for 2001) and Subsequent Model Motor Vehicles" and the EPA Federal Register 40 CFR Part 86, Subparts B and S. (**Note:** The year (2001) references Model Year and not publication date of the reference.) The For Europe and applications which adhere to 70/220/EEC, a conformity of production test is required, and shall be executed using GMW15873.

3.2.1.3.3 Fire Resistance. Refer to the Integrated Fuel Tank Component Technical Specification (CTS).

3.2.1.3.4 Unusable Capacity. Refer to the Integrated Fuel Tank CTS.

3.2.1.3.5 Fuel Containment. There shall be no fuel spillage due to vehicle maneuvers and fuels specified in GMW14880. Refer to the Integrated Fuel Tank CTS for further definition.

3.2.1.3.6 Thermal and Maneuver Induced Liquid Carryover. Liquid fuel (excluding condensed vapor) carryover to the vapor canister shall be less than the total of 17% of the canister EPA working capacity plus the liquid trap capacity for the canister as it is installed in the vehicle for any thermal and/or vehicle maneuver:

- Requirement applies to normal vehicle operations, as well as test procedures defined in GMW14880 and GMW15017.
- The maximum carryover in milliliters may be calculated as follows:
- (0.17 × EPA working capacity ÷ 0.75 specific gravity) + liquid trap capacity (milliliters).

Note: For Partial Zero Emission Vehicle (PZEV) applications, liquid carryover is limited to the vapor canister's liquid trap only.

- Liquid carryover shall not obscure the vapor pressure sensor vent path, when tested to GMW14880.

3.2.1.3.7 Fuel Expulsion Due to Tank Pressures. Refer to the Integrated Fuel Tank CTS.

3.2.1.3.8 Diagnostic and Purge Tank Pressure. The fuel subsystem shall be designed to be robust to pressure and vacuum conditions related to Powertrain diagnostics and purge.

- Standard Gasoline Powered Applications, -4.10 kPa (gage) to 1.86 kPa (gage).
- Evaporative Leak Check Pump (ELCP) type diagnostic, -4.55 kPa (gage) to 3.5 kPa (gage).

The fuel subsystem components shall be robust to these pressure levels to avoid undue warranty and/or customer complaints (for example, but not limited to, excessive tank deflection which may cause a perceptible shift in the fuel gauge Instrument Panel (IP) position or fuel tank capacity). Permanent deformation of the fuel tank is not allowed. Reference GMW14508.

3.2.1.4 Sense Fuel Quantity. The fuel subsystem shall sense fuel quantity in the tank according to 3.2.1.4.1 and 3.2.1.4.2.

3.2.1.4.1 Static Fuel Quantity Signal Accuracy. The fuel quantity signal proportional to fuel volume shall be accurate within the lesser of ± 1.9 L (0.5 gal) or ± 3.0% of usable fuel when the vehicle is in either of the following states.

- The vehicle is stationary and level within ± 2 degrees in any combination of pitch and roll.
- The vehicle is moving at nearly constant speed, e.g., with less than 0.34 m/s^2 instantaneous or constant acceleration or deceleration, on surface grades < 3.5%.

3.2.1.4.2 Dynamic Fuel Quantity Signal Accuracy. The fuel quantity signal proportional to fuel volume shall be accurate within ± 2.4% of usable fuel at indicated empty and linear to ± 4.8% of usable fuel at indicated full.

3.2.1.4.3 Fuel Quantity Signal Validity. The fuel subsystem shall provide a valid fuel quantity signal in all vehicle orientations up to grades of 30%.

3.2.1.5 Supply Fuel. The fuel subsystem shall supply fuel to the engine according to 3.2.1.5.1 through 3.2.1.5.9.

3.2.1.5.1 Flow and Pressure. The fuel subsystem shall meet the minimum flow and the pressure requirements of the specific Powertrain and Platform and captured in the ICD with GM Powertrain. The Fuel Pump and Sender Module CTS GMW14081 may be referenced along with the Platform/Powertrain fuel delivery ICD for gasoline system, and/or GMW17820 for diesel fuel application interfaces.

GMW15695 and/or GMW14507 shall be performed to evaluate fuel delivery requirements of the fuel subsystem and to determine fuel subsystem losses and/or backpressure of the fuel subsystem.

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Diesel applications shall be evaluated using GMW14507 criteria.

Note: Maximum delivery fuel subsystem pressure shall be limited per the Fuel Pump and Sender Module CTS GMW14081 pressure relief section (approximately 900 kPa (g) to 1000 kPa (g)).

3.2.1.5.2 Low Fuel Starting Performance. Refer to the Integrated Fuel Tank CTS.

3.2.1.5.3 Low Fuel Performance.

3.2.1.5.3.1 Lateral and Longitudinal Accelerations.

3.2.1.5.3.1.1 Standard Performance. The feature shall maintain fuel flow and pressure as specified in 3.2.1.5.1 with a lateral and longitudinal acceleration range of -9 m/s^2 to 9 m/s^2 for a duration of 20 s and transitions of 500 ms when tested in the vehicle down to a 10% fuel volume.

3.2.1.5.3.1.2 High Performance. The feature shall maintain fuel flow and pressure as specified in 3.2.1.5.1 with a lateral and longitudinal acceleration range of -15 m/s^2 to 15 m/s^2 for a duration of 20 s and transitions of 500 m/s when tested in the vehicle down to a 10% fuel volume.

3.2.1.5.4 Electrostatic Discharge. The fuel subsystem shall not generate an electrostatic charge, or create ESD related damage at any point in the fuel subsystem.

3.2.1.5.5 Fuel Supply for Onboard Generators. Refer to the Integrated Fuel Tank CTS.

3.2.1.5.6 Auxiliary Fuel-Fed Devices. Any auxiliary fuel-fed device shall be able to operate using normal commercial fuels described in 3.1.3.3.

3.2.1.5.7 Pressure Pulsations. The fuel subsystem shall be limited to pressure pulsations as detailed in the Platform/Powertrain ICD. GMW16240 shall be used to evaluate Spark Ignition Direct Injection (SIDI) engine generated pulsations in vehicle and their amplitude within the chassis fuel subsystem components.

Note: In most applications, a feed line check valve is used to control pulsations from the SIDI engine mounted fuel pump. GM Powertrain is responsible for packaging the check valve; however, in some limited cases the Chassis Fuel System Subject Matter Team (SMT) may be required to package the valve.

3.2.1.5.8 Filtered Fuel. The fuel subsystem shall deliver clean filtered fuel per the filtration specifications contained within the Fuel Pump Module CTS GMW14081, the Diesel Fuel Filter CTS GMW14839, and/or the Gasoline and Flex-Fuel Filter Assembly GMW16438.

Note: Gasoline fuel filters are located internal to the fuel pump module except for regions with high particulate content which may require regular servicing of the fuel filter, as identified in the Chassis Fuel GSSLT System Robustness document.

Note: All diesel applications in all regions shall have external fuel filters.

Note: Fuel pressure regulators located in the fuel subsystem must receive filtered fuel to prevent debris from affecting the regulators function (reference 3.7.1.5 and GMW14081).

3.2.1.5.9 Manage Heat.

3.2.1.5.9.1 Gasoline and Flex-Fuel and North America Only. The fuel subsystem shall be designed to minimize bulk fuel heating. The bulk fuel temperature rise within the fuel tank shall not exceed 16.7 °C (30 °F) when executing the running loss portion of the CARB procedures. For E85 compliant vehicles or vehicles with E10 certification fuel, the fuel temperature rise shall not exceed 12.8 °C (23 °F).

The CARB running loss procedures are identified in the California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles and the California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles. (**Note:** The year (2001) references Model Year and not publication date of the reference.)

Note: Smaller fuel tanks, such as those used in hybrid applications, may warm quickly due to the lower thermal mass/volume.

Note: Low Emission Vehicle (LEV) III utilizes E10 as the certification fuel; therefore, the temperature rise shall not exceed the 12.8 °C (23 °F) delta temperature.

3.2.1.5.9.2 Diesel Applications. Fuel delivered to the engine shall not exceed 80 °C continuous or 90 °C excursion when tested to GMW14507, GMW14854, and GMW14555. Reference 3.2.1.8 for bulk fuel temperature.

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Note: GM Powertrain may calibrate certain diesel engines with a “power reduction” or “pump protection mode” under hot fuel conditions. If this feature is enabled, the maximum temperature requirement identified in this section may be exceeded with GM Powertrain’s agreement.

3.2.1.5.10 Run Dry. The fuel subsystem when run out of fuel, shall be completely functional after a subsequent refill event.

Note: Electronically Regulated Fuel System (ERFS) type subsystems shall have logic to prevent the fuel pump from running after fuel run out or at a predetermined loss of pressure (below standard operating pressures, as detailed in the Powertrain/Platform Fuel Pump Module (FPM) Assembly ICD).

Note: Mechanically Regulated Fuel Systems (MRFS) type subsystems with dual fuel tank configurations shall have logic to prevent the secondary/auxiliary fuel pump from running for an extended period of time as the secondary/auxiliary fuel tank empties. For example, this condition may be achieved by allowing the fuel pump to run only for a specific period of time when the fuel level falls below a certain calibrated level.

3.2.1.6 Manage Fuel Vapor. The fuel subsystem shall manage fuel vapor according to the limits and conditions of 3.2.1.6.1 through 3.2.1.6.3.

3.2.1.6.1 Vapor Generation and Escape. The fuel subsystem requirements for control of vapor generation and escape are:

- The fuel subsystem shall provide a minimum vapor odor (Rating Trace (8) or better per GMW14264 “Subjective Rating Scale”) inside the passenger compartment with the windows closed and the air conditioning (A/C) operating in the fresh air mode while driving in accordance with the City Traffic schedule defined in GMW14509.
- The fuel subsystem shall provide a minimum vapor odor (Rating of Moderate (6) or better per GMW14264 “Subjective Rating Scale”) outside the vehicle when standing at each entry door with the vehicle stopped or parked while performing the City Traffic schedule defined in GMW14509.
- Refer to the Integrated Fuel Tank CTS for additional requirements.

Note: The underbody fresh air vent shall not be located adjacent to a passenger compartment air vent, or have a direct air path to the passenger compartment.

Note: The “Subjective Rating Scale” rating may be averaged to address operator sensitivities/biasing (jury assessment rather than single voice). Rating verbiage is used to avoid intermediate scale rating allowed by GMW14264, and to account for the influence of other vehicle subsystem, system, or feature emissions (e.g., engine oil, transmission oil, etc.)

Note: Turbo charged engine applications purge under different conditions than naturally aspirated engines. Test and validation plans may require both a naturally aspirated and a turbo charged engine to be tested within a platform/architecture, if each type of engine exists in the program. If multiple turbo charged engines exist in the same platform/architecture, additional discussion with GM Powertrain calibration is required to establish a worst case vehicle selection.

3.2.1.6.2 Vapor Transportation and Storage. The fuel subsystem shall transport and store vapor for controlled purge and combustion in the engine.

The vapor purge components shall meet the Powertrain purge restriction requirements found in the VIS Global ICD database, fuel system, emissions interface, found in the Fuel System VPPS. The system may be evaluated using hardware and physical tests or simulated using Computer Aided Engineering (CAE) analysis.

Turbocharged applications have a purge line check valve packaged between the purge solenoid and the intake plenum released by GM Powertrain. In very limited cases, packaging constraints may dictate the check valve be located in the chassis purge line. This location change shall be defined and negotiated during development of the Platform/Powertrain Emissions ICD.

3.2.1.6.3 Tank Vapor Pressure. The fuel subsystem requirements for constraining the vapor pressure within the tank are defined in 3.2.1.6.3.1 through 3.2.1.6.3.3.

3.2.1.6.3.1 For gasoline and flex-fuel applications, the fuel subsystem shall prevent pressure from falling below -8.0 kPa (-32 in H_2O) relative to atmospheric pressure.

For diesel applications, the fuel subsystem shall prevent pressure from falling below -5.5 kPa (gage) (-22 in H_2O) relative to atmospheric pressure.

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