GM WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW15986

Fuel and Vapor Purge Lines Component Technical Specification

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 Fuel Feed, Fuel Return and Vapor Purge Lines. This document shall only be used when invoked by a program-specific technical specification. References to the program-specific technical specification are included in this document where program-specific requirements are expected to exist.

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

1.2 Applicability. This document applies to gasoline and diesel vehicles only.

1.3 Remarks. The fuel feed/return and vapor purge lines shall provide the capability to transfer liquid fuel and fuel vapor, respectively. These lines are to carry out these functions while meeting specific requirements of the customer, fuel subsystem interfaces, mandated safety standards, emission standards, and company objectives.

2 References

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

2.1 External Standards/Specifications.

ASTM A269	IATF 16949	SAE J1645	SAE J2587
ASTM A666	ISO 11469	SAE J2044	
ASTM D1175	ISO 12345	SAE J2045	

2.2 GM Standards/Specifications.

9985784	GMW14754	GMW15733	GMW17334
GMW3059	GMW14854 (ID)	GMW15862	GMW17540
GMW3116	GMW14872	GMW16600	GMW17560
GMW14234	GMW14911	GMW16709	GMW17568
GMW14555	GMW15272	GMW16776	GMW17752
GMW14638	GMW15309	GMW17000	GMW17823
GMW14655	GMW15311	GMW17136	

(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.

- 10442882
- 10445318 Label
- 14087086 Chart
- CG1752
- CG2022

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- CG3546
- CG3548
- Fuel Storage and Handling Subsystem Technical Specification (SSTS)
- GM1730
- GM1747
- GMPT-6-006 (ID)
- GMPT-6-019 (ID)
- GMPT-6-020 (ID)
- GMPT-3-007 (ID)
- GMPT-6-025 (ID)
- GMPN 10442882 (ID)
- GM Chart drawing 10093203
- GM Serviceability Pamphlet Design Criteria for Lifting, Towing, and Washing GM Cars and Light Trucks

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The fuel feed and vapor purge lines are to provide the following functions:

- Fuel Feed Line: It allows clean liquid fuel to be transferred to the powertrain from the fuel tank.
- Fuel Return Line: It allows liquid fuel to be transferred from powertrain back to the fuel tank.
- Vapor purge line: It allows fuel vapor to be transferred to the powertrain from the vapor canister.

A functional context diagram for the fuel feed/return and vapor purge lines is given in Appendix A, Figure A1.

3.1.1 Appearance. Not applicable.

3.1.2 Content. The required physical and functional content for the fuel feed/return and vapor purge lines are identified in the following paragraphs.

3.1.2.1 Physical Content. The fuel feed/return and vapor purge lines typically include the following parts:

- Quick connectors.
- Crimped fittings.
- Interference fittings.
- Clips.
- Liquid fuel pressure sensor.
- Rigid lines.
- Flexible lines.
- Protective sleeves.
- Ground clip/bracket.
- In-line fuel filter.
- Fuel caution label.
- Fasteners.
- Spark Ignition Direct Injection (SIDI) check valve.
- Flex fuel alcohol sensor.
- Fuel pulsation damper.

3.1.2.2 Functional Content. The fuel feed/return and vapor purge lines are to provide the following primary functions:

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3.1.2.2.1 The fuel feed line shall transfer clean fuel from the fuel tank to the powertrain according to the pressure (kPa) and flow requirements (g/s) of the powertrain.

3.1.2.2.2 The fuel return line shall transfer fuel from the powertrain to the fuel tank according to the pressure (kPa) requirements (Diesel) of the powertrain.

3.1.2.2.3 The vapor purge line shall transfer fuel vapor through the canister from fuel tank to the powertrain.

3.1.2.2.4 The fuel feed/return and vapor purge lines shall contain liquid fuel and fuel vapor.

3.1.2.2.5 The fuel feed/return and vapor purge lines shall be mounted to the underbody or frame.

3.1.3 Ambient Environment. The ambient environmental conditions to which the lines may be exposed within their useful life are defined in the following paragraphs.

3.1.3.1 Ambient Air Temperature. See program Component Technical Specification (CTS).

3.1.3.2 Operating Environment. See program CTS.

3.1.3.3 Non-Operating Conditions. The fuel feed and vapor purge lines shall meet all operating performance requirements under the operating environment defined in 3.1.3.2 without loss of function or degradation of service life after exposure to the following non-operating conditions:

3.1.3.3.1 Transport by airplane at altitudes up to 13 700 m.

3.1.3.3.2 Free air temperature of -48 °C to 93 °C.

3.1.3.3.3 Transport by ground via haul-away carriers, and/or ship, train.

3.1.3.4 Fuels. Test fuels shall be obtained from GM approved test fuel suppliers.

3.1.3.4.1 Soak Fuels. The fuel feed/return and vapor purge lines shall be capable of withstanding exposure to the fuels identified in Appendix A, Table A1. Reference the Fuel Storage and Handling Subsystem Technical Specification (SSTS), for the complete list of fuels applicable to the fuel subsystem and its components.

3.1.3.4.2 Permeation Fuels. Appendix A, Table A2 identifies the fuels that shall be used for permeation tests.

3.1.3.5 Potential Contaminants. Appendix A, Table A3 identifies the potential contaminants that the fuel feed/return and vapor purge lines shall either withstand prolonged exposure to or be located, packaged, or protected from to assure no degradation from its design function.

3.1.3.5.1 Corrosives. See GMW15311.

3.1.4 Interfaces. The following interfaces will affect or constrain the functions, performances, and designs of the fuel feed/return and vapor purge lines.

3.1.4.1 Assembly Plant Usages. The fuel feed/return and vapor purge lines design shall accommodate the assembly plant installation requirements.

3.1.4.1.1 Restricted Fuel Flow. The fuel feed/return and vapor purge lines design shall account for usual road debris to avoid damages that may cause reduction/loss of flow.

3.1.4.2 Component to Component. The following paragraphs describe the interfaces between the fuel feed/return and vapor purge lines and other components.

3.1.4.2.1 Fuel Tank Lines. The fuel feed/return and vapor purge lines will interface with the fuel tank lines such as the fuel tank feed/return line and the vapor canister purge line. The design and operation of these lines shall satisfy the following conditions:

3.1.4.2.1.1 The fuel feed/return and vapor purge line ends shall provide leak free joints.

3.1.4.2.1.2 The fuel feed/return and vapor purge lines shall be free of blockage or restriction.

3.1.4.2.1.3 The fuel feed/return line shall be sufficiently conductive according to SAE J1645 and electrically connected to allow any electrostatic charge buildup to be properly dissipated to vehicle ground.

3.1.4.2.1.4 The fuel feed/return and vapor purge lines shall be error proofed to avoid misconnection.

3.1.4.2.2 Underbody or Frame and Motor Compartment. The fuel feed and vapor purge lines will be mechanically attached to the underbody or frame. The design and operation of these lines shall satisfy the following conditions:

3.1.4.2.2.1 The fuel feed/return and vapor purge lines shall minimize transmission of subsystem noise.

3.1.4.2.2.2 The fuel feed/return and vapor purge lines shall be free of squeaks and rattles.

3.1.4.2.2.3 The fuel feed/return line shall not create any leak that causes it to fail crashworthiness requirements.

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3.1.4.2.2.4 The fuel feed/return and vapor purge lines shall not create any leak that causes them to fail evaporative emission requirements.

3.1.4.2.2.5 The liquid fuel line(s) shall have an electrical ground path.

3.1.4.2.2.6 The fuel feed/return and vapor purge lines shall be adequately secured.

3.1.4.2.3 Powertrain. The fuel feed/return and vapor purge lines will interface with Powertrain through the fuel rail/high pressure pump or fuel feed/return jumper line and the purge solenoid. The design and operation of these lines shall satisfy the following conditions:

3.1.4.2.3.1 Fuel Rail/High Pressure Pump or Fuel Feed/Return Jumper Line.

3.1.4.2.3.1.1 The fuel line end shall provide a leak free joint.

3.1.4.2.3.1.2 The fuel line shall be free of blockage or restriction.

3.1.4.2.3.1.3 The fuel line shall be efficiently conductive according to SAE J1645 and electrically connected to allow any electrostatic charge buildup to be properly dissipated to vehicle ground.

3.1.4.2.3.1.4 The fuel line shall allow for powertrain movement, engine roll, and vibration.

3.1.4.2.3.1.5 Stainless steel quick connect with stainless steel redundant clip or plastic quick connects like described in 3.7.1.1.1 shall be used for all connections.

3.1.4.2.3.1.6 If a different material than GMW17540 is used, underhood thermal simulations and hardware measurements are required to prove that the selected material is capable for these temperatures.

3.1.4.2.3.2 Purge Solenoid.

3.1.4.2.3.1 The vapor purge line shall be free of blockage or restriction.

3.1.4.2.3.2 The vapor purge line shall allow for powertrain movement, engine roll, and vibration.

3.1.4.2.3.3 Quick connect like described in 3.7.1.1.1 with connection verification feature shall be used for this interface.

3.1.4.3 Chassis Structures Interface.

3.1.4.3.1 The fuel feed/return and vapor purge lines should be mechanically attached to the body/chassis structures with attachment features (e.g., holes) provided by the body/chassis structures.

3.1.4.3.2 Body/chassis structure attachment features should provide electrical grounding of the lines to meet the requirements of Electrostatic Discharge (ESD) if the engine fuel rail is not grounded.

3.1.5 Usage Definition. Refer to CG3546 as well as the Program Vehicle Technical Specification (VTS).

This requirement shall not be confused with the component target life according to 3.2.3.

3.1.5.1 Underhood Wash. See GMW15311.

3.1.5.2 Vehicle Wash. See GMW15311.

3.1.5.3 Road Splash. See GMW15311.

3.1.5.4 Water Submersion/Fording. See GMW15311.

3.2 Product Characteristics.

3.2.1 Performance Requirements. The functional performance requirements for the fuel feed/return and vapor purge lines are specified in 3.2.1.1 and 3.2.1.4. All requirements apply for the conditions specified in 3.1.3 and 3.1.5, except where noted otherwise. Special vehicle, operational or ambient conditions may be identified in the performance requirement paragraphs.

3.2.1.1 Fuel Feed Line Maximum Pressure. See program CTS.

3.2.1.2 Fuel Feed Line Maximum Flow Restriction. See program CTS.

3.2.1.3 Vapor Purge Line Flow Restriction. See program CTS.

3.2.1.4 Leak Detection. For leaks to the atmosphere, the component (aka Fuel Line Bundle per GMW15311) shall satisfy the leak requirements found in GMW15311.

3.2.1.5 Vapor Emissions. The complete fuel and vapor line assembly must meet its Hydrocarbon (HC) Permeation allocation, which may be specified in the program CTS. Review the materials, lengths, diameters, and packaging environment of all non-metallic components in the complete fuel and vapor line assembly with the GM Evaporative Emissions Bill of Materials (BOM) Family Owner (BFO). The Evaporative Emissions BFO

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will calculate the expected HC permeation based upon existing data if possible. If HC permeation data for any non-metallic components is not available, testing per GMW16776 and CG1752 will be required.

3.2.1.6 Squeaks and Rattles. See GMW15311.

3.2.1.7 Electrostatic Charge Dissipation. The resistance from any point on the Identification (ID) of a fuel line to vehicle ground shall not be more than 1 mΩ in resistance.

3.2.1.8 Crashworthiness. The fuel line shall not have and/or create any leak that causes the fuel system to fail crashworthiness requirements.

3.2.1.9 Fuel Feed Line Hammer. The fuel feed line will see pressure pulsations up to 20 kPa.

3.2.1.10 Mechanical Attachment to Vehicle. The attachment feature shall not exceed the maximum installation effort requirements or torque requirements, per type of attachment.

3.2.1.10.1 Line to Clip Attachment. The maximum pipe deformation of Polymide (PA) tube captured within a retention clip shall be < 10% of the tube Outer Diameter (OD). The deformation shall be measured after 24 h of storage at 120 °C.

3.2.1.10.1.1 The minimum clip to line retention requirement is 175 N. Hold the clip in the fixture at its body mounting point(s). Grasp the line on each side of the clip and pull in the direction opposite of the installation direction until the line separates from its channel in the clip. Record the force at which the separation occurred.

3.2.1.10.1.2 Line insertion efforts shall not exceed GM Ergonomic requirements in GMW14234. Hold the clip in the fixture at its body mounting point(s). Force is to be applied to the line on both sides of the clip. Record the force required to seat the line into its channel.

3.2.1.10.1.3 Repositioning. The following represents the requirements for clip repositioning forces on the line (for isolated Bundle Clips only).

- 50 N Will not move.
- 179 N Must move.

With the clip help stationary, apply force to the line on both sides of the clip and in the direction parallel to the axis of the clip.

3.2.1.10.2 Clip to Body Attachment. Clips used to attach the lines to the body or body frame, shall utilize one (1) of the three (3) attachment schemes listed below, as required by the specific platform or program:

3.2.1.10.2.1 Push-on to Weld Stud. Clip installation efforts shall not exceed GM Ergonomic requirements in GMW14234. Grasp the clip at the weld stud location and measure the force required to fully seat the clip onto the weld stud for which it is designed.

3.2.1.10.2.1.1 Locations that allow full hand access at vehicle assembly = 80 N maximum.

3.2.1.10.2.1.2 Locations that only allow finger access at vehicle assembly = 45 N maximum.

3.2.1.10.2.2 Push-on to Body Hole via Push-On or Christmas Tree on Clip. Clip installation efforts shall not exceed GM Ergonomic requirements in GMW14234. Grasp the clip at the body retainer location and measure the force required to fully seat the clip into the body hole for which it is designed.

3.2.1.10.2.2.1 Locations that allow full hand access at vehicle assembly = 80 N maximum.

3.2.1.10.2.2.2 Locations that only allow finger access at vehicle assembly = 45 N maximum.

3.2.1.10.2.3 Pull of Clip from Body. The clip must provide a secure attachment to platform component that will exceed 200 N with force applied axially to the attachment point. Hold the clip in the fixture at its body mounting point(s). Force is the be applied to the clip on both sides of the body attachment.

Nut and Bolt attachments shall meet the torque requirements that are specific to the nut and bolt sizes used. Torqueing the nut and bolt shall not cause the line to disconnect from its clips.

3.2.1.11 Internal Cleanliness. The fuel feed/return line and vapor line internal cleanliness requirements are given in the following paragraphs.

3.2.1.11.1 Fuel Lines. The internal cleanliness of all Gasoline fuel lines and Diesel return and feed lines, prior to the filter, shall be tested according to SAE J2045. When tested according to SAE J2045, the component shall contain ≤ 0.15 g/m^2 (flexible tubing assembly) or ≤ 0.25 g/m^2 (flexible tubing assembly with steel tubing attached) of interior surface area.

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3.2.1.11.2 Diesel Feed Lines (clean side). The diesel feed lines after the filter (clean side) shall be tested according to ISO 12345. The cleanliness requirements are shown in Table 1. It may require a washing of the line to achieve the target values of Table 1.

Table 1: Cleanliness Requirements

Size Class (µm)	Number of permitted particles
50 to 100	300
100 to150	80
150 to 200	30
200 to 400	25
400 to 600	10
> 600	0

3.2.1.12 Resistance to Externally-Induced Damage or Degradation. This paragraph specifies the maximum allowable changes in the component when it is exposed to specific environmental or other external conditions. The requirements may apply under either one-time or multiple exposures.

Note: This paragraph applies to potential damage or degradation of subsystems and components that are not covered in 3.2.1. This damage or degradation is caused by specific levels of exposure that falls within the time duration, wear out, and incidents-per-vehicle documented in 3.2.3.1 and 3.2.3.2.

3.2.1.12.1 Corrosion Resistance. The Fuel Lines shall meet the corrosion performance and validation requirements of GMW15272.

3.2.1.12.1.1 Testing for cosmetic corrosion performance of underbody components shall be to GMW14872, UB, Method 1/2, Exposure A. Underhood components shall be tested to GMW14872, UH, All, Method 1/2, Exposure B. Cosmetic corrosion performance shall meet GMW15272 Appendix A, Table A1, Suffix J or H (as applicable).

3.2.1.12.1.2 Testing for functional corrosion performance of underbody components shall be to GMW14872, UB, Method 1/2, Exposure E. Underhood components shall be tested to GMW14872, UH, All, Method 1/2, Exposure E. Functional corrosion is to be evaluated as described in GMW15272. In addition, the fuel and vapor lines shall not leak after corrosion testing when tested per the conditions of the production air leak check specified in 3.2.1.15.

3.2.1.13 Fuel Filter Filtration Performance. See Fuel Pump Module CTS.

3.2.1.14 Fuel Filter Performance. Metal fuel Filters per Preferred Materials Catalog (PMC).

3.2.1.15 Fuel Line Assemblies Production Leak Check. Fuel line assemblies shall be leak tight to an equivalent 15 µm standard, reference GMW15311 and SAE J2587. Vapor line assemblies shall be leak tight to an equivalent 20 µm standard (reference SAE J2587). Process capability is to be demonstrated to this standard and confirmed by periodic audits as defined in the process control plan.

In addition, all fuel line assemblies must demonstrate leak tightness using a 100% production air leak check at 1035 kPa ± 35 kPa with an allowed maximum leak rate of 8 cm^3/minute. All vapor lines assemblies must demonstrate compliance with the leak tightness requirement using 100% production air leak at 70 KPa ± 7 kPa with an allowed maximum leak rate of 2 cm^3/minute.

3.2.1.16 Thermal Requirements. The chosen material of the fuel and vapor lines shall stay within their thermal limits when they are tested according GMW14555 and GMW14854. The temperature limits of the fuel line material are specified according to CG3548.

3.2.2 Physical Characteristics. The required physical characteristics for the fuel feed/return and vapor purge lines are specified in the following paragraphs.

3.2.2.1 Dimensions and Capacity. See program CTS.

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3.2.2.2 Mass Properties. See program CTS.

3.2.3 Reliability. The reliability requirements for the component are given in the following paragraphs.

3.2.3.1 Reliability Evaluation Point (REP). See Program specific SSTS, for any deviations. The REP is defined as highest point at which long-term reliability and durability requirements are set.

3.2.3.2 Reliability Requirements. The fuel subsystem shall have no Class 1 or Class 2 type problems that have not been addressed at the start of production of saleable vehicles.

Class 1 and Class 2 type problems are problems which occur during development or validation, under conditions expected to occur within the vehicle's REP and target market area, and which result in any of the following:

3.2.3.2.1 Class 1 Type.

3.2.3.2.1.1 Non-compliance with any applicable government regulation.

3.2.3.2.1.2 Loss of function leading to major injury to any person (such as vehicle occupants, pedestrians, or service personnel) and/or major vehicle damage.

3.2.3.2.1.3 Loss of function such that the vehicle is disabled and requires repair at a dealership or other repair facility before it can be driven (e.g., walk homes which cannot be addressed at the problem occurrence site via a typical roadside assistance vehicle).

3.2.3.2.2 Class 2 Type.

3.2.3.2.2.1 Vehicle function severely degraded, requiring immediate service at a dealership or other repair facility.

3.2.3.3 Reliability Requirements. The integrated fuel tank assembly shall meet all requirements of this specification, within its target life with 98% probability at a 50% confidence level.

A statistically significant sample size, limit part testing, or simulations should be employed to demonstrate compliance with expected variation.

Note: A minimum of three (3) samples shall be completed (without any failure) in order to represent statistical significance.

3.2.4 Serviceability. The following paragraphs define the constraints and requirements associated with serviceability of the Fuel Feed/Return and Vapor Purge Lines subsystem. Serviceability is the ease and cost of performing the maintenance, diagnosis, and repair operations necessary to preserve the original performance level of the vehicle throughout its target life.

3.2.4.1 Service Infrastructure.

3.2.4.1.1 Essential Tools. The subsystem should not require the development of any new essential tools, for the performance of diagnosis, maintenance, and repair procedures.

3.2.4.1.2 Fasteners/Fittings/Connectors/Seals.

3.2.4.1.2.1 Fasteners with a service specification of torque plus angle should be avoided in the areas where customer performed maintenance or service is recommended (i.e., wheel lug nuts, oil pan drain plug etc.)

3.2.4.1.2.2 Effort should be made to avoid the use of torque to yield fasteners in areas where fasteners are typically reused or in areas where an adjustment point is located.

3.2.4.1.2.3 All serviceable fasteners that are considered reusable shall withstand a minimum of five (5) remove and replace procedures.

3.2.4.1.2.4 Fasteners requiring a back-up wrench for removal shall have adequate clearance for back-up tools.

3.2.4.1.2.5 The system shall use fasteners that are readily available from GM.

3.2.4.1.2.6 Dynamic torque values shall be provided for service publications.

3.2.4.1.2.7 Quick connectors/fittings and seals should be reusable and serviceable separately.

3.2.4.2 Customer Interface. Not applicable.

3.2.4.3 Maintenance.

3.2.4.3.1 Performance of Scheduled/Unscheduled Maintenance. System components shall not interfere with normal maintenance procedures.

3.2.4.3.1.1 The fuel feed and vapor lines shall not require scheduled maintenance or service during their target life.

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3.2.4.3.2 Lubricants and Chemical Products. Lubricants and chemical should be compatible with current products already released by GM.

3.2.4.3.2.1 The Fuel feed and Vapor Line subsystem shall not require the use of any lubricants to maintain operational performance during its target life (REP).

3.2.4.3.3 Exterior and Interior Cleaning. The system shall be capable of being cleaned with any current cleaning agents currently released by GM.

3.2.4.4 Repair.

3.2.4.4.1 Mechanical and electronically integrated components shall be serviced separately.

3.2.4.4.2 System components should be accessible for adjustment or replacement with standard shop hand tools and without removal of unrelated parts or components.

3.2.4.4.3 Repairs shall consist of replacement with new or remanufactured service parts.

3.2.4.4.4 System components shall not interfere with normal maintenance procedures.

3.2.4.4.5 Only complete lines shall be replaced, no splicing of lines shall be allowed.

3.2.4.5 Service Parts. GM part numbers shall be released for any parts identified in Table 2, as well as any additional assembly, subassembly, or component specified by the product release engineer or aftersales service engineer.

Table 2: Service Part Release Criteria

Part Description
Production fuel supply line assembly
Individual production EVAP line or vent hose assemblies
Individual fuel line and pipe clips and brackets
Plastic Fuel line QC retainers (Locking feature only, not the entire end form)
Liquid fuel pressure sensor
Flex Fuel sensor

Note: EVAP = Evaporative; QC = Quick Connector

3.2.4.6 Market Regulatory Requirements. Compliance with market-specific regulatory requirements for service parts, fluids, and chemicals. Service parts (Articles), fluids and/or chemicals (Preparations) are subject to a variety of regional, country, state/province, and city specific regulations that may or may not apply to the production equivalent (optional to add specific name of requirement – e.g., INMETRO). Seller is responsible to understand these regulatory requirements where their parts or products will be sold and assure that the engineering requirements, manufacturing/quality processes, part marking, packaging and labeling are designed to comply with those requirements. Seller must also be in accordance with GMW3059 material specification requirements. Seller will be responsible to validate the part, fluid and/or chemical to these specific requirements, and apply for/obtain and maintain the appropriate certification and registration if required in a time frame to meet Buyer's Supply Chain schedules. These regulatory requirements apply to service parts regardless of whether the vehicle is in production or not. Should the usage of these commodities be expanded to additional regulated markets, or should regulations change in the future; Buyer and Seller will work together to address any changes which may be required.

3.2.5 User System/Subsystem/Component/Part Interface.

3.2.5.1 Natural Frequency. The natural frequency of the fuel, vapor purge, and brake lines shall be > 30 Hz for frame or engine mounted components, and > 50 Hz for suspension/axle mounted components (unsprung mass, wheels and wheel suspension), when attached to the vehicle.

3.3 Design and Construction. The following paragraphs describe requirements and constraints of the design and construction characteristics of the fuel feed/return and vapor purge lines.

3.3.1 Materials, Processes and Parts Selection Guidelines. Constraints, standards, and guidelines that affect the selection of materials, processes, and parts are described in the following paragraphs.

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