



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 corporate objectives.

2 References

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

2.1 External Standards/Specifications.

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

2.2 GM Standards/Specifications.

9985784	GMW3116	GMW14854 (ID)	GMW16240 (ID)
GM6130M	GMW14234	GMW14911	GMW16709
GM9060P	GMW14555	GMW15272	GMW17000
GM9080P	GMW14638	GMW15309	GMW17136
GM9676P	GMW14655	GMW15311	GMW17334
GMW3059	GMW14754	GMW15733	GMW17752

(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.

- GMPT-6-006-A (ID)
- GMPT-6-019-A (ID)
- GMPT-6-020-A (ID)
- GMPT-3-007-A (ID)
- GMPT-6-025-A (ID)

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- 10093203 Chart
- 10442882
- 10445318 Label
- 14087086 Chart
- GM1730
- GM1747
- Fuel Storage and Handling Subsystem Technical Specification (SSTS)

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 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
- Service port
- Liquid fuel pressure sensor
- Rigid lines
- Flexible lines
- Protective sleeves
- Ground clip/bracket
- In-line fuel filter
- Fuel caution label
- Fasteners
- 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:

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

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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 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 paragraph 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 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 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. Table A2 identifies the fuels that shall be used for permeation tests.

3.1.3.5 Potential Contaminants. 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 Fuel Storage and Handling SSTs.

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.

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:

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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 paragraph 3.7.1.1.1 shall be used for all connections.

3.1.4.2.3.1.6 If a different material than GM6130M 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 paragraph 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 if the engine fuel rail is not grounded.

3.1.5 Usage Definition. Refer to CG3546 "Chassis Fuel Vehicle Data", referenced in GMW15311, the "Specification for Fuel Storage and Handling Subsystem" as well as to the Program VTS.

This requirement shall not be confused with the component target life according to paragraph 3.2.3.1 (Reliability Evaluation Point 'REP').

3.1.5.1 Underhood Wash. See Fuel Storage and Handling SSTs.

3.1.5.2 Vehicle Wash. See Fuel Storage and Handling SSTs.

3.1.5.3 Road Splash. See Fuel Storage and Handling SSTs.

3.1.5.4 Water Submersion/Fording. See Fuel Storage and Handling SSTs.

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 the following paragraphs. All requirements apply for the conditions specified in paragraphs 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. See program CTS.

3.2.1.3 Vapor Purge Line Flow. See program CTS.

3.2.1.4 Leak Detection. For leaks to the atmosphere, the component as it is called the Fuel Line Bundle in Fuel Storage and Handling SSTs shall satisfy the leak requirements found in paragraph 3.2.1.6.5 of the Fuel Storage and Handling SSTs.

3.2.1.5 Vapor Emissions. See program CTS.

3.2.1.6 Squeaks and Rattles. See Fuel Storage and Handling SSTs.

3.2.1.7 Electrostatic Charge Dissipation. The resistance from any point on the 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 pressure pulsations in the fuel feed line shall be $< \pm 20$ kPa excursions, tested according to GMW16240.

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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 PA tube captured within a retention clip shall be < 10% of the tube 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 requirements is 175 N.

3.2.1.10.1.2 Line insertion efforts shall not exceed GM Ergonomic requirements Full Hand = 80 N.

3.2.1.10.1.3 Fingers = 45 N.

3.2.1.10.1.4 Repositioning. The following represents the appropriate range for clip repositioning forces on the line (for isolated Bundle Clips only).

- < 89 N Will not move.
- (89 to 178) N May move.
- > 178 N Must move.

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

3.2.1.10.2.1 Push-on to Weld Stud.

- Full Hand = 80 N
- Fingers = 45 N

3.2.1.10.2.2 Push-on to Body Hole via push-on or Christmas tree on clip.

- Full Hand = 80 N
- Fingers = 45 N

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.

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. All gasoline fuel lines and Diesel return and feed lines prior the filter shall be tested according to the internal cleanliness section of the SAE J2045. When tested according to the Internal Cleanliness section of SAE J2045, the component shall contain $\leq 0.15 \text{ g/m}^2$ (flexible tubing assembly) or $\leq 0.25 \text{ g/m}^2$ (flexible tubing assembly with steel tubing attached) of interior surface area.

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 in μm	Number of permitted particles
50 to 100	300
100 to 150	80
150 to 200	30
200 to 400	25
400 to 600	10
> 600	0

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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 by functional performance requirements in other subparagraphs of paragraph 3.2.1. This damage or degradation is caused by specific levels of exposure that are within the levels typically defined in paragraph 2 (Definitions and Constraints) and falls within the time duration, wearout, and incidents-per-vehicle documented in the Reliability Evaluation Point sections of paragraphs 3.2.3.1 and 3.2.3.2 (subparagraphs of 3.2.3 Dependability).

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

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

3.2.1.14 Fuel Filter Performance.

- Metal fuel Filters per PMC

3.2.1.15 Fuel Line Assemblies Production Leak Check. Fuel lines shall be leak tight to an equivalent 15 μm standard, reference GMW15311 paragraph 3.2.1.6.5.1 and SAE J2587.

All fuel lines need a 100 % production air leak check at (1035 ± 35) kPa. Per SAE J2587 the allowable leakage at 1035 kPa is $\leq 0.53 \text{ cm}^3/\text{minute}$ (to demonstrate compliance to the 15 μm standard) and may be performed as an audit (to demonstrate process capability) or 100 % in production. If 15 μm equivalent leak testing is run only as an audit (captured in the process control plan), 100 % production leak test is required with an allowed maximum leak rate of $8 \text{ cm}^3/\text{minute}$ air, to verify control of the assembly process.

3.2.1.16 Thermal Requirements. The chosen material of the fuel 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 GMW15311 Appendix A.

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.

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 Class 1 and Class 2 Type Problems. 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 and 3.2.3.2.2).

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 (for example, 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.

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

Note: A minimum of 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 (REP).

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 as defined below, for the performance of diagnosis, maintenance, and repair procedures. (Essential tool = a tool called out in the manufacturer's service manual diagnosis or repair procedure, which is required to perform that operation.)

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 (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 (REP).

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.

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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

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.

3.3.1.1 Material Guidelines.

3.3.1.1.1 Materials shall be selected in accordance with the General Motors Worldwide Standards, GMNA Materials and Processes Standards, and GMNA Preferred Material Catalog. Exceptions to these specifications shall be identified and superseded by the Component Technical Specification.

3.3.1.1.2 Usage of selected materials shall require guidance and agreement from appropriate material and product engineers.

3.3.1.1.3 Usage of selected fasteners shall require guidance and agreement from appropriate product and fastener engineers.

3.3.1.1.4 The materials and parts of the fuel feed/return and vapor purge lines shall comply with the specifications referenced in paragraph 2.

3.3.1.1.5 Plastic parts shall be identified for recycling considerations in accordance with ISO 11469, with a subsystem design goal of (Platform Specific) percent recyclable per GMW3116.

3.3.1.1.6 Materials for gasoline applications should be selected to minimize permeation.

3.3.1.1.7 Materials subjected to flowing fuel shall be selected in accordance with SAE J1645.

3.3.1.1.8 Materials used in US shall be selected from the approved list American Automobile Manufacturers Association/Association of International Automobile Manufacturers (AAMA/AIAM report, 11/16/95), or shall demonstrate an ASTM rating of 0 on the ozone test defined in ASTM D1175 with acceptable durability during subsequent thermal aging.

3.3.1.1.9 Materials shall be compatible with the fuels specified in paragraph 3.1.3.4 and withstand the contaminants specified in 3.1.3.5.

3.3.1.1.10 Parts shall be free of volatile silicone, and the use of non-fuel soluble additives in manufacturing or assembly (cor lube, die lube, tire lube, water) shall not result in residue in component or interface parts.

3.3.1.1.11 Lubricant specified per 9985784 or de-ionized water may be used as an assembly aid for push-on connectors. Additional external lubricant shall not be used on quick-connectors.

3.3.1.2 Processes Guidelines. Unless otherwise specified, the fuel feed/return and vapor purge lines design shall conform to:

3.3.1.2.1 Global Bill of Process (GBOP).

3.3.1.2.2 Product Assembly Document (PAD).

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3.3.1.2.3 Manufacturing Ergonomic Requirements ERG1.2.

3.3.1.2.4 GM Human Factor Design Objectives.

3.3.1.2.5 Requirements identified in the General Motors Worldwide Standards and GMNA Materials and Processes Standards.

3.3.1.2.6 Routing Quality Assessment (RQA). The complete fuel line routing should be evaluated according the latest RQA template and reviewed during the Peer Reviews.

3.3.1.2.7 Key Characteristic Designation System. The Key Characteristic Designation System shall be used to evaluate the need for Key Product Characteristics (KPC). The Product Development Team (PDT) shall identify KPCs and Key Control Characteristics, (KCC). The fuel feed and vapor purge lines design must be made 33 robust to minimize or eliminate the need for KPCs. Where KPCs are deemed necessary, the supplier shall document via the Control Plan. The Control Plan shall be available for review at the request of the GM Engineering and Purchasing.

3.3.1.3 Parts Guidelines.

3.3.1.3.1 All parts should be selected to maximize commonality across subsystems and vehicle platforms.

3.3.1.3.2 When possible, standard fasteners out of the global fastener catalog should be used.

3.3.2 Design Guidelines and Constraints. The design of the fuel feed/return and vapor purge lines should comprehend the followings.

3.3.2.1 BOC Design Guidelines. (Stakeholders: 15.03 Exhaust, 15.05 Fuel Storage & Handling).

3.3.2.2 Design Best Practices. (Stakeholders: 15.03 Exhaust, 15.05 Fuel Storage & Handling).

3.3.2.3 Ergonomics Guidelines. Not applicable.

3.3.2.4 Clearance Considerations.

3.3.2.4.1 All types of hoists and jacks shall be considered. Refer to G.M. Serviceability pamphlet Design Criteria for Lifting, Towing, and Washing G.M. Cars and Light Trucks.

3.3.2.4.2 Ground clearance shall be 130 mm minimum to ground with vehicle at gross vehicle mass, if not otherwise specified in the program CTS.

3.3.2.4.3 Lines shall be routed inboard relative to the Rocker Inner(s) or inboard relative to the outboard surface of the Frame Rail(s) and 10 mm above the lower edge of the Rocker Inner(s) pinch weld flange or the Frame Rail bottom. In fore-aft direction, the lines shall be protected by chassis structure, such as the sub frame.

3.3.2.4.4 Lines should be routed in recessed areas whenever possible.

3.3.2.4.5 Lines shall be properly secured as to avoid excessive hanging during car assembly.

3.3.2.4.6 The following minimum clearances to fuel feed/return and vapor purge lines should be considered for full forward and reverse engine movement with non-functional engine mounts (metal to metal):

3.3.2.4.6.1 Shift linkages: 35.0 mm.

3.3.2.4.6.2 Shielded exhaust parts: 50.0 mm.

3.3.2.4.7 Allow adequate clearance to the Front Cradle, Left Hand Engine Rail Cradle and Body; provide clear access to steering I-shaft, ensure clear path between cradle and body for chassis marriage. Body Frame Integral (BFI) only.

3.3.2.4.8 Do not pinch items such as wiring between the lines and body.

3.3.2.4.9 Edges of the fuel filter shall be constructed, or protection provided, so that they will not damage adjacent lines (due to abrasion) during shipping or vehicle operation.

3.3.2.4.10 The fuel filter should be located in an area which protects it from road debris and other hazards.

3.3.2.4.11 Design for adequate tool clearance including, but not limited to, the following:

- Transmission area
- Installation of engine/chassis bolts and bolt installation tools
- Installation tools for line flare nuts
- Assembly plant fixtures and tooling.
- Ensure Master Cylinder fill equipment clearance.

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