



Fuel System Component Vibration Test

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. To verify robustness to vehicle induced vibration of various chassis and fuel tank mounted fuel subsystem components used for Body on Frame (BOF) and Body Frame Integral (BFI) applications. For the Fuel Pump Module (FPM) the purpose is to verify robustness of the FPM pass through electrical connector and interfaces for fretting corrosion, as well as overall integrity of the module when exposed to simulated vehicle vibration conditions.

1.2 Applicability. This is a component level and/or subsystem level test applicable to the chassis fuel subsystems.

1.3 Remarks. This standard evaluates the integrity and provides verification of various fuel subsystem components against vehicle vibration input conditions. The fuel subsystem components that may be assessed by this test include but are not limited to the following:

- FPM electrical connectors, FPM reservoir and related components, FPM flange, FPM flange to reservoir interface components, such as guide rods, seats, etc.
- Canisters and brackets
- Fresh air inlets
- Fuel tank mounted components, vent valves, inlet check valves, etc.
- Fuel fill pipes
- Electronic Leak Check Pump (ELCP) and brackets
- Diurnal Control Valve (DCV)
- External fuel filters and brackets
- Fuel coolers and brackets
- Diesel Exhaust Fluid (DEF) full assemblies, components, subassemblies and brackets
- Mounting brackets and clips for brake and fuel lines

1.3.1 This standard may be conducted by the supplier or by General Motors. Deviations from this standard require the agreement of the Chassis Fuel Global Subsystem Leadership Team (GSSLT). This test is broken down into two (2) discrete areas. See Table 1.

1.3.2 For fuel tank mounted components where chassis vibration inputs have a transfer function affecting the vibration schedule, see Appendix A, Section A1, Tables A1, A2, A3 and A4.

Note: The schedules defined herein account for the transfer function between the fuel tank and its frame mounting, and are directly used to drive the vibration table. Consequently, parts tested to this schedule may be directly mounted to the vibration table as the transfer function is accounted for in the schedule.

1.3.3 For chassis mounted components where the component is directly mounted to the frame/structure of the vehicle, see Appendix B, Section B1, Table B1 and Table B2.

1.3.4 Electrical Components shall meet the requirements in GMW3172 for Vibration with Thermal Cycling.

Note: FPMs shall meet the requirements of GMW3172, utilizing the vibration schedules found in Appendix A (Tables A2, A3 and A4), since the component is fuel tank mounted.

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1.3.5 Electrical Connectors shall meet the requirements of GMW3191, Connector Test and Validation Specification.

Table 1: Examples Not Limited to the Example Parts Defined

	Components
Appendix A	FPMs, mechanical evaluation, grade vent valves, fill limiting vent valves, inlet check valves, clips, tank mounted canisters, recirculation vent valves, DEF components, subassemblies and brackets, etc.
Appendix B	Underbody mounted canisters, external fuel filters, fuel coolers, fresh air solenoids, fill pipes, ELCP systems, DCVs, DEF full assemblies, etc.

Note: The schedules in Appendix B (Tables B1 and B2) have been generated as default schedules in the absence of vehicle specific schedules. These schedules represent chassis fuel system vibration environments for each type or classification of vehicle, e.g., passenger cars versus trucks.

Note: Crossover vehicles shall use the passenger car or BFI schedule (Appendix A, Tables A2, A3 and A4). Since a variety of vehicles from the same classification, various car platforms, were used to create the schedules found in Appendix A, these schedules are more severe than what may actually be measured on any individual vehicle within architecture. This severity ensures that variants in vehicle programs are covered when the components are validated, e.g., a single validation test should cover 45.7 cm and 50.8 cm (18 in and 20 in) tires or a touring and sport suspension on the same architecture given the additional severity.

It is important to recognize that the vibration schedule is accelerated for the purposes of laboratory testing. The number of hours and energy levels are factored from raw vehicle data. Other time and energy levels may be used at the discretion of General Motors.

Note: In the event vehicle/architecture specific vibration schedules are available, components may be tested using the vehicle specific schedule in place of Appendix A or Appendix B. The Design Release Engineer must ensure that the schedule used comprehends variations in the architecture to ensure robustness of the part across all variants of vehicles. For example, variation in suspension tuning, tire sizes, vehicle stiffness, etc.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3172

GMW14081

GMW14106

GMW16044

GMW3191

3 Resources

3.1 Facilities. Supplier conducted test by an accredited laboratory or at the GM Lansing Fuels Lab at GM's discretion.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Closed loop vibration table capable of executing the Power Spectral Density (PSD) schedule defined in Appendix A (Tables A2, A3 and A4) and Appendix B (Tables B1 and B2). As a general note, the vibration schedules are to be controlled with a kurtosis of three (3).

3.2.2 A data collection system with time/date stamp capability.

3.2.3 Provisions for FPM electrical connection only testing.

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3.2.3.1 Instrumentation with the ability to measure and record information at 1.0 Hz. Instrumentation should be installed so as not to affect component test.

3.2.3.2 Electrical power supply capable of delivering 14 A minimum, or program-specific as defined by the Design Release Engineer (DRE) continuously, and resistor bank to simulate fuel pump load. The power supply shall be set to control current.

Note: Current is the key measure in the wattage which can cause degradation, therefore, the test voltage is left to the discretion of the test facility. Voltage is recommended to be between 2 V and 12 V.

3.2.3.3 An electrical monitoring circuit capable of measuring the change in circuit voltage at the electrical connectors. A resistance shift shall be calculated from the current and voltage and reported in milliohms (mΩ).

Alternatively, thermal degradation may be used to assess the connector performance. Thermocouples sized appropriately for the electrical terminals, and data recorder capable of detecting and recording thermal shifts over time in degrees Celsius.

3.2.3.4 A FPM above flange connector instrumented with secondary leads on the fuel pump and sender electrical feeds and ground circuits. The leads allow the voltage in the fuel pump connectors up through the fuel pump terminals to be monitored for change. The leads shall be attached to the connector in such a manner as to limit the resistance of the connection and be durable throughout the vibration test, e.g., insulation stripped back, circuit monitoring leads soldered to the pump circuit, and shrink wrapped to protect the junction. All terminal interfaces shall be visually reviewed during teardown and Design Review Based upon Test Results (DRBTR) per GMW16044 assessments, for evidence of fretting corrosion as well.

3.2.4 Test Fixture A fixture to mount the fuel component(s) onto the vibration table replicating the intended production vehicle installation. The natural frequency of the test fixture shall be measured and shall be high enough that it does not influence the test (> 250 Hz).

3.2.5 Test Fixture FEA. A Finite Element Analysis (FEA) of the planned vibration test fixture shall be performed to determine any resonant frequencies in each of the three (3) axes over the test frequency spectrum (BFI Tank Mounted = 7 Hz to 250 Hz, Frame Mounted = 10 Hz to 1000 Hz). The results shall be reviewed with the GM Validation Engineer before the test can begin. The results of this FEA shall be included in the test report.

3.2.6 Test Fixture Verification. A frequency response sweep of the vibration test fixture resonance shall be performed to determine the frequency response curve of the vibration test fixture in each of the three (3) axes (GM Validation Engineering to approve the setup prior to the test). The input for the sweep shall be a sinusoidal 1G input. Time to sweep shall be approximately 1 minute/100 Hz.

The results of the frequency response sweeps shall be included in the test report. Any deviations from the specified vibration profile must be documented in the test report, including the GM Validation Engineer's signature.

There must be 15 mm of static clearance between the test fixture and any part of the test specimen at start of test. No components shall be added to the test fixture after the test has begun.

3.2.7 Accelerometers. The accelerometer, or other closed loop control sensor, mounted to the fixture or table, shall remain in the same position throughout the test series or group of test pieces. The location of the closed loop sensor may change for different components.

3.3 Test Vehicle/Test Piece. The test pieces used shall replicate production intent.

3.3.1 Recommended Test Plan Frequency. It is recommended that this test be conducted very early in the program development cycle (i.e., at the Design Validation (DV) stage of the validation timeline) to provide time for any corrective actions. Test results shall be re-verified with components from production tools, if not done so originally (i.e., at the Process Verification (PV) stage of the validation timeline).

3.3.2 Variants to consider within this test procedure are:

- If a component is substantially similar or the same to the parts tested, surrogate data from the first test may be used
- If surrogate data is to be used, the part number, program name, model year, and test report are to be included in the surrogate statement in all documentation.

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3.4 Test Time.

Calendar time: 9 days to 21 days
Test hours: 210 hours to 373 hours
Coordination hours: 32 hours

3.5 Test Required Information.

3.5.1 Record 3.5.1.1 through 3.5.1.3 prior to running any test.

3.5.1.1 Record part number, model year, vehicle program, serial number, test piece number, source, production level (i.e., prototype, production), part number suffix level, etc., and date.

3.5.1.2 Technician's name, test location, and name of test facility.

3.5.1.3 FPM Only. Record circuit resistivity at test startup using the power conditions defined in 3.2.3.2 and the intended trip limits. The trip limits shall terminate the test in the event the circuit resistance increases beyond the trip limit.

Note: The fuel pump brushes may require to be jumped or electrically shorted, to allow monitoring of the electrical circuit without influence of the motor armature. GM Engineering and the supplier shall review and determine the need and process to instrument a jumper of the armature during the test preparation.

3.5.2 For FPM to fuel tank interface, see GMW14106.

3.5.3 For FPM performance criteria, see GMW14081.

3.6 Personnel/Skills. Individuals responsible for the actual test shall be knowledgeable in:

- Operation of closed loop vibration test
- Operation of data acquisition equipment
- Ability to download stored code information
- Ability to evaluate the data

4 Procedure

4.1 Preparation.

4.1.1 Obtain the test pieces.

4.1.1.1 For Fuel Pump Electrical Connectors. Assemble the electrical circuit such that the vibration is inputted directly to structure supporting the connector for the FPM flange or to the fuel pump connector.

4.1.2 Assemble test piece to the test fixture which will support the component during testing.

4.1.3 Mount the test fixture to vibration table in the desired orientation (axis) with the closed loop sensing device also orientated in the desired axis.

4.1.4 Attach the test wire harness and connector to the FPM flange integrated connector.

4.1.5 FPM Testing Only.

4.1.5.1 Connect the FPM electrical monitoring leads to the data collection system for monitoring resistance of the circuit across the FPM electrical terminals.

4.1.5.2 It is not necessary to power the circuit with the same level of voltage and current as would be seen during normal vehicle usage. However, the electrical circuit is to be energized to monitor resistance at the terminals.

4.1.5.3 Power the FPM circuit and let resistance levels stabilize (powered for approximately 15 minutes). This will account for any change in resistance due to heat buildup. Check and document the voltage across the FPM electrical circuit, to establish a starting point voltage.

4.1.5.4 Connect the closed loop lead to the vibration table controller.

4.2 Conditions.

4.2.1 Environmental Conditions. Only Applies to electrical connector type testing. Perform the vibration test using the superimposed thermal cycle defined in Figure 1 and Table 2.

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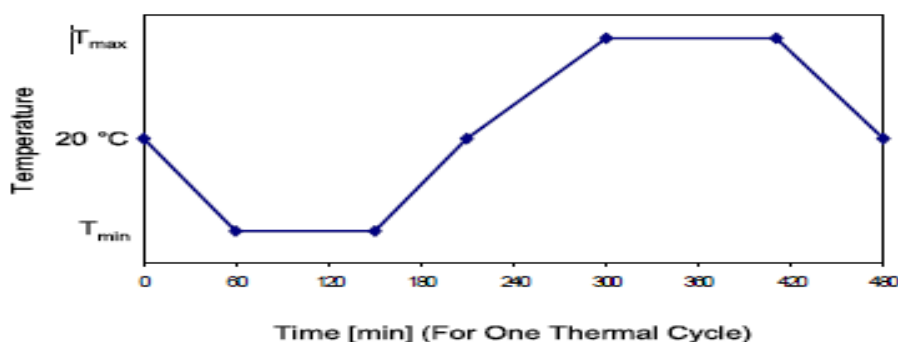
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Note: max = maximum, min = minimum, min = minutes.

Figure 1: Thermal Cycle Profile (Graph) Used During All Vibration Tests

Table 2: Thermal Cycle Profile (Data) Used During All Vibration Tests

Time	Temperature
0 minutes	20 °C
60 minutes	-40 °C
150 minutes	-40 °C
210 minutes	20 °C
300 minutes	90 °C
410 minutes	90 °C
480 minutes	20 °C

Note: 90 °C is used here for underbody conditions; if an underhood condition is being evaluated, 180 °C shall be used in place of the 90 °C sections.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions. Run the vibration table to the prescribed schedule defined in Appendix A (Tables A2, A3 or A4) or Appendix B (Tables B1 or B2) or per GMW3172.

4.3.1 For FPM Testing Only. Monitor voltage through the electrical connectors on the FPM. If the voltage/current changes by an equivalent 15 mΩ, terminate the test and collect the date, time, and test piece that experienced the shift in resistance. Other pieces may continue testing if they have not exceeded the 15 mΩ resistance increase.

4.3.2 Alternative Method Using Thermal Monitoring. Monitor the temperature at the electrical connectors by peening thermocouples to the connector terminal. Set a high limit of 116 °C to shut down the test if exceeded. Other parts on test may continue, if they have not achieved the thermal limitation. Record data on Data Sheet C1 in Appendix C.

5 Data

5.1 Calculations.

5.1.1 Report either the completion of the test cycle lives or plot test terminated for exceeding the circuit resistance requirement, using Weibull analysis. See Appendix A, Section A1.

5.1.2 Report any other observations from the test setup. For example; part damage, wear, separated components, etc.

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