GM	WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW17488

Fuel Pump Module Performance Test Procedures

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 contains guidance toward the writing and execution of supplier Fuel Pump Module (FPM) performance test procedures. This document is only to be used in conjunction with GMW14081 to provide a complete set of technical requirements for the FPM.

1.2 Applicability. This document applies to all hardware described in GMW14081.

2 References

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

2.1 External Standards/Specifications.

ASTM D1125 ISO 12103-1 SAE J905 SAE J1696

2.2 GM Standards/Specifications.

GMW14081

2.3 Additional References.

- CG2021 Fuel Pump and Sender Module Validation Cross Reference Index (VCRI)
- GMPT-2-017
- GMPT-3-018
- GMPT-6-001
- GMPT-6-013

Note: The supplier shall work with the responsible GM Engineer to comprehend these requirements.

3 Resources

3.1 Facilities. This procedure is facility independent, but does require a suitable lab area capable of safely handling the test fuels specified by GMW14081. Reference schematics and procedural information are provided as guidance for test execution. A supplier test procedure for each test shall be provided to GM Validation for final approval.

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. Recommended equipment is detailed in suggested test schematics throughout the procedure.

3.3 Test Vehicle/Test Piece. Sample size shall be at the discretion of the FPM Product Development Team (PDT) based upon examination of hardware design, processes, and related variation (potential bandwidth and quantities). Samples sizes shall be documented in the VCRI (CG2021) and shall be approved by GM Validation.

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3.4 Test Time.

Calendar time:	167 d
Test time:	4000 h
Coordination time:	250 h

3.5 Test Required Information. See specific procedures in 4.3.

3.6 Personnel/Skills. Laboratory technicians skilled in safe fuel handling and data acquisition.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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.

4.3.1 Low Energy Mechanical Shock.

4.3.1.1 Test shall be conducted in a fixture similar to Figure 1.

- Detailed test description including accelerometer placement; photos of fixture, hardware, hardware installed in fixture; and load vs. time plots shall be included in test report.
- Fixture surface in contact with lower module shall be constructed using either an actual fuel tank bottom or a surface of representative geometry, material and finish. A flat surface may be used if actual geometry is not determined.

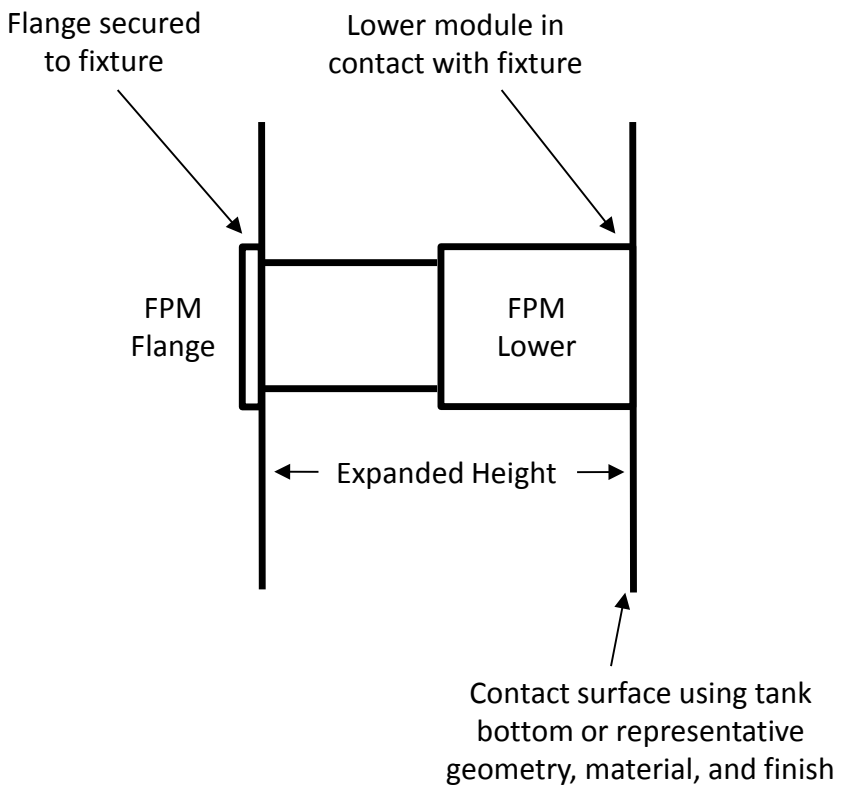

Figure 1: Low and High Energy Mechanical Shock Test Setup

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4.3.1.2 Perform pretest functional measurements, per GMW14081.

4.3.1.3 Install FPM into fixture compressing module to PDT determined expanded height (reference GMW14081).

4.3.1.4 Orient fixture to apply load toward front side of FPM using in-vehicle position as a reference (module side facing front of vehicle is front side of module).

4.3.1.5 Apply load to tank or fixture sufficient to generate 245 m/s^2 (25G) force in < 30 ms, recording load vs. time (plot).

4.3.1.6 Remove FPM from test fixture and perform posttest functional measurements and interim (non-destructive) visual inspection per GMW14081.

4.3.1.7 Reinstall FPM into test fixture, rotating to apply load toward the next adjacent side and repeat 4.3.1.5 through 4.3.1.6 until shock has been applied to the FPM in five (5) directions (toward front, left, rear, right, bottom) or until FPM does not satisfy posttest requirements.

4.3.1.8 If FPM fails to meet posttest requirements before completing all five (5) directions, install a new FPM in the last tested orientation and initiate next series from this point to determine if failure is due to this specific orientation or accumulation of shocks.

4.3.1.9 Repeat 4.3.1.2 through 4.3.1.8 using a new FPM to complete three (3) series (three (3) parts, five (5) directions per part, 15 shocks total).

4.3.1.10 Complete final visual inspection to evaluate components, which may not be accessible in interim inspections, such as internal components which may have been damaged or shifted out of position.

4.3.1.10.1 Alternate Method: Use new part for each shock in each direction (15 parts, one (1) direction per part, 15 shocks total).

4.3.2 High Energy Mechanical Shock.

4.3.2.1 Complete and review Finite Element Analysis (FEA) and material properties with PDT prior to any tooling or testing to confirm design.

4.3.2.2 Determine worst case direction of applied load based upon orientation in vehicle, potential interaction with flange-mounted or flange-adjacent components.

4.3.2.3 Test shall be conducted in a fixture similar to Figure 1.

- Detailed test description including accelerometer placement; photos of fixture, hardware (pretest and posttest), hardware installed in fixture, lower module displacement, and load vs. time plots shall be included in test report.
- Fixture surface in contact with lower module shall be constructed using either an actual fuel tank bottom or a surface of representative geometry, material and finish. A flat surface may be used if actual geometry is not determined.

4.3.2.4 Perform pretest functional measurements, per GMW14081.

4.3.2.5 Install FPM into fixture compressing module to PDT determined expanded height (reference GMW14081).

4.3.2.6 Orient fixture to apply load toward the direction determined as worst case per 4.3.2.2. If no worst case direction is obvious, then direct toward front side of FPM using in-vehicle position as a reference (module side facing front of vehicle is front side of module).

4.3.2.7 Apply load to tank or fixture sufficient to generate 981 m/s^2 (100G) force in < 30 ms (or other load less than anticipated to cause failure), recording load vs. time (plot), and lower module displacement. Auxiliary modules may require the addition of weight to the lower unit for sufficient mass to generate separation, subject to PDT review and approval.

4.3.2.8 Terminate testing if one (1) of the ~~2~~ following conditions exist:

- Flange does not pass flange leak tightness test.
- Lower module is separated from flange.

4.3.2.9 Repeat 4.3.2.7 through 4.3.2.8 increasing the load by 245 m/s^2 (25G) until one (1) of the termination conditions defined in 4.3.2.7 are met.

4.3.2.10 Remove FPM and perform posttests per GMW14081 for each orientation.

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4.3.2.11 Repeat steps 4.3.2.4 through 4.3.2.10, installing a new FPM, rotating the FPM 90 degrees from the original (or previous) direction, until all four (4) directions have been tested.

4.3.2.12 Compare test results against FEA analysis.

4.3.3 Tubing Flexibility Determination for Internal Port Strength Optimization.

4.3.3.1 Tests shall be conducted in a fixture similar to Figure 2.

4.3.3.2 Balance tube of minimum length 200 mm on top of 15 mm rod attached to tensile test pulling apparatus while raising test pulling apparatus until tube is held by roller anvils on both sides. Small diameter tubing used for jet pumps may use shorter lengths, minimum 150 mm tube should be straight at starting position.

4.3.3.3 Raise test pulling apparatus at a rate of 50 mm/minute, bending and drawing tube through opening between both roller anvils.

4.3.3.4 Record maximum load achieved. Results shall be used for tubing flexibility and port strength analysis.

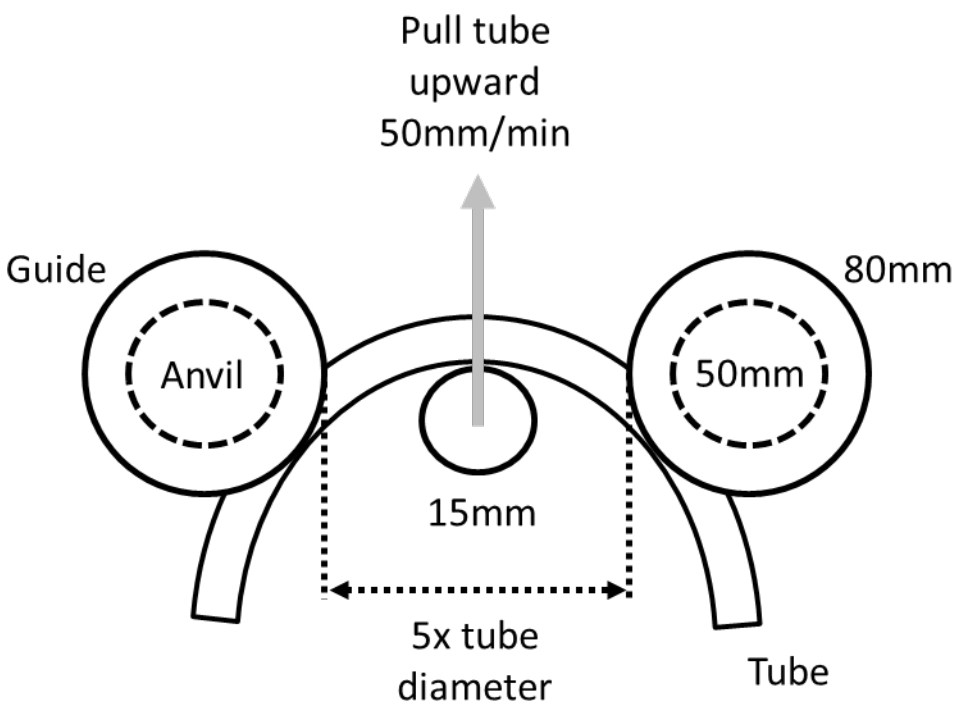

Figure 2: Tubing Burst Pressure, Wrapped

4.3.4 Tubing Burst Pressure, Wrapped.

4.3.4.1 Tests shall be conducted in a fixture similar to Figure 3.

4.3.4.2 Assemble tubing of sufficient length to wrap around mandrel of diameter no ≤ 5x tubing diameter, or at least 540 degrees (1.5 turns around mandrel). Wrapped tubing shall be perpendicular to mandrel with minimal distance between tube coils in the area where two (2) tube sections are present.

4.3.4.3 Connect one end of tubing to pressure source and plug opposite end. Connections should be capable of maximum burst pressure anticipated.

4.3.4.4 Assemble sleeve no ≤ 8x tubing diameter over wrapped section to maintain tubing in its position.

4.3.4.5 Up to three (3) tubes may be attached in series provided that at least five (5) sets of tubing are present for a total of 15 tubes are included in the test.

4.3.4.6 Soak three (3) samples for a minimum of 1 h in hydraulic oil at temperature specified in GMW14081 and then apply pressure at a rate of 500 kPa/minute until burst.

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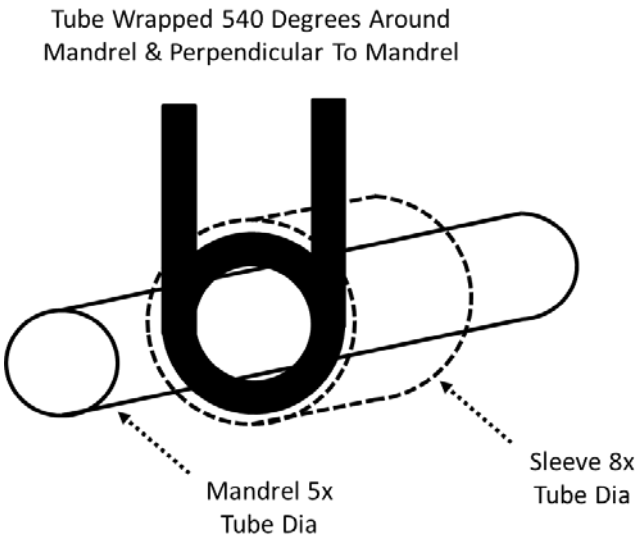
4.3.4.7 Soak remaining 12 samples in application-specific test fluid, as defined in GMW14081, removing three (3) samples every 500 h and repeat burst test to provide soak time vs. burst pressure for 500 h, 1000 h, 1500 h, and 2000 h. Samples shall remain wrapped on soak mandrel for burst testing. Samples may be transferred from a soak mandrel to another mandrel for burst testing, provided sample shape is maintained and transferred within 5 minutes.



Note: Dia = Diameter

Figure 3: Tubing Burst Pressure, Wrapped

4.3.5 Ignition Containment.

4.3.5.1 Prepare test vessel designed to contain combustion of a propane/air mixture. The test container must also have a thermocouple to detect combustion and a spark plug to test combustibility.

4.3.5.2 Place a fuel pump configured with an internal thermocouple and spark plug in a test vessel.

4.3.5.3 Flow a stoichiometric propane/air mixture through the fuel pump and into the surrounding test container, completely filling both with a combustible mixture. This ensures that a stoichiometric air/fuel mixture is present in the fuel pump.

4.3.5.4 Seal the outer container after filling.

4.3.5.5 Ignite the mixture in the pump and record the temperature output of the two (2) thermocouples.

Note: Ignition of the fuel/air mixture in the fuel pump and/or in the surrounding container is confirmed by a rapid temperature rise on the corresponding thermocouple(s).

4.3.5.6 After igniting the mixture in the fuel pump, flush and refill the system with combustible mixture.

4.3.5.7 Repeat the test ten (10) times for each pump.

4.3.5.8 After the 10th pump ignition, ignite the mixture in the test vessel and record the temperature output of the two (2) thermocouples to confirm combustibility of the mixture in the test vessel.

Note: Ignition is verified by observing a rapid temperature rise in the outer chamber thermocouple due to combustion, confirming that earlier ignitions within the fuel pump have been contained and have not ignited the mixture in the outer chamber.

4.3.5.9 Run the test using three (3) separate pumps.

4.3.6 Hot Performance, Gasoline.

4.3.6.1 Tests shall be conducted in a fixture similar to Figure 4.

- Detail test schematic, including venting detail and fuel volume shall be included in test report.

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- Venting shall be sufficient to avoid any pressure increase within the fixture during the test (pressure should be equal between test chamber and outside environment).
- Heating managed within the test chamber fluid near the bottom of the vessel – external heating not allowed.

4.3.6.2 Install FPM into vessel and make appropriate connections.

4.3.6.3 Add fuel to the vessel considering fuel evaporation during the test and heating rate.

- Minimum fuel level: ensure fuel height above lowest practical limit at end of test (reference GMW14081).
- Maximum fuel level: optimize fuel volume to manage heating rate. Fuel height shall not exceed 50 mm above reservoir bottom at beginning of test.
- Fuel: GMPT-2-017 (High Altitude E10).
- Reid Vapor Pressure (RVP): 79.2 kPa ± 3.4 kPa (11.5 psi ± 0.5 psi) (shall be confirmed at the start of each test run).

4.3.6.4 Stabilize fuel temperature at 20 °C ± 3 °C.

4.3.6.5 Close bench valve and apply power based upon system architecture. Prime the FPM for at least 2 minutes to purge air from system.

- Mechanically Regulated Fuel System (MRFS): 12.0 Vdc.
- Electronically Regulated Fuel System (ERFS), high load: Voltage to develop Wide Open Throttle (WOT) flow rate (do not adjust during test).
- ERFS system, idle load: Voltage to develop 5 L/h flow rate (do not adjust during test).

4.3.6.6 Open bench valve until pressure decreases to 350 kPa(g). Do not adjust valve thereafter.

4.3.6.7 Heat fuel at a rate of 0.6 °C/minute to 1.0 °C/minute (to be maintained from 20 °C to 70 °C).

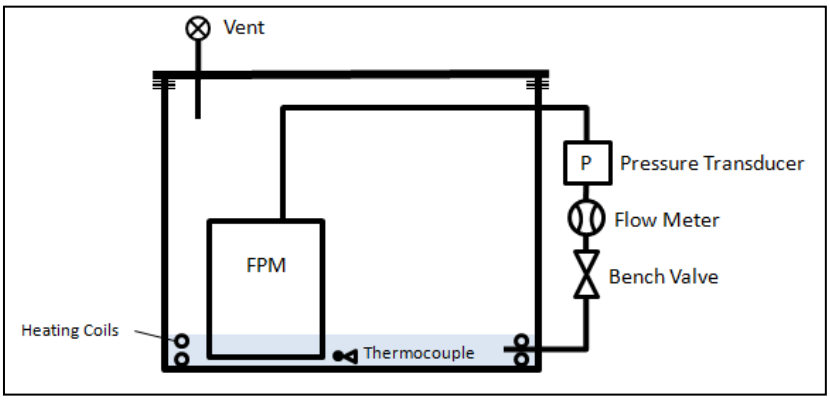
4.3.6.8 Remove power from module for 1 minute, maintaining temperature at 70 °C.

4.3.6.9 Apply power to module for 2 minutes, maintaining temperature at 70 °C.

4.3.6.10 Repeat 4.3.6.8 through 4.3.6.9 once for a total of two (2) cycles.

4.3.6.11 Record the following:

- Flow, pressure, rpm vs. temperature.
- Temperature vs. time.
- Heating rate as dT/dt in C/minute.



Note: FPM shall sit on a solid surface during testing.
Note: Thermocouple shall be placed as close to the reservoir inlet as possible.

Figure 4: Hot Performance, Gas Test Setup

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