



Vehicle Level Fuel Pump Noise Evaluation Procedure

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 procedure describes the process for measuring vehicle level fuel pump noise.

1.2 Applicability. This procedure is applicable for all passenger cars, multi-purpose passenger vehicles, minibuses, and light commercial vehicles with a gasoline or diesel engine and an electric fuel pump.

1.3 Remarks. This test is used to assess fuel pump noise performance. The noise from the fuel pump shall not be noticed as disturbing even outside of the vehicle.

2 References

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

2.1 External Standards/Specifications.

ANSI/ASA S1.4 Part 1

2.2 GM Standards/Specifications.

GMW14172

GMW16178

3 Resources

3.1 Facilities. All measurements shall be performed in a semi-anechoic test room free from interfering noises or outdoors in a free-field area.

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 Microphones. Microphones regionally accepted for vehicle interior noise measurements (see GMW16178). Free field exterior microphones.

3.2.2 Data Acquisition System. Multi-channel data acquisition hardware capable of calculating frequency domain results between 22 Hz and 11 200 Hz with a minimum of 80 dB dynamic range. This hardware shall meet Class 1 accuracy corresponding to ANSI/ASA S1.4 Part 1 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

3.2.3 Digital Voltmeter. Digital voltmeter for monitoring voltage of the fuel pump.

3.2.4 Variable DC Power Supply. Variable Direct Current (DC) power supply with sufficient capacity to provide at least 20 V at 15 A.

3.2.5 Oscilloscope. Oscilloscope to observe vehicle supplied voltage to fuel pump.

3.2.6 Current Meter. Current meter for monitoring current of the fuel pump.

3.2.7 Clip. Clip to close the hose to the pressure regulator.

3.3 Test Vehicle/Test Piece. The tests shall be performed on a vehicle that represents the current part release status. Deviations (e.g., obvious faults) shall be eliminated or recorded.

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3.4 Test Time.

Calendar time:	4 d
Test hours:	16 h
Coordination hours:	16 h

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Engineer or qualified technician with basic knowledge of acoustics.

4 Procedure

4.1 Preparation. Check the vehicle and the fuel module reservoir (MRA) according to 3.3. Ensure the fuel is of proper Reid Vapor Pressure (RVP) at 62 kPa (9 psi).

Determine if the vehicle fuel MRA is an Electronic Return-less Fuel System (ERFS) or Mechanical Return-less Fuel System (MRFS). Connect the universal connector in series between the vehicle wiring harness and the fuel pump wiring harness. Operate the vehicle in idle. Use an oscilloscope to monitor voltage supplied to the fuel pump. Observe if the voltage is pulse width modulated. If the voltage is pulse width modulated, the module is an ERFS and the root mean square (RMS) voltage value will be the standard operating voltage at idle.

4.2 Conditions.

4.2.1 Environmental Conditions. The test shall be performed with the fuel temperature of $+20\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ as the standard measurement condition. Optional measurements may be repeated at fuel temperatures of $-20\text{ }^{\circ}\text{C}$, $-10\text{ }^{\circ}\text{C}$, $0\text{ }^{\circ}\text{C}$, and $+40\text{ }^{\circ}\text{C}$. The fuel temperature can be changed by adjusting the ambient air temperature, either by parking the vehicle outside or in an environmentally controlled room, and allowing the vehicle temperature to stabilize to the room temperature. If any of these fuel temperatures are impossible to reach within a semi-anechoic test room, the measurements can be made outdoors in a free-field area.

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.

4.2.3 Standard Test Conditions.

4.2.3.1 Steady State at Vehicle Idle. Operate vehicle at idle, measure steady state fuel pump noise levels with applied voltages from 2 V below to 2 V above standard operating voltage in 0.5 V intervals.

4.2.3.2 Steady State with Vehicle Engine Off. Apply voltage to the fuel pump. If the vehicle is not return-less, plug or seal the manifold vacuum hose to the pressure regulator with the engine running at idle. This will allow the pump to work at "normal fuel pressure".

Turn the vehicle engine off and measure steady state fuel pump noise levels with applied voltages from 2 V below to 2 V above standard operating voltage in 0.5 V intervals.

4.2.3.3 Speed Sweep with Vehicle Engine Off (Optional). If the vehicle is not return-less, plug or seal the manifold vacuum hose to the pressure regulator with the engine running at idle. This will allow the pump to work at "normal fuel pressure".

Turn the vehicle engine off and measure fuel pump noise while sweeping the fuel pump operating speed by incrementing the applied voltage from 4 V to 14 V over 120 s.

4.3 Instructions.

4.3.1 Calibration Verification. Check equipment for valid calibration date. Replace out of date equipment. Perform microphone calibration verification. Record calibration tone if applicable (see GMW14172).

4.3.2 Install Data Acquisition Equipment. Install microphones in positions as specified in Figure A1 and Figure A2 in Appendix A. Standard positions for left hand drive vehicles are Left Front/Right Ear (LFRE), Right Rear (RR), and Left Rear (LR), with an optional Right Front (RF) position. Standard positions for right hand drive vehicles are Right Front/Left Ear (RFLE), RR, and LR, with an optional Left Front (LF) position.

Position exterior microphones at the global exterior microphone locations M_{G8} , M_{G9} and M_{G10} detailed in Figure B1 in Appendix B. The microphones shall be positioned 1.0 m from the vehicle and 1.6 m from the ground.

4.3.3 Vehicle Setup. The vehicle should be unloaded except for the driver and the test equipment. Adjust seats and headrests according to Appendix C. Close all windows, sliding roof and sunscreen. Fuel tank shall be approximately $\frac{1}{4}$ full or, at the worst case, level for fuel pump noise.

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Connect the fuel pump to the external power supply. Measure the operating voltage at the pump. Measure the operating current on the positive line from the power supply. Measure the signal synchronous with the fuel pump speed in rpm for the sweep test condition.

Switch off the air conditioning at least ten minutes before the start of the test. Turn off heater blower, radio and other accessories. Turn floor ventilation on low (adjust accordingly if ventilation noise occurs).

4.3.4 Data Acquisition.

4.3.4.1 Steady State Data Acquisition. Set up the data acquisition system to acquire A-weighted sound pressure level data capable of providing steady state narrowband data using the following parameters:

Frequency range: 22 Hz to 11 200 Hz

Frequency resolution: 1 Hz

Window: Hanning, Energy Correction

Amplitude: Root Mean Square (RMS)

Averaging: 50 Averages, 50% Overlap

Acquire data for each steady-state condition, as required from 4.2.3.1 and 4.2.3.2 and for the fuel temperatures specified in 4.2.1. If recording data with a digital recording system, record at least 20 s of data for each required steady state condition.

Repeat measurements as required for all applicable fuels. Fuels with different RVPs can influence the fuel pump noise levels.

4.3.4.2 Sweep Data Acquisition (Optional). Sweep the fuel pump speed by incrementing the applied voltage from 4 V to 14 V over 120 s.

Set up the data acquisition system to acquire fuel pump speed based data capable of providing the following:

Overall A-Weighted Sound Pressure Level (SPL).

A-Weighted SPL order cuts at prominent fuel pump orders.

Time data, waterfall data, or LMS Temporary Results Data Storage (TRDS) files are required for post processing. Acquire data for full 4 V to 14 V sweep. If recording data with a digital recording system, record the full sweep condition.

5 Data

5.1 Calculations. Process noise and vibration data as defined below.

5.1.1 Steady State Narrowband Data. Process the fuel pump noise data to calculate the overall A-weighted sound pressure level in decibels (dB) relative to 20 μ Pa. The associated vehicle and test condition documentation shall be included when entering the data.

5.1.2 Speed Sweep Analysis (Optional). Process the fuel pump sweep test to define overall level and any prominent fuel pump orders below 40th order. These are the orders with high levels that significantly exceed the broadband level. An order summation through the entire speed sweep will provide this information. Calculate levels for overall and each identified prominent order. Cut each prominent fuel pump order using a 0.1 to 0.2 order bandwidth.

5.2 Interpretation of Results. Compare all steady state fuel pump noise measurements made with the vehicle engine off, at all microphone locations, for all applied fuel pump voltages, and for all measured fuel temperatures to the target levels as specified in the Vehicle Technical Specification (VTS).

5.3 Test Documentation. Standardized formats contained in the Global VTS template shall be used to view data.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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