



Vehicle Fuel Tank Slosh and Clunk 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. To determine the level of fuel generated noise (**slosh** and **clunk**) in a vehicle due to the motion of the fuel inside the tank.

1.2 Applicability. All passenger cars and light-duty trucks with gasoline or diesel fuel tanks.

1.3 Remarks.

1.3.1 This test procedure was designed using various fuel levels and vehicle motions to attempt to cause **clunk** or **slosh** so that a noise rating may be given. However, since not all fuel levels or vehicle motions can be done in a relatively short test, additional investigations may be needed, e.g., ride trips, etc. Fuel **slosh** has normally occurred with un-baffled, poorly isolated fuel tanks, or poorly insulated or weak body structures.

1.3.2 This test procedure is not designed to quantitatively measure fuel pump noise. It also does not evaluate noise due to poor retention of the fuel tank to the vehicle, because this test procedure has no significant vertical load inputs. This procedure is not intended to evaluate or measure squeak or rattle issues associated with the fuel tank. Noise due to poor retention of the fuel tank would best be evaluated using squeak and rattle procedures.

2 References

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

2.1 External Standards/Specifications.

IEC 651

2.2 GM Standards/Specifications.

GMW14264

GMW14508

GMW15311

GMW15444

GMW14485

2.3 Additional References.

- GM Research and Development (R&D) Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators"
- Siemens PLM Software, Incorporated, Plano, Texas, www.plm.automation.siemens.com

3 Resources

3.1 Facilities. Flat smooth surface free from extraneous noise and vehicles. A nearby fuel supply is recommended to reduce time spent filling the tank to different test levels.

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 Static accelerometer capable of measuring braking deceleration rates of up to 1.0G in the fore-aft direction.

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3.2.2 Equipment for measuring fuel. A commercial fuel pump is acceptable.

3.2.3 Equipment for measuring vehicle speed. The vehicle speed may be captured off the Controller Area Network (CAN) bus or measured using a tachometer on the axle shaft and converting to vehicle speed or Global Positioning System (GPS). Vehicle speed data acquisition should be at least 4 Hz or faster for GPS (CAN bus recommended).

3.2.4 Random incidence or free field microphones.

3.2.5 Microphone calibrator.

3.2.6 Twenty four (24) bit analog-to-digital converter is required along with processing software capable of analysis. This should allow for simultaneous acquisition of vehicle speed, vehicle acceleration, and sound pressure level.

All devices shall meet Class 1 accuracy corresponding to IEC 651 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

The measuring instruments used shall conform to the significant characteristics of the standards. The conformity to the tolerances is limited to the frequency range 22 Hz to 11 200 Hz.

3.3 Test Vehicle/Test Piece.

3.3.1 Test vehicle selected with consideration to noise reduction components, including mats, insulation, flooring, etc.

3.3.2 Fuel System. Fuel system to design intent with regards to:

- Tank Material
- Baffle Systems (number and type)
- Tank Straps
- Tank Shields
- Tank Pads (including position)
- Tank Position
- Fuel Pump/Sender Module

3.4 Test Time. Preparation and other downtime, actual test, and analysis of data were considered in the total calendar time.

3.4.1 Subjective Test.

Calendar time:	1 day
Preparation hours:	2 hours
Evaluator resource hours:	6 hours
Engineer resource hours	2 hours

3.4.2 Objective Test.

Calendar time:	2 days
Preparation hours:	2 hours
Measurement resource hours:	12 hours
Engineer resource hours	6 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Noise evaluators must have normal hearing verified by an audiological test.

3.6.1 Auditor Skill Level. Novice evaluators shall have completed three prior full vehicle subjective noise evaluations under the direct supervision of an experienced Noise and Vibration (N&V) evaluator. Reference GMW14485.

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3.6.2 Hearing Requirements. It is recommended that all evaluators for noise evaluations have a hearing test performed, and be aware of their limitations. Any professional hearing test is acceptable, but the following test is given as a reference: GM R&D Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators".

4 Procedure

4.1 Preparation.

4.1.1 Turn off all vehicle accessories using instrument panel controls that may generate noise such as:

- Windshield wipers
- Radio
- HVAC fan
- Close windows/sunroofs
- Windshield washer fluid bottle should be either empty or full to minimize noise

4.1.2 The vehicle shall be evaluated from the driver's seat and the seat position closest to the fuel tank.

4.2 Conditions.

4.2.1 Environmental Conditions. The pavement should be dry enough to obtain the braking specifications in this test, and ensure that road and tire noise are not significant noise interference sources.

The wind speed shall be less than 12 km/h (8 km/h preferred). There should be no noticeable audible effects of wind inside the vehicle during data acquisition such as wind gusts. The air temperature shall be between 5 °C and 35 °C. Do not record data in the event of interfering noise emissions (aircraft, other vehicles).

The vehicle must be parked in an environment where the ambient temperature is above 16 °C for at least 12 h prior to test.

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 Subjective Evaluation Preparation.

4.3.1.1 Calculate 25%, 50%, 70%, 80%, 90% and 100% of the fuel tank usable capacity (as defined by GMW14508) for the fuel levels at which to run this test. Approximations may be used at the discretion of the engineer. Record volumes on Table B1 in Appendix B prior to starting test.

4.3.2 Subjective Evaluation. The test maneuvers in this section are done at 25%, 50%, 70%, 80%, 90% and 100% of usable capacity per engineer in 4.3.1.1. Record fuel gage reading at each fuel level on Table B1 in Appendix B.

Wait at least 20 s between test maneuvers to stabilize fuel.

In the case where the vehicle background masking noise is not representative of the platform as a whole, the engine may be shut off prior to the stop. This would include cases where the platform has a hybrid or stop/start powertrain but the test property is not a hybrid, or if the vehicle is not properly sealed or acoustic content is not production intent. A gas vehicle shall not be evaluated as a substitute for a diesel powertrain. These conditions shall be noted on the subjective evaluation form in Appendix B, Table B1.

4.3.2.1 Light Stop.

4.3.2.1.1 Accelerate lightly to 10 km/h (6 mph).

4.3.2.1.2 Maintain 10 km/h (6 mph) for 5 s to stabilize fuel.

4.3.2.1.3 Brake lightly to a stop.

4.3.2.1.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.1.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.1.6 Repeat this section doing an engine key off just after the vehicle velocity has stabilized. Use the rating scale in Table A1 (Appendix A).

4.3.2.2 Moderate Stop.

4.3.2.2.1 Accelerate lightly to 16 km/h (10 mph).

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4.3.2.2.2 Maintain 16 km/h (10 mph) for 5 s to stabilize fuel.

4.3.2.2.3 Brake moderately to a stop.

4.3.2.2.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.2.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.2.6 Repeat this section doing an engine key off just after the vehicle velocity has stabilized. Use the rating scale in Table A1 (Appendix A).

4.3.2.3 Maximum Stop.

4.3.2.3.1 Accelerate lightly to 16 km/h (10 mph).

4.3.2.3.2 Maintain 16 km/h (10 mph) for 5 s to stabilize fuel.

4.3.2.3.3 Brake at maximum rate to a stop.

4.3.2.3.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.3.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.4 Start/Stop (Traffic Jam).

4.3.2.4.1 Accelerate lightly/moderately to a speed between 1.6 km/h (1 mph) and 16 km/h (10 mph).

4.3.2.4.2 Brake lightly/moderately to a rolling stop.

4.3.2.4.3 Repeat acceleration and rolling stop several times as if in very slow moving traffic. This section of the procedure is meant to be sufficiently open so that the worst case speed and braking can be determined for the specific vehicle platform. It may take some trial and error to determine the acceleration and braking rates to use.

4.3.2.4.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.4.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.5 Sudden Start.

4.3.2.5.1 From a stop, release brakes.

4.3.2.5.2 Quickly apply and release throttle (25% to 40% opening), also known as a Jab step to throttle pedal.

4.3.2.5.3 Release throttle fully and coast.

4.3.2.5.4 Wait quietly and listen for fuel noise for 10 s.

4.3.2.5.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.6 Stop and Turn.

4.3.2.6.1 Accelerate lightly to 10 km/h (6 mph).

4.3.2.6.2 Maintain 10 km/h (6 mph) for 5 s to stabilize fuel.

4.3.2.6.3 Brake moderately to a stop while turning the wheels sharply to the left.

4.3.2.6.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.6.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

4.3.2.6.6 Repeat 4.3.2.6 maneuver, except turn to the right.

4.3.2.7 Reverse Stop.

4.3.2.7.1 Accelerate in reverse gear lightly to 16 km/h (10 mph).

4.3.2.7.2 Maintain 16 km/h (10 mph) for 5 s to stabilize fuel.

4.3.2.7.3 Brake moderately to a stop.

4.3.2.7.4 Wait quietly and listen for fuel noise for 20 s.

4.3.2.7.5 Record noise rating and any comments on Table B1 (Appendix B). Use the rating scale in Table A1 (Appendix A).

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