



Road Noise

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 measure the interior sound level of a vehicle as it is driven over a smooth or coarse road surface at a constant speed.

1.2 Applicability. This test is applicable to passenger cars, multi-purpose passenger vehicles, minibuses and light commercial vehicles with a maximum authorized total weight of up to 3500 kg.

1.3 Remarks. This test is to be used for the purpose of establishing new product program goals through the benchmarking of competitive vehicles, the development of new product program designs to achieve the specified vehicle interior sound, and the validation of the vehicle interior sound specified for new product programs in the Vehicle Technical Specification (VTS). This test procedure shall be followed in its entirety.

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.

None

2.3 Additional References.

- Vehicle Technical Specification

3 Resources

3.1 Facilities. The tests shall be performed on GM global noise road surfaces which include “Stud Damaged Concrete” and “Smooth Asphalt”.

The test site must be free of obstacles that could reflect sound.

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. Random incidence microphones and a 24 bit analog-to-digital converter are required for testing. However, free-field microphones may be used.

All devices shall meet Class 1 accuracy corresponding to ANSI/ASA S1.4 Part 1 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

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.

3.2.1 Four (4) sets of calibrated bumps are required. Two rectangular calibrated strips make up one set. The calibrated bump shall be made from aluminum solid stock with the following dimensions: 38 mm W x 7 mm H x 457 mm L (1.5 in W x 0.25 in H x 18 in L) standard aluminum stock.

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November 2015

Page 1 of 9

3.3 Test Vehicle/Test Piece. The tests shall be performed on a vehicle which represents the current release status. Eliminate any inappropriate content or unwanted problems. Verify and note the status of all hardware relative to the current release status. Record the following vehicle and test information:

- Vehicle Numbers: VIN and GM Fleet Number
- Build Stage (if appropriate)
- Camouflage (Yes/No)
- Vehicle: Make, Model, Series, and Model Year
- Tire: Make, Model, Size, Tread Depth and Air Pressure (see 4.1.1)
- Wheel Material (e.g., steel, aluminum, alloy, etc.)
- Engine: Displacement, Orientation, Configuration (V or In-line), Number of Cylinders, and Fuel type (e.g., Gasoline, Diesel)
- Driveline configuration Front Wheel Drive (FWD), Rear Wheel Drive (RWD), All Wheel Drive (AWD), Four Wheel Drive (4WD)
- Transmission: Number of Forward Gears, and Type (e.g., automatic, manual, etc.)
- Interior Material (e.g., leather, cloth, etc.)
- Seating Capacity
- Roof Type (sunroof, moonroof, standard, etc.)
- Any options that could influence interior noise level.
- Test: Date, time and location
- Environment: Wind speed and direction and temperature at the test site at the time of test

3.4 Test Time.

Calendar time: 1 d
Test hours: 6 h
Coordination hours: 1 h

Note: The required environmental conditions (low wind, dry roads) can be difficult to obtain during certain climatic conditions. When scheduling the test, be aware that additional time may be spent waiting for the environmental conditions to be achieved.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. A minimum of one person is required to perform this test. This person should be trained in the use of noise recording and analysis instrumentation. Some knowledge of good signal processing practices is required. This person must have successfully completed the regional safety and training classes required to use the test roads in that region.

Note: If necessary, an additional occupant may be located in the rear seat to assist in data acquisition.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Preparation. Check the vehicle according to 3.3.

4.1.1.1 The vehicle must be parked in an environment where the ambient temperature is above 16 °C for at least 12 h prior to test. Install measuring instruments. The coordinates of the measuring points and all possible microphone positions are defined in Figure A1 and Figure A2 in Appendix A. Standard positions to be used for testing are left front seat, right ear (LFRE), seat is occupied by a driver and right seat rear (RR). The standard positions are mirrored symmetrically for Right Hand Drive (RHD) vehicles (RFLE and Left Seat Rear (LR)). This vehicle diagonal configuration captures events on both sides of the vehicle and in both the front and rear seat positions. For all vehicles with a 3rd row, the microphone should be placed in the center seat (C3). In cases where there is no center seat, the microphone should be placed in a location which would simulate a center seat in the 3rd row by placing the microphone stand on the floor.

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November 2015

Page 2 of 9

Note: All microphones shall be pointed towards the front of the vehicle if using random incidence and pointed up if using free-field microphones.

4.1.1.2 Check that the spare wheel is securely seated. Adjust tire pressures to nominal values as stated by the vehicle manufacturer (cold). Fuel tank shall be at least $\frac{3}{4}$ full. Camouflage shall be removed if testing for validation purposes. Camouflage and/or car covers shall not be stored in the vehicle during the test. The microphone locations shall be located per Appendix A. The data collected per this procedure is valid for the case in which an optional binaural transducer is located in the front passenger seat during measurements. Seats shall be positioned per Appendix B.

Note: The driver's seat location is likely to move from the nominal location to allow the driver to safely operate the vehicle. However, the microphone should be located relative to the seat position as defined in Appendix C and not the final seating position during test. All windows, sliding roof and sun screen are closed.

4.1.1.3 Heating, Ventilation and Air Conditioning (HVAC) system shall be turned off prior to testing so that all HVAC system noises are gone prior to testing.

4.1.1.4 Before turning off the HVAC system, footwell ventilation and "Recirculation" mode on (adjust accordingly if ventilation noise occurs). Radio should be turned off.

4.1.1.5 Drive vehicle until engine operating temperature is reached.

4.1.1.6 Drive the vehicle to ensure that the vehicle is free from squeaks and rattles and extraneous noises. Eliminate all extraneous noises prior to testing. Remove all camouflage for validation testing.

4.2 Conditions. All regional safety requirements and applicable laws must be followed during the course of testing. For example, at North American Operations - Milford Proving Ground the vehicle headlamps must be turned on.

4.2.1 Environmental Conditions. 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).

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.

4.2.2.1 For Impact Boom. Affix a set of calibrated bumps (see 3.2.1) onto the road surface such that the vehicle front wheels impact both strips simultaneously. Then affix the remaining three sets of strips along a globally approved smooth road surface such that there is at least 6 s to 8 s (60 m to 80 m) between impacts. If tape is used to affix the impact strips, it shall follow the contours and completely cover the calibrated strip.

Note: Impact event must occur separately on front and rear tires. Do not position impact bumps so that front and rear tire events occur simultaneously.

4.2.2.2 The test road surfaces shall be completely dry and clear of loose debris, rocks, and dirt.

4.3 Instructions. Install measurement equipment. Before the start of the test, the instrument settings and the vehicle settings shall be checked again. For data processing measuring instruments, the adjustments according to Section 5 shall also be performed from the start of the test.

4.3.1 Equipment Calibration Verification. Turn on all equipment and leave on for 5 minutes prior to recording a reference signal. Verify all equipment is in good working order and recording noise levels correctly. Note expiration date on the calibration label. Record a reference tone both prior to and immediately following the test measurement sequence.

4.3.2 Measurement. Warm up the vehicle. (see 4.1.1). The microphone signal gain shall be set to maximize the signal amplitude entering the data acquisition front end without overloading the corresponding input channel. Make a pre-test run if necessary. Tests shall begin at the designated point on the test track at the designated constant speed in **Drive ("D")** for automatic transmissions. See 4.2.1 through 4.2.2.2 for operating conditions. For manual transmissions, either 4th or 5th gear is recommended to minimize powertrain noise contribution to the measurement. In case the vehicle thereby shows a distinct boom, a measurement in the next lower gear shall be performed. The vehicle must remain at constant speed during the recording. Record the same event at three times. Overlay runs to make sure that there are not extraneous noises during data acquisition.

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November 2015

Page 3 of 9

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