



Trimmed Body Acoustic Sensitivity 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. Determination of Frequency Response Functions (FRF) (sound pressure over force) between body-side attachments and interior microphone locations in trimmed bodies to describe structure-borne noise characteristics.

1.2 Applicability. Passenger cars, multipurpose passenger vehicles, minibuses and light commercial vehicles. Any fully trimmed body or trimmed structure.

1.3 Remarks. This test is to be used for directing new product programs through the benchmarking of competitive vehicles and the development of new product program designs to achieve desired structural response. Acoustic sensitivity is to be used for the purpose of characterizing the trimmed body to external dynamic excitations.

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.

GMW8702

GMW14172

GMW14174

GMW14181

2.3 Additional References.

Not applicable.

3 Resources

3.1 Facilities. Acoustic sensitivity measurements are performed in a full or hemi-anechoic room or in an acoustical environment as specified in 4.2.1.

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 Data acquisition system with FRF analysis capability. An acquisition system with at least two (2) channels shall be used.

3.2.2 Impact hammer with the appropriate force transducer and a hammer tip capable of providing uniform force input out to the highest frequency of interest. A hand held shaker, force transducer and associated power supply and input signal capable of providing uniform input out to the maximum frequency required may also be used.

3.2.3 Microphones. Microphones shall be used for testing that conform to all Class 1 accuracy standards listed in IEC 651. Minimum microphone sensitivity shall be 40 mV/Pa.

Note: For measurements below 1000 Hz, both pressure and free-field/zero degree incident type microphones can be used. For measurements above 1000 Hz, free-field/zero degree incident microphones cannot be used with this test procedure.

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3.2.4 Microphone Preamplifier. This may not be needed for Integrated Circuit Piezoelectric (ICP) type microphones or when using a front end capable of providing microphone supply power.

3.2.5 Microphone Calibrator.

3.2.6 Interior Microphone Seat Stands.

3.2.7 Appropriate hardware or fixtures for all body attachments of interest. See GMW14181 for proper fixturing and attachment locations.

3.3 Test Vehicle/Test Piece. The complete trimmed body or trimmed structure. Vehicle shall be in the appropriate state as defined in GMW8702.

3.4 Test Time.

Calendar time: 3 days

Test hours: 16 hours

Coordination hours: 8 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Two (2) people are required to perform this test. One (1) person shall be trained in the use of data acquisition and analysis instrumentation. Some knowledge of good signal processing practice is required.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Preparation. The trimmed body or trimmed structure shall have all relevant attached subsystems as defined in GMW8702. The doors and windows must be closed.

4.1.1.1 Vehicle Support. Mount the trimmed body on four isolator blocks (100 N/mm to 300 N/mm rate) or another suitable material as to approximate a free-free mounting boundary condition. The trimmed body or structure will be supported at a height which allows excitation access at all desired attachment locations on the body.

4.1.1.2 Microphone Installation. Install microphones in locations as specified in Appendix A. Standard measurement locations for left-hand drive vehicles are Left Front (LF) seat and Right Rear (RR) seat. Standard measurement locations for right-hand drive vehicles are Right Front (RF) seat and Left Rear (LR) seat. For vehicles with three (3) rows of seats, install a microphone at the center of the 3rd row (C3). Microphones shall be oriented and seats/headrests shall be adjusted according to Appendix B.

4.1.1.3 Miscellaneous. No extraneous weight shall be placed on the vehicle during the test. The vehicle will not be used to support any equipment other than response transducers during the test. Any objects left on or in the vehicle during the test will affect the test results and must be removed prior to testing. Any objects that rattle may be secured with tape or glue. Prior to measurement, survey the locations chosen for measurement to ensure repeatability.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient Noise Levels. The preferred environment for acoustic sensitivity measurements is a hemi-anechoic test room. Other test environments may be acceptable if they meet the ambient noise level requirement. The ambient background noise levels measured inside the car must meet the following criteria:

4.2.1.1.1 Hemi-anechoic chamber (car test room and chassis dynamometer rooms). The ambient background noise levels measured inside the room shall be less than NC-15 sound pressure levels, NC-20 for chassis dynamometer rooms.

4.2.1.1.2 Ambient noise levels shall be 10 dB lower than the noise levels generated inside the car during the test and should facilitate acoustic sensitivity coherence values of at least 0.95 at all acoustic sensitivity maxima in the frequency range of interest.

4.2.1.2 Temperature and Humidity. The test facility should not experience variations in temperature of greater than 10 °C or variation in humidity of greater than 10% over the duration of testing. All measurements for a given vehicle shall be taken in the same day if possible.

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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 Calibration Verification. Check equipment for valid calibration date. Replace out-of-date equipment. Perform equipment calibration verification as defined in GMW14172.

4.3.2 Measurement. Set up a data acquisition system to acquire acoustic sensitivity FRFs in the units of Pascal per Newton (Pa/N) with 1 Hz resolution. Refer to the requirement frequency range to ensure that the frequency range of interest is measured accurately. In general, measure FRFs from 30 Hz to 800 Hz.

Use A-weighting functions for the microphones if necessary to optimize the signal to noise ratio and achieve good coherence across the frequency range of interest. Post processing will remove the A-weighting from the data and the data will be presented as linear.

Measure FRFs between each interface attachment point and the vehicle interior microphone position as appropriate. All three (3) orthogonal directions shall be measured at each body interface attachment point. The GM standard vehicle coordinate directions shall be followed as defined in Appendix C. In the event that the bushing does not line up with the vehicle coordinate system, use a local coordinate system relative to the bushing alignments. Document the local coordinate system used and record the angle relative to the global coordinate system.

For each measurement, check coherence and verify levels. Upon measurement completion, store the acoustic sensitivity FRF, coherence and force auto power spectrum.

For acoustic sensitivity reciprocity procedure, see Appendix D.

5 Data

This section describes methods to calculate the data for both target validation and root cause analysis.

5.1 Data Calculations for Target Validation.

5.1.1 One-third ($\frac{1}{3}$) Octave Linearly Weighted Acoustic Sensitivity. Calculate the $\frac{1}{3}$ octave acoustic sensitivity spectra according to GMW14181, Appendix C and based on results of linearly weighted data calculated in 5.1.2.

Display:

X-axis: 20 Hz to 800 Hz ($\frac{1}{3}$ octave scale)

Y-axis: dB (Re: 20e-6 Pa/N), either 30 dB to 65 dB or 40 dB to 80 dB

5.1.2 Narrowband Linearly Weighted Acoustic Sensitivity. If necessary, recalculate data to linear weighting.

Display:

X-axis: 20 Hz to 800 Hz, linear scale

Y-axis: dB (Re: 20e-6 Pa/N), either 30 dB to 65 dB or 40 dB to 80 dB

5.1.3 Data Calculations for Root Cause Analysis. For root cause analysis, the reciprocal measurement method may be a more efficient use. For calculations, see Appendix D.

5.2 Interpretation of Results. Verify whether requirements are achieved using display formats according to 5.1.1 and 5.1.2.

5.3 Test Documentation. Wholly contained in GMW14181.

Include photographs of all attachment locations in the condition in which they were measured. Show hardware or fixtures used in the test.

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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