



Binaural Data Acquisition Master Test 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 provide guidelines for a common method of setting up and acquiring operating data using a binaural head.

1.2 Applicability. This test procedure is appropriate for the evaluation of all subsystems, components and vehicles.

1.3 Remarks. Binaural data provides a means through which the sound can be objectively and subjectively evaluated.

2 References

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

2.1 External Standards/Specifications.

IEC 959

2.2 GM Standards/Specifications.

None

2.3 Additional References.

E-Squared Knowledge Set (E2KS) Technical Memory Best Practices, NVI 837, Noise and Vibration (N&V) Standard Work: Listening Based Analysis (ID): <https://gmweb.gm.com/sites/E2ks/Pages/Home.aspx>

(ID) = This is a specification/web site that is limited to Internal Distribution within General Motors. Contact the GM Lead Engineer for further instructions.

3 Resources

3.1 Facilities. Facility requirements may vary depending on the type of test setup. For example, a hemi-anechoic chamber may be required for noise measurements.

All facilities shall be free of extraneous N&V sources, as well as electrical noise (e.g., electromagnetic interference at 50 Hz or 60 Hz.)

On-Road sound measurements shall utilize regionally approved surfaces for standard road noise testing. Non-standard tests require road surfaces as appropriate to the test being performed.

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.

3.1.3 Room Properties. Noise and vibration test rooms have varying properties based on their function. The following examples are intended to define some different room types and properties.

3.1.3.1 Hemi-Anechoic Chamber (Car Test Room and Chassis Dynamometer Rooms). The ambient background noise levels measured shall be 10 dB lower than the lowest noise level(s) of interest at all frequencies.

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3.1.4 Road Surfaces. A full on-road test of vehicle sound typically involves three (3) surfaces including; Smooth Asphalt (SMA), rough or Stud-Damaged Concrete (SDC) and Wet Smooth Asphalt (WSMA).

Other surfaces conducive to a particular vehicle excitation may be chosen on a case-by-case basis depending on the needs of the test.

3.2 Equipment.

3.2.1 Binaural Recording System. Binaural recording systems are considered single units of dedicated test equipment. They are generally maintained and calibrated as systems, not as individual data acquisition front ends, transducers, etc. Binaural recording system shall conform to IEC 959 standard for binaural recording devices.

3.2.2 Test Fixtures. Any fixtures used to mount or position the binaural recording systems shall be designed to have minimal influence on the measurement. This is because the measurement should characterize the test structure and not the fixture.

3.3 Test Vehicle/Test Piece. This test procedure is applicable for subsystem, component or vehicle level testing. For the purpose of validation, the subsystem, component or vehicle to be tested shall represent design intent.

3.4 Test Time.

Calendar time: 1 to 3 days

Test hours: 4 to 8 hours

Coordination hours: 2 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. To complete this test, at least one (1) technician and/or one (1) engineer skilled in binaural data acquisition, analysis, equipment usage and test setup is required.

4 Procedure

4.1 Preparation.

4.1.1 Boundary Conditions. For full vehicle binaural recordings, ensure all vehicle settings are at the nominal adjustments, such as, fluid levels and tire inflation as prescribed for the vehicle.

4.1.2 Vehicle, Subsystem or Component Preparation.

4.1.2.1 Fluids. If the component being evaluated featuring a radiator, coolant bottle, fuel tank, etc., it shall be filled to the desired level per the evaluation procedure.

4.1.2.2 Position. If the component is adjustable (e.g., steering column), set it to the nominal position in all adjustable directions unless otherwise specified in the evaluation procedure.

Adjust the seats and headrests according to Appendix A.

4.1.2.3 Restraints. The component (steering column, suspension, powertrain, etc.) shall not be bound up or restrained in any way that is not intended. This may add non-linear constraints to the system.

4.1.2.4 Squeaks and Rattles. Any part of the component that squeaks or rattles shall be secured.

4.1.2.5 Sealed Cavity. In the case of sound pressure measurement, ensure vehicle cavity is sealed (windows up, doors closed, cracks taped, etc.)

4.1.2.6 Test Piece Temperature. The test piece temperature shall be at equilibrium with the ambient temperature, see 4.2.1.

4.1.3 Verify Binaural Systems Calibration. This check is equipment-specific, but typically includes completion of an internal self-test and a verification of a valid calibration data.

4.2 Conditions.

4.2.1 Environmental Conditions. The ambient temperature shall be between 10 °C and 30 °C or at the appropriate range specified by the referring procedure. For on-road tests, the ambient wind speed should be below 8 km/h to perform the test or at the appropriate range specified by the referring procedure.

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.

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4.3 Instructions.

4.3.1 Binaural Recording Device Mounting. Binaural recording tests usually consist of a head and torso simulator positioned in a realistic and normal position within the vehicle. Appendix A in this document outlines position of the seat during testing. Appendix B, Section B1 outlines placement of Binaural Head/torso unit on a seat.

Some binaural recording devices consist of only a microphone headset worn by the operator. This method yields a less precise recording position in the vehicle when compared with a head/torso simulator, but positioning guidelines are similar for both systems.

Tests done exterior to the vehicle may require the head portion of the recording system to be mounted on a tripod stand (or similar) in an external location appropriate to the specific test. Appendix B, Section B2 outlines placement of head using global exterior microphone location.

4.3.2 Binaural Recording Device Settings. When possible for binaural recordings, the system is typically set to 104 dB input range, 24 bit resolution, 44 100 Hz audio sampling rate, 20 Hz high-pass filter and Independent of Direction (ID) equalization. Refer to Appendix C for device setting details of a specific Binaural Recording System commonly used with GM.

4.3.3 Data Acquisition. Acquire the data while operating the test specimen. If there are any abnormalities in the data acquisition, restart the measurement.

4.3.4 Aural Verification. Binaural recordings are verified mainly by listening-based methods. All recordings shall be verified to be free of obvious disturbances, anomalies, unwanted sounds, overloads and/or any other elements to maintain the fidelity of the recordings.

5 Data

5.1 Calculations. Typically, calculations on binaural data reference the referring test procedure(s).

5.1.1 Trimming of Binaural Data. Although not a specific form of interpretation, almost all binaural data must be trimmed into specific selections or samples which represent data needed for the analysis. Trimming techniques are usually listening-based, but may be specific to a condition, time or analysis. Trimming techniques may also include time-based removal of specific flaws or anomalies (e.g., pops, clicks, gusts) from otherwise good recordings. Examples of trimming will be found in Appendix D.

5.2 Interpretation of Results.

5.2.1 Interpreting Binaural Data. Binaural data is often interpreted both quantitatively and qualitatively. Reference E2KS Technical Memory Best Practices, NVI 837 for further information.

5.2.1.1 Quantitative Binaural Data Analysis. In addition to calculations mentioned earlier, binaural data may be quantified using specifically designed sound metrics which seek to more accurately describe human hearing. Loudness, in linear unites of Sones, is a typical example.

5.2.1.2 Qualitative Binaural Data Analysis. Listening-based analysis of binaural data may involve evaluation of quietness, quality, preference and character depending on the objective of the tests.

5.3 Test Documentation.

5.3.1 Quantitative Documentation. In addition to documentation required by the relevant procedure, all plots shall include the following information:

- Binaural data shall be stored as time histories.
- Project files which include specific marks, filters and analysis should be stored.

5.3.2 Qualitative Documentation. In addition to documentation required by the relevant procedure, document results of jury testing, subjective ratings, focus group evaluations, etc. shall be included.

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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