



## Operating 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 setting up and acquiring operating data for noise and vibration evaluation procedures.

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

**1.3 Remarks.** Operating data provides a means through which the noise and vibration characteristics can be determined.

### 2 References

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

#### 2.1 External Standards/Specifications.

None

#### 2.2 GM Standards/Specifications.

GMW14172

#### 2.3 Additional References.

- GM Noise and Vibration (N&V) CAE Analysis Guideline OC-02-030-A "Numbering Noise and Vibration Models"

### 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 have the ability to create appropriate boundary conditions. Boundary conditions are typically defined as **in-situ**, **to ground** or **free-free**. See 4.1.1 for more details.

All facilities shall be free of extraneous noise and vibration sources as well as electrical noise, e.g., electromagnetic interference, 60 Hz in the US.

**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 (Dyno) Rooms).** The ambient background noise levels measured inside the room shall be less than NC-15 sound pressure levels (NC-20 for chassis dyno rooms). In addition, the ambient background noise levels measured shall meet the following criteria.

**3.1.3.1.1** Ten decibels (dB) lower than the lowest noise level(s) of interest.

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**3.1.3.1.2** Shall be no greater than 40 dB, and shall facilitate coherence values of at least 0.95 at all Sound pressure level over force (P/F) maxima in the frequency range of interest.

**3.1.3.2 Bedplate/Test Room.** The bedplate/test room facility may be any interior environment with a hard level surface to mount the test piece and test equipment with background vibration levels that facilitate coherence values greater than 0.95 at all frequency response function (FRF) maxima over the frequency range of interest.

## **3.2 Equipment.**

**3.2.1 Test Equipment.** Appendix A contains more detailed information regarding acquisition system requirements (Table A1) and transducer examples (Table A2).

**3.2.1.1 Data Acquisition System.** An acquisition system with one or more data acquisition channels shall be used.

**3.2.1.2 Measurement Tools.** Accelerometers, microphones, or any other appropriate transducer for a response measurement.

**3.2.1.3 Miscellaneous.** Equipment including but not limited to: appropriate cables, adapters, adhesive substances (see Appendix B), and transducer signal conditioning as required. Miscellaneous equipment including but not limited to: appropriate cables, adapters, adhesive substances (see Appendix B), and transducer signal conditioning as required.

## **3.2.2 Test Fixtures.**

**3.2.2.1 General Guidelines.** The test item shall be constrained in a realistic fashion. Test fixtures shall be used to reflect a boundary condition similar to what the test item experiences in operation.

Fixtures and other hardware attached to test structures will affect measurement results. For this reason, measurements shall be made without the use of fixtures whenever possible.

When fixturing is necessary, vehicle hardware shall be used wherever possible. In some cases, however, shop made fixtures will be required to execute the desired measurements.

Fixtures shall be designed to have minimal influence on the measurement. This is because the measurement should characterize the test structure and not the fixture.

**3.2.2.2 Design Guidelines for Fixtures.** Fixtures shall be lightweight and stiff. The lowest natural frequency of any bracket or fixture shall be 10 times greater than the frequency range of interest. Bolting the fixture to a bedplate and measuring the FRF can be used to verify that this requirement has been met.

**3.3 Test Vehicle/Test Piece.** This test procedure is good for any subsystem, component, or vehicle level test. For the purpose of validation, the subsystem, component or vehicle to be tested shall be fully assembled and represent design intent. Refer to the referencing procedure for test piece details. Note the condition of the subsystem, component or vehicle on test documentation.

**3.4 Test Time.** Variable.

**3.5 Test Required Information.** Not applicable.

**3.6 Personnel/Skills.** To complete this test, at least one technician and/or one engineer skilled in noise and vibration data acquisition, analysis, equipment usage, and test setup is required.

## **4 Procedure**

### **4.1 Preparation.**

**4.1.1 Boundary Conditions.** Choose one of the following.

**4.1.1.1 In-situ Boundary Condition.** Corresponds to testing a component or subsystem in a trimmed body, trimmed structure, or vehicle (whichever is appropriate for the component).

Mount the component or subsystem into vehicle per recommended installation, bolt torque shall be checked to ensure that the attachment stiffness is correct or production intent.

**4.1.1.2 Rigid Fixture Mounting.** May require custom fixturing. For example, a fabricated test fixture can be mounted to ground (bedplate or rigid fixture) for component mounting.

The fixture shall have a first mode that is at least ten times the desired flexure natural frequency of the component. If this is not possible, make sure that the fixture and component drive point mobilities have at least

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20 dB of separation in all three directions. The first natural frequency of the fixture shall be evaluated with a rigid mass equal to that of the component attached to it.

**4.1.1.3 Free-Free Mounting.** In this condition, the test piece has **no constraints**. This is not achievable realistically, so free-free mounting is approximated by using compliant springs. Determining spring compliance is dependent on certain test information.

A free-free boundary condition in lab can include but is not limited to the following suggestions.

**4.1.1.3.1 Bungee or Spring Mounting.** Hanging the test piece from bungee cords or coil springs. The test piece shall be secured appropriately and the loading limits shall not be exceeded.

**4.1.1.3.2 Mounting on Low Stiffness Material.** For high frequency (50 Hz to 800 Hz) testing, place the test piece on low stiffness material, e.g., isopads (soft rubber pads). The test piece shall be mounted so that the highest system rigid body mode natural frequency is less than one-tenth ( $1/10$ ) the lowest flexural natural frequency of the component.

The first natural frequency of the free-free mounting system shall be determined with a mass equal to that of the component attached to it. This is because resonant frequencies are inversely proportional to the square root of the mass.

**Note:** Natural frequencies of mounting materials and free-free components can be evaluated by making driving point measurements in three orthogonal directions at the attachment points between the fixture and the component.

#### 4.1.2 Component Preparation.

**4.1.2.1 Fluids.** If the component being evaluated features 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 (steering column, seat, etc.) set it to the nominal position in all adjustable directions unless otherwise specified in the evaluation procedure.

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

**4.1.2.4 Squeak and Rattles.** Any part of the component that 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 Instrument Calibration.

**4.1.3.1 Verify Transducer System Calibration.** See GMW14172.

**4.1.3.2 Verify Acquisition System Calibration.** The acquisition system calibration shall be verified by the appropriate instrumentation personnel.

#### 4.2 Conditions.

**4.2.1 Environmental Conditions.** The ambient temperature shall be between 18 °C and 29 °C and temperatures shall not vary more than 6 °C during a given test unless otherwise specified.

**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.** The transducer shall be connected to the analyzer noting the channel used.

The following acquisition parameters are recommended but may vary depending on the dynamics of the component being tested and the desired frequency span and resolution.

Typical Acquisition Parameters:

- Free run trigger.
- For steady state measurements, use a Hanning Window.
- For transient events that cannot be completely observed, use Force/Exponential Windows; otherwise, use a Uniform Window.
- AC Coupled (1 Hz high pass filter).

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