



Generator Sound Power - Component Evaluation Procedure

1 Scope

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. Define the method of quantifying sound power emitted by the generator or Motor Generator Unit (MGU) when measured at a component level. The product of this procedure will be a set of sound power measures in dB (A) magnitude (refer 10^{-12} W).

1.2 Foreword. The sound power (Lw) of a component is one of the factors affecting airborne noise. Lw correlates to noise levels in the passenger compartment and outside the vehicle.

1.3 Applicability. This test procedure is appropriate for all engine driven electro-mechanical devices used in vehicles to supply the electrical system with electric energy and to recharge the battery.

1.3.1 Motor Generator Unit. This test procedure is appropriate for MGUs. MGUs are engine belt driven electro-mechanical devices used in vehicles to supply the electrical system with electric energy. The MGUs require additional power electronics and facilities that are approved by General Motors Company that are not defined in this GMW. The MGUs have sound power characteristics that require additional processing, and that processing is not defined in this GMW.

2 References

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

2.1 External Standards/Specifications.

ANSI S1.11	IEC 61260
ANSI S12.54	ISO 3744
ANSI S12.55	ISO 3745
DIN 45652	JIS Z8732
IEC 60651	JIS Z8733

2.2 GM Standards/Specifications.

GMW14172

2.3 Additional References.

- Isolators: R2/RD2 (gray) series neoprene mountings produced by VMC-Korfund are typically used to isolate the generator. Information for these isolators are available online.
- Component Technical Specification (CTS)

3 Resources

3.1 Facilities. Semi-anechoic test cell meeting requirements defined in ISO 3745 or ISO 3744 standards.

3.1.1 GM Deviation or Additions to the ISO 3744. Room shall meet requirements in ISO 3744, 3.9, note 14, from 224 Hz to 11360 Hz (higher if the component has content within 15 dB of the overall GM component specifications).

GM requires room upper frequency to be capable of measuring all frequency content within 15 dB of the specification.

GM requires the Lw band limited overall (defined in 5.1.4.2) background noise to be 15 dB below the overall GM component specifications. This separation will require no K1 corrections.

3.2 Equipment.

3.2.1 Generator Dynamometer. The Generator dynamometer shall have the capability to run the generator over a speed range of 1250 rpm to 18 250 rpm.

3.2.2 Data Acquisition Equipment. Multi-channel data acquisition hardware capable of calculating frequency domain results between 0 Hz and 22 387 Hz, with a frequency resolution 1 Hz, and a minimum dynamic range of 80 dB is required. This hardware shall meet class 1 accuracy corresponding to IEC 60651.

3.2.2.1 Data channels. The minimum data channels required is 25 (plus four optional) plus two tachometer channels.

Physical Channel ID	Point	Measured Quantity
Tachometer 1	Gen tachometer	Rotational Speed
Tachometer 2	Dynamometer Tachometer	Rotational Speed
Input 1	Mic_1	Pressure
Input 2	Mic_2	Pressure
Input 3	Mic_3	Pressure
Input 4	Mic_4	Pressure
Input 5	Mic_5	Pressure
Input 6	Mic_6	Pressure
Input 7	Mic_7	Pressure
Input 8	Mic_8	Pressure
Input 9	Mic_9	Pressure
Input 11	Mic_10	Pressure
Input 11	Mic_11	Pressure
Input 12	Mic_12	Pressure
Input 13	Mic_13	Pressure
Input 14	Mic_14	Pressure
Input 15	Mic_15	Pressure
Input 16	Mic_16	Pressure
Input 17	Mic_17	Pressure
Input 18	Mic_18	Pressure
Input 19	Mic_19	Pressure
Input 20	50 cm Mic	Pressure
Input 21	Gen Top (1)	Acceleration
Input 22	Gen Top (1)	Acceleration
Input 23	Gen Top (1)	Acceleration
Input 24	Gen Temp 25 mm regulator	Voltage
Input 25	Gen Temp, Celsius (°C)	Voltage
Input 26	Battery Voltage (Volts)	Voltage
Input 27	Battery neg Discharge (Ampere)	Voltage
Input 28	Gen_Volts, (Volts)	Voltage
Input 29	Gen_Current, (Ampere)	Voltage

Mic = microphone; **Gen** = generator; **neg** = negative; **ID** = Identification

3.2.2.2 Generator Tachometer. An instrument grade tachometer signal probe, such as an optical

tachometer pickup, capable of providing a 1 pulse/revolution jitter free signal is required.

3.2.3 Dynamometer Tachometer. A tachometer signal is required to track the dynamometer speed and potential issues. The signal can be an encoder or a jitter free tachometer.

3.2.4 Microphone Array. Microphone and array requirements are defined in ISO 3744 and ISO 3745 sound power standards. The preferred hemispherical array contains 19 microphones at a 1 m radius over a reflecting plane as defined in Figures 1 and 2.

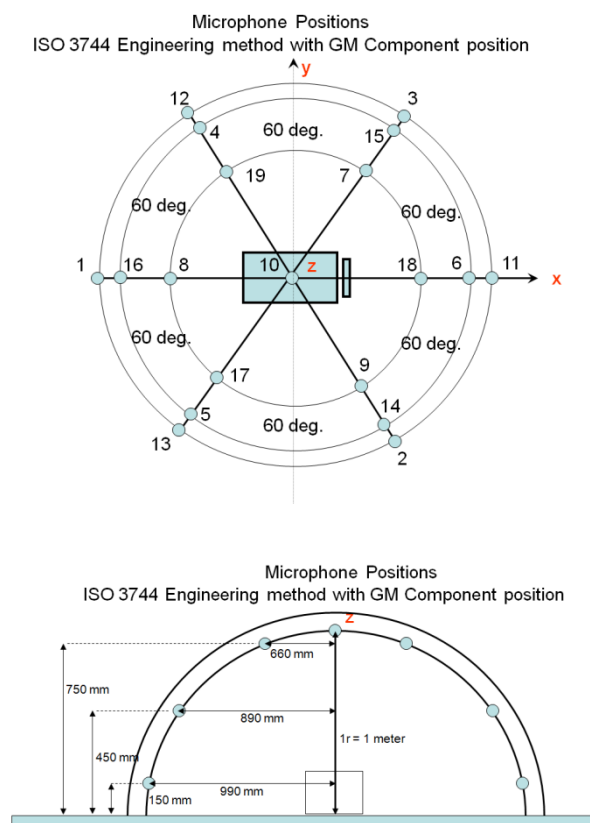


Figure 1: Preferred Test Stand Microphone Array

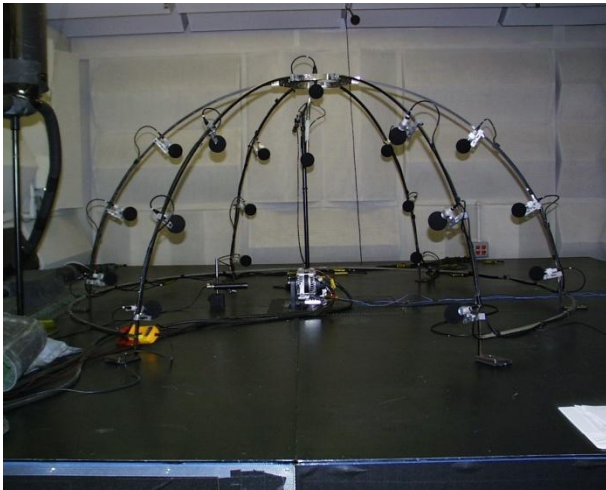


Figure 2: Preferred Microphone Array

3.2.4.1 Fifty (50) cm Microphone (optional). The microphone specifications are the same as the 19 microphones above. A 50 cm microphone is placed directly above the generator unless otherwise specified. (This microphone is not used in the calculation of sound power L_w .)

3.2.5 Accelerometer (optional). One (1) high sensitivity accelerometer with a flat frequency response from 5 kHz to 6.4 kHz and a temperature range of 10° C to 152° C or greater shall be used. The Generator vibration is measured on the case top near the pulley. Direction orientation is: X is along axis of generator, Z is vertical. Check Appendix A for positioning details.

3.2.6 Thermal Couple. Thermal couples are used to measure the generator case temperature and air temperature near the regulator.

Temperature equipment tolerance $\pm 1^\circ \text{C}$.

3.2.7 Two (2) Current Measurement Devices. Use a Direct Current (DC) and Alternating Current (AC) (0 Hz to 6400 Hz) capable inductive current clamps to measure current. Use a current clamp with at least a 300 A range and a tolerance $\pm 2\%$.

3.2.8 Two Voltage Divider Boxes. The generator voltage must be within the measurements systems input voltage range. The use of a voltage divider may be required.

Voltage equipment tolerance $\pm 50 \text{ mV}$.

3.2.9 Load Bank. A device capable of controlling the electronic load applied to the generator. Reference Transistor Devices Inc., Dynaload Model DLVP-100-300-3000.

3.2.10 Pulse Width Modulation (PWM) Controller. For GM Regulated Voltage Control (RVC). A device capable of variable frequency and

duty cycle control of PWM signal to the generator such as the Model 205 PWM Controller from Applied Processor and Measurement, Inc. is required for generators that use PWM control.

3.2.11 Battery. Battery requirements: Minimum 700 CCA, not older than 12 months, replace if battery is deep cycled (dead battery). Two (2) to four (4) batteries in parallel shall be used for Generators with outputs over 150 A.

3.3 Test Vehicle/Test Piece. One (1) belt driven motor generator unit (MGU) representing the design under test is required.

3.4 Test Time.

Calendar time:	1 day
Test hours:	7 hours
Processing time:	0.5 hour
Coordination hours:	0.5 hour

3.5 Test Required Information. The generator supplier must provide a method to control the output of the generator.

3.6 Personnel/Skills. One (1) qualified engineer or technician trained in the use of acoustic data acquisition and recording equipment, and having significant knowledge of digital signal processing.

In addition, knowledge of electrical charging systems and operation of the motor/controller used to drive the generator is required.

4 Procedure

4.1 Preparation.

4.1.1 Generator Mounting. Use GM qualified or approved dynamometer mounting bracket that has three rubber isolators to mount the generator to the test stand, as shown in Figures 3 and 4.

4.1.1.1 Ability to level and position the component to achieve the correct angle and drive belt tension when driven. The corporate allowable pulley axial misalignment is $\frac{1}{2}$ degree total (looking in the plane of the belt between pulleys). This misalignment is the total allowed including all misalignment contributors. (Example: A 470 mm belt span using the $\frac{1}{2}$ degree specification allows a total of 4.1 mm misalignment.)

4.1.1.2 Ability to minimize belt noise and Belt joint bump at all operating speeds.

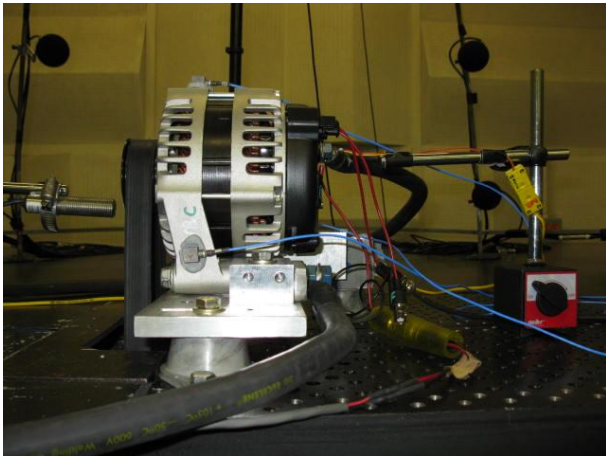


Figure 3: Example of Generator Mounting

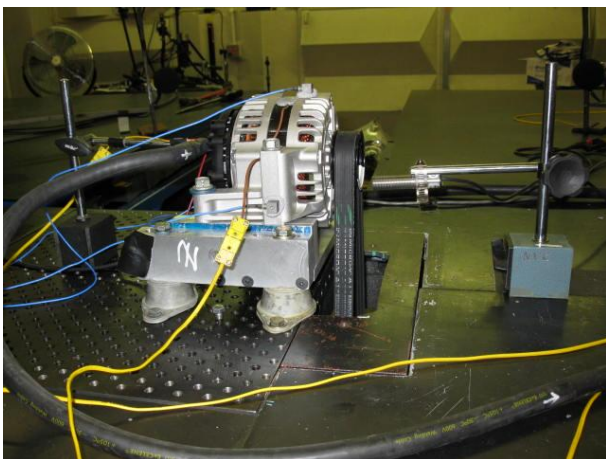


Figure 4: Example of Generator Mounting

4.1.2 Generator Circuitry. Connect the generator to a battery and load bank as defined below (load bank and battery in parallel with generator). See Appendix B.

4.1.2.1 Battery. Ensure battery is properly charged to 12.65 V to 12.7 V (no load).

Ensure the battery is charged and without defects. Connect the load bank positive output terminal to the positive battery terminal. Connect the negative battery terminal to the load bank negative.

4.1.2.2 Load Bank. Connect the generator positive terminal to the load bank positive terminal (cable sized to allow less than 0.3 V drop at maximum generator current). Connect the negative generator case/bracket to the load bank negative (cables sized to allow less than 0.3 V drop at maximum generator current). Refer to the load bank operating manual (less than 0.6 V for positive and negative cables together – Generator to battery).

4.1.3 Generator Output Control. Generator output - Three loads are run:

1. The 20 A, 13.8 V (250 to 300 W) is low load (some applications no load is possible and is used in place of the 20 A load) and is used for understanding mechanical noise.
2. The 60 A, 13.8 V (800 to 850 W) is moderate load. Both the 20 A and 60 A loads are common for generator to generator comparisons.
3. The maximum load is a function of the generator. Maximum load is measured by setting the load bank to 110% of the maximum generator load (The batteries will supply the load not supplied by the generator - pushing the limit of the generator.)

Note: All loads are set at a starting case temperature of $43^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 13.8 V generator voltage output (RVC - PWM set to 60%) and 7500 rpm. (Load varies with rpm – 7500 rpm is our load set RPM).

Control the generator output as defined below:

4.1.3.1 RVC Voltage Regulators. PWM signal (5 V square) and 60% Duty Cycle – standard voltage output is 13.8 V (see Appendix C).

4.1.3.2 Non-RVC Voltage Regulators/Generators. Request a circuit diagram and controls from the generator supplier to provide 13.8 V output.

4.1.3.3 Non-RVC Voltage Regulators/Generators That Cannot Set Voltage Equal The RVC 60% Duty Cycle, 13.8 V Then Match Equivalent Output Power Output. For Non-RVC applications the low load can be 0 W to 300 W. The $60\text{ A} \pm 2\text{ A}$ load or 800 W to 850 W load requires the load to stay within the range over the sweep.

4.1.4 Generator Measurement Setup. Set up the following devices to monitor and measure:

4.1.4.1 Generator Output Current. Connect a current measuring device such as a DC current clamp between the generator and battery/load bank that is rated to measure full output current.

Connect a current measuring device such as a DC current clamp between the load bank and battery that is rated to measure full output current. Need to assure that the battery state of charge is stable before the start of test (negative value is battery discharge)

4.1.4.2 System Voltage. Measure the system voltage across the Generator terminals and case/bracket.