



Electrically Powered Coolant Pump - Sound Power and Free-Acceleration 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. This test procedure defines the process for quantifying the free acceleration and sound power (L_w) third octave and narrowband spectra of electrically powered coolant pumps. The product of this procedure will be: a series of sound power spectra in decibel magnitude (reference 10⁻¹² W) (A-weighted), overall acceleration, input and output power, efficiency, inlet and outlet pressures, voltage and current (all are a function of pump flow rates).

1.2 Foreword. Sound power of an energized component defines the component's source level for airborne noise.

Note: The airborne sound power can be changed by the mounting of the component in the vehicle. Sound power, along with other parameters, will be used to predict noise levels in the vehicle passenger compartment and outside the vehicle.

1.3 Applicability. This test procedure is appropriate for electrically powered system actuated coolant pumps that can be tested free-free, with and without complex electronic controls, with a defined fluid controls system.

1.3.1 Coolant pumps used for, but not limited to:

- Heater core cooling
- Electric Rear Differential Module (RDM) cooling
- High-voltage battery cooling
- Powertrain electric control module cooling, such as the transmission power inverter module (TPIM), electric motor/generator unit (MGU), starter/generator control module (SGCM) or the powertrain electronics box (PEB)

2 References

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

2.1 External Standards/Specifications.

IEC 651

ISO 3744

ISO 3745

ISO 9614-2

2.2 GM Standards/Specifications.

GMW14172

GMW14227

2.3 Additional References.

None

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3 Resources

3.1 Facilities. Use a hemi-anechoic test room (reference ISO 3744 or ISO 9614-2). The room must be ISO 3744 qualified using the ISO 3744 Annex A, A.3 Absolute Comparison Test. The sound power must be K_2 corrected for the 250 Hz to 10 kHz one-third octave range using the microphone sound power array. The overall A-weighted component target sound power minus background A-weighted overall sound power must be >10 dB. (This is an allowed and GM approved deviation to avoid the use of ISO 3744 K_1 corrections, which are not allowed).

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 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 Figure 1.

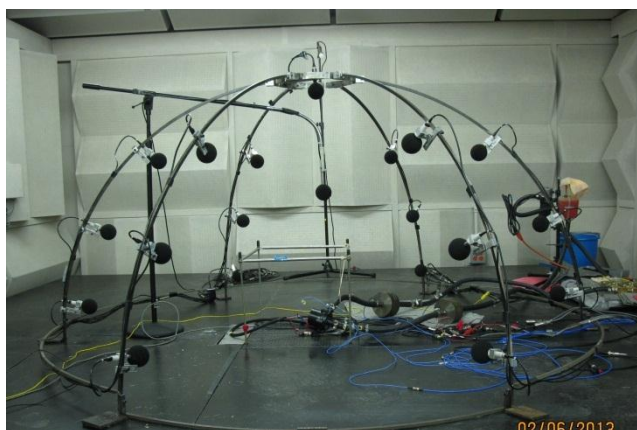


Figure 1: Preferred Microphone Array

3.2.2 Intensity Probe. Required for sound power calculation from sound intensity measurements (reference ISO 9614-2).

3.2.3 Data Acquisition System (Acoustic). Data acquisition hardware capable of calculating frequency domain results between 22 Hz and 11 400 Hz, with a minimum 80 dB dynamic range. This hardware shall meet Class 1 accuracy corresponding to IEC 651 or the equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

3.2.4 Data Acquisition System (Vibration and Other). Data acquisition hardware capable of calculating frequency domain results between 0 Hz and 11 400 Hz with a minimum 80 dB dynamic range. This hardware shall meet Class 1 accuracy corresponding to IEC 651 or the equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

3.2.5 Accelerometer. High-sensitivity accelerometers with a flat frequency response from 5 Hz to 6.4 kHz and a temperature range appropriate for the application. The mass of the effect of the accelerometer shall be $<3\%$ of the overall measurement.

3.2.6 Fifty (50) cm Microphone (Optional). The microphone specifications are the same as the 19 array microphones. A 50 cm microphone is placed directly above the coolant pump unless otherwise specified. (It is available for positioning anywhere desired.) This microphone is not used in the calculation of sound power.

3.2.7 Thermocouple. A thermocouple is used to measure the coolant temperature. Equipment tolerance is ± 1 °C.

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3.2.8 One Current Measurement Devices. Use a Direct Current (DC) and Alternating Current (AC) 0 Hz to 6400 Hz-capable inductive current clamp to measure current. Use a current clamp with at least a 50 mA to 10 mA range and a tolerance of 3% of reading ± 50 mA.

3.2.9 One Voltage Divider Box. The coolant pump voltage must be within the measurement system's input voltage range. The use of a voltage divider may be required.

3.2.10 Two Pressure Transducers. Transducers shall be 200 kPa sealed gage with a dynamic frequency range of 0 Hz to 2000 Hz. These are used for the inlet and outlet pressures. The inlet can go negative pressure, so the transducer must have negative pressure capability to -40 kPa.

3.2.11 Flow Meter. The flow meter must be capable of the following:

- Flow range: 2 L/m to 20 L/m with accuracy of $\leq \pm 0.1$ L/s (5%) at 2 L/s and $\leq \pm 0.2$ L/s (1%) at 20 L/s
- Fluid used: DEX-COOL® or as defined in the Statement of Requirements (SOR)

The range for temperature testing with DEX-COOL® is 5 °C, 23 °C and 70 °C (all are ± 5 °C).

3.2.12 Fluid Control System (Hoses, Pipes, Flow Meter, Valves, Heater - All Without the Pump). This is a defined coolant flow system with three fixed orifice selections (Figure 2) that will have nine coefficients of resistance for a single fluid.

Note: The coefficient of resistance is a function of the fluid properties that change with temperature; therefore, the term "fixed orifice" will be used (three fluid temperatures given one orifice results in three coefficients of resistance).



Figure 2: Setup for Three Fixed Orifices and Valves

There is measurement sensitivity to the position of the components and transducers in the fluid control system; therefore, there are defined locations/positions. Other systems can be approved for use by the Bill of Material (BOM) Family Owner and Noise and Vibration coolant pump Subject Matter Expert.

The flow system with a remote pump (no pump noise) shall not add to the noise/background noise sound power level.

The flow system layout diagram (Figure 3) is for reference only. There are many ways to achieve satisfactory results.

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