



Vehicle Level Hydraulic Power Steering Noise 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. This procedure describes the process for evaluating and measuring vehicle level hydraulic power steering system noise.

1.2 Applicability. This procedure is applicable for all passenger vehicles with hydraulic-assisted power steering systems.

1.3 Remarks. This procedure describes the noise measurement of hydraulic assisted power steering systems. Specific noises covered in this procedure include:

- Hydraulic Power Steering Pump Noise.
- Hydraulic Power Steering Gear Noise.

This test procedure includes quantification of typical hydraulic power steering gear noises, such as squawk, hiss and whistle. Squawk, a type of closed loop instability, usually has a frequency range of 80 Hz to 350 Hz. The frequency range for hiss is typically 1000 Hz to 4000 Hz. The frequency range for whistle is typically above 4000 Hz.

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.

GMW14172 GMW16178

2.3 Additional References.

Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. All measurements shall be performed in a semi-anechoic test room free from interfering noises or outdoors in a free-field area.

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. Two (2) microphones regionally accepted for vehicle interior noise measurements (see GMW16178).

3.2.2 Data Acquisition System. Data acquisition hardware capable of calculating frequency domain results between 22 Hz and 11 200 Hz with a minimum of 80 dB dynamic range. This hardware shall meet or exceed Class 1 accuracy corresponding to IEC 651 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$).

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September 2017

Page 1 of 9

3.2.3 Temperature Meter. A portable temperature meter or data acquisition temperature input is required and be capable of ± 1 °C measurement of the Power Steering Reservoir fluid temperature.

3.2.4 Tachometer. Optical or inductive sensor capable of accurately measuring engine or power steering pump speed in revolutions per minute (rpm).

3.2.5 Coarse Tire Surface Contact Patch. A tire surface contact patch (3M "Safety-Walk" Series 600 anti-slip self-adhesive coating or equivalent).

3.2.6 Vacuum Pump. A hand held vacuum pump (Mityvac or equivalent) is required for bleeding the power steering system prior to testing.

3.3 Test Vehicle/Test Piece. The tests shall be performed on a vehicle that represents the current release status. The entire hose routing shall be checked prior to the test, to ensure there is no accidental contact between hoses and surrounding components and that any intentional contact (i.e., isolation or indexing features) is correctly represented. If there is uncertainty as to whether contact is intentional or accidental, the responsible engineer must be contacted before proceeding with the test. Any deviations (e.g., obvious faults) must be noted and corrected prior to testing.

3.4 Test Time.

Calendar time: 1 day

Test time: 8 hours

Coordination time: 4 hours

3.5 Test Required Information. Record vehicle content information. Include the number of vanes in the power steering pump and the power steering pump to crankshaft pulley ratio. See Appendix B, Data Sheet B1.

3.6 Personnel/Skills. Engineer or qualified technician with basic knowledge of acoustics.

4 Procedure

4.1 Preparation. Check the vehicle according to 3.3.

4.2 Conditions.

4.2.1 Environmental Conditions. The ambient air temperature should remain between 10 °C and 30 °C.

Note: All interfering noise emissions from test stand devices must be eliminated.

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.

4.2.3 Standard Test Conditions.

4.2.3.1 Sweep Noise Unloaded Steering System. Measure steering system noise with the vehicle stationary, the transmission in neutral, the Power Steering Reservoir fluid temperature at approximately 90 °C, and the steering system unloaded with the Steering wheel "on center". Sweep the engine speed from idle to rated engine speed or the maximum useable rpm over a measurement time of one (1) minute.

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September 2017

Page 2 of 9

4.2.3.2 Sweep Noise Loaded Steering System. Measure steering system noise with the vehicle stationary, the transmission in neutral, the Power Steering Reservoir fluid temperature at approximately 90 °C, and the steering system loaded as follows:

- Hold steady pressure on the steering wheel to the right at 1/6 of full steering angle and Sweep the engine speed from idle to 5000 engine rpm (or maximum rpm that can be achieved under 5000 rpm) over a measurement time of one (1) minute.
- Hold steady pressure on the steering wheel to the right at full steering lock and Sweep the engine speed from idle to 5000 engine rpm (or maximum rpm that can be achieved under 5000 rpm) over a measurement time of one (1) minute.

4.2.3.3 Steady State Noise at Idle. Measure steering system noise with the vehicle stationary, the transmission in neutral and the engine operating at idle with Power Steering Reservoir fluid temperatures of 80 °C and 100 °C for each of the following conditions:

- The steering wheel centered and unloaded.
- The steering wheel loaded with steady pressure to the right to the worst observed position for steering hiss noise.
- The steering wheel loaded with steady pressure to the left at the worst observed position for steering hiss noise.
- The steering wheel loaded with steady pressure to the right to the worst observed position for steering moan noise.
- The steering wheel loaded with steady pressure to the left at the worst observed position for steering moan noise.

4.3 Instructions.

4.3.1 Calibration Verification. Check equipment for valid calibration date. Replace out of date equipment. Perform equipment calibration verification (see GMW14172).

4.3.2 Install Instrumentation.

4.3.2.1 Microphone. Install interior microphones in positions as specified in Appendix A, Figures A1 and A2. The standard locations for left hand drive vehicles are Left Front Seat Right Ear (LFRE) and Right Front Seat (RF) positions. The standard locations for right hand drive vehicles are Right Front Seat Left Ear (RFLE) and Left Front Seat (LF) positions.

4.3.2.2 Tachometer. Install tachometer to measure engine or power steering pump speed in rpm.

4.3.3 Vehicle Setup. Adjust the tire pressures to nominal values (cold). Locate each of the vehicle front tires on top of a tire surface contact patch.

The vehicle should be unloaded except for the driver and the test equipment. Adjust the seats and headrests according to Appendix A. Close the engine compartment hood, trunk, sliding roof, sunscreen, doors, and windows.

Switch off the air conditioning at least ten minutes before the start of the test. Turn off the heater blower, radio and other accessories. Ensure all customer actuated systems are off.

4.3.3.1 Power Steering System Bleed. The power steering system must be bled before measurements are taken in order to take out air in the power steering fluid. To achieve a proper bleed of the system perform the following steps: With the engine off, fill the Power Steering Reservoir to the proper level. Use a hand held vacuum pump (Mityvac or equivalent equipment) to apply a vacuum of 68 kPa (maximum) to the Power Steering Reservoir for five (5) minutes (a modified cap with a tube is used). Refill the Power Steering Reservoir Fluid to the proper level. Start the engine and warm up the Power Steering Reservoir fluid up to a minimum of 75 °C by steering the front wheels from stop-to-stop a minimum of five (5) times. If Hydro-boost is used, depress the brake pedal a minimum of 10 (ten) times. Release the vacuum and check the Power Steering Reservoir fluid level against the vehicle fluid fill dipstick or reservoir markings. Add fluid if necessary. Allow the engine to idle for five (5) ± one (1) minute. At the end of five (5) minutes of idling turn the steering wheel from stop to stop another five (5) times (with engine running) prior to making noise measurements. Warm the fluid up to at least 75 °C again by steering the front wheels from stop-to-stop a minimum of five (5) times and proceed with noise testing. For applications with Hydro-Boost, press and release the brake pedal a minimum of ten (10) times.

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September 2017

Page 3 of 9