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| GM | WORLDWIDE ENGINEERING STANDARDS | Test Procedure | GMW14975 |

# Vehicle Brake Noise Evaluation

## 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 standard describes a method to objectively quantify vehicle brake noise performance.

**1.2 Applicability.** To all passenger car and light truck brake corners.

**1.3 Remarks.** This standard is intended to quantify brake noise frequencies and amplitudes as well as the operating conditions under which the brake noise(s) occurs. This standard is intended to be used with any design representative vehicle at any point in the development process up to and including production. This standard is intended to objectively capture brake squeal in the frequency range of (1 to 17) kHz and subjectively evaluate low frequency brake noise.

## 2 References

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

**2.1 External Standards/Specifications.**

FMVSS 135

**2.2 GM Standards/Specifications.**

GMW14974 GMW15319

## 3 Resources

**3.1 Facilities.**

**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** Milford Proving Ground (MPG) Oval test track or equivalent test facility shall be used.

**3.1.4** Milford Proving Ground Cold Box or equivalent test facility shall be used.

**3.1.5** Milford Proving Ground Splash Trough 15.24 m or equivalent test facility shall be used.

**3.1.6** Milford Proving Ground access road to Variable Grade Ramp facility or equivalent moderate inclined road shall be used. Refer to 4.3.7.

**3.2 Equipment.**

**3.2.1** A Roush Brake Data Acquisition (DAQ) measurement system or equivalent.

**3.2.2** Two (2) Endevco pressure transducers or equivalent.

**3.2.3** Four (4) K-type thermocouples.

**3.2.4** Speed Measurement Device (Optional).

**3.2.5** Production representative brake corner hardware.

**3.2.6** The following measurements shall be made and digitally recorded at 100 Hz:

**3.2.6.1** Speed (km/h) (optional).



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**3.2.6.2** Sound pressure level (dB).

**3.2.6.3** Corner acceleration (G).

**3.2.6.4** Brake apply pressure (kPa).

**3.2.6.5** Brake lining temperature (°C). Alternative: Brake rotor temperature.

**3.2.6.6** Ambient temperature (°C).

**3.2.6.7** Relative humidity (%).

**3.3 Test Vehicle/Test Piece.** Not applicable.

**3.4 Test Time.**

| | |
|---|---|
| Calendar time: | (10 to 11) work days |
| Test hours: | (40 to 50) h track time |
| Coordination hours: | Minimum 12 h cold soak<br>(2 to 4) h documentation |

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

**3.6 Personnel/Skills.** One (1) technician capable of operating the Roush Brake Data Acquisition (DAQ) system equipment, setting up vehicle, and performing the duties described in paragraph 4 is required.

## 4 Procedure

**4.1 Preparation.**

**4.1.1** If the brake hardware is production intent, the hardware on the vehicle can be tested in its current condition. New brake hardware (linings and rotors/drums) may be installed if requested by the test engineer.

**4.1.2** Thermocouple brake linings per Federal Motor Vehicle Safety Standard 135 (FMVSS 135.)

Alternative: Embedded thermocouple in the brake rotor per GMW14974.

**4.1.3** Install transducers and data acquisition equipment. The interior microphone should be placed near the driver's right ear.

**4.1.4** Calibrate the microphone. Use method recommended by instrument manufacturer.

**4.1.5** Place and wire the accelerometers and accelerometer charge amplifiers at each brake corner. Verify that the instrumentation is functioning properly by using tuning forks in the range of (1 to 17) kHz.

**Note:** Put a tuning fork on left front accelerometer. The instrumentation should be recording a noise event. If instrumentation is not recording a noise event, consult test engineer before proceeding. Repeat for right front, left rear, and right rear brake corners.

**4.1.6** Install the accelerometers on either the lining backing plate or the caliper for a disc brake and on the backing plate for a drum brake using dental cement or similar adhesive.

**4.1.7** Waterproof and install the accelerometer charge amplifiers within 1 m of the accelerometers.

**4.1.8** Load the vehicle to curb mass plus driver and instrumentation plus full fuel load. Other loading conditions may be specified by the requesting engineer. All ballast must be properly secured. Document the vehicle test weight.

**4.2 Conditions.**

**4.2.1 Environmental Conditions.** Not applicable.

**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.

**4.2.2.1** Radio off during testing.

**4.2.2.2** All windows should be open a minimum of 15 cm for the Wet, Cold, and Warm sections. All windows should be completely closed for the Creep Groan and the Dynamic Groan/Grind sections of the procedure.

**4.2.2.3** Air conditioning fan setting restricted to off or low position during testing.



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**4.3 Instructions.**

**Note:** For all the Cold, Wet, and Warm test sections, driver is to note any low frequency brake noise heard. The stop number and subjective rating is to be noted on the Driver Evaluation sheets. Utilize GMW15319 for the subjective rating scale.

**Note:** If at any point during the test, a low frequency brake noise of a 7 subjective rating or below is heard, the Test Technician shall immediately contact the Test Engineer and the noise shall be demonstrated. Additional work may be required to quantify the noise.

**Note:** The following instructions are for performing the test at the GM Proving Ground, Milford, Michigan, USA. Modify the instructions as needed when using equivalent facilities.

**Note:** The IBT value for the defined stops should be taken from the left front corner. From the installed thermocouples at rotor or pad (see 4.1.2).

**Note:** For automatic transmission use drive or reverse position for any brake stop. For manual transmission use neutral or disengaged clutch during brake stop.

**4.3.1** Stabilize the cold box temperature at +1 °C.

**Note:** In the absence of a cold box an ambient soak can be conducted when ambient temperatures remain < +10 °C for 2 h or more. An environmentally controlled chassis dynamometer can be used to perform 4.3.3. If possible, set the relative humidity for > 90 %.

**4.3.2** Soak vehicle in cold box for 2 h minimum at +1 °C. (As an option, the test engineer may request the vehicle be driven through the splash trough at 5 km/h prior to being placed in the cold box. In this case, the cold box temperature should be raised to +5 °C and the soak time increased to 4 h minimum.)

**4.3.3** Remove the vehicle from cold box and perform stops according to the Table 1. If squeal is found, continue stop condition until the squeal goes away, resume procedure at the next condition. Finding squeal will increase the total number of stops.

**Table 1: Stops after Cold Box**

| Stop Number | Speed in km/h | Deceleration in G | Gear |
|---|---|---|---|
| 1 to 3 | 10 | 0.1 | Drive |
| 4 to 6 | 10 | 0.1 | Reverse |
| 7 to 9 | 10 | 0.2 | Drive |
| 10 to 12 | 10 | 0.2 | Reverse |
| 13 to 18 | 10 | 0.3 | Drive |
| 19 to 21 | 10 | 0.1 | Drive |
| 22 to 24 | 10 | 0.1 | Reverse |
| 25 to 27 | 10 | 0.2 | Drive |
| 28 to 30 | 10 | 0.2 | Reverse |
| 31 to 36 | 10 | 0.3 | Drive |
| 37 to 39 | 10 | 0.1 | Drive |
| 40 to 42 | 10 | 0.1 | Reverse |
| 43 to 45 | 10 | 0.2 | Drive |
| 46 to 48 | 10 | 0.2 | Reverse |
| 49 to 54 | 10 | 0.3 | Drive |

**4.3.4** Fill the 15.24 m (50 ft) splash trough to 230 mm for passenger cars, 305 mm for trucks and utility vehicles. Before entering the trough, the brake corner initial brake temperature (IBT) should be < +70 °C.



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