



## Squeak & Rattle Evaluation of Entertainment System-Driven Squeak & Rattle Testing

### 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 test, evaluate and demonstrate that the vehicle under test is free from squeaks and rattles excited by the entertainment system speakers.

It is also intended that any subsystems or components that squeak and rattle (S&R), as a result of this test procedure, are located and identified with necessary documentation to press the issue to resolution.

This test is applicable during all phases of vehicle development, validation, release, and manufacturing.

**1.2 Applicability.** This test procedure applies to all GM vehicles equipped with a compact disc (CD) player or alternate audio input device such as a Universal Serial Bus (USB) port. This procedure is applicable to development testing, validation testing, and audit testing. This test shall be applied across all durability schedules at regular intervals to insure that squeaks and rattles from sound systems do not manifest by themselves. It is recommended that this procedure be used in conjunction with GMW8518.

**1.3 Remarks.** This procedure describes the methodology to input band limited white noise (BLWN) into the vehicle audio system. The speaker system then induces structure-borne and airborne energy into the vehicle subsystems exciting the squeaks and rattles expected to be heard by our most critical customers. Squeaks and rattles can then be detected and the root cause determined. Sine sweeps (SS) and monotones (M) are also included in this procedure for root cause analysis of squeaks and rattles.

### 2 References

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

#### 2.1 External Standards/Specifications.

None

#### 2.2 GM Standards/Specifications.

GMW8518                      GMW14264

#### 2.3 Additional References.

- GM Research and Development (R&D) Report AS-598, located at;  
<https://gmweb.gm.com/sites/GMLibraryRDP04/19901999/AS-598.PDF>.
- K-PAC Set Number NVI-S531 in GM Auros System, located at;  
[https://e2ks.gm.com/e2ks/e2ks\\_home.jsp](https://e2ks.gm.com/e2ks/e2ks_home.jsp) (Open CoP "NVI" and search in K-PAC Sets.)

**Note:** Requests for R&D and K-PAC files outside of General Motors should be made through a GM engineer.

- Occupational Safety and Health Administration (OSHA) standards and regulations, located at;  
<http://www.osha.gov>.

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### 3 Resources

**3.1 Facilities.** This procedure can be carried out with minimal equipment and facilities. The two (2) important factors to be considered are ambient noise levels  $\leq 52$  dB(A) Root Mean Square (RMS) (in order to ease locating resonating components) and the comfort of technician in locating the squeaks and rattles. For a thorough evaluation of the vehicle, a range of temperature conditions in a controlled environment is required, see 4.2.1.

**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.** This test is designed using basic and low cost equipment:

**3.2.1 Test sound files Band Limited White Noise (BLWN), Sine Sweep (SS) and Monotone (M).** The sound files (in mp3 format) can be downloaded from Knowledge Set K-PAC Number NVI-S531 (see 2.3). Test sound files on CDs are available at the S&R laboratory at the Milford Proving Grounds. Requests for the audio files outside of General Motors should be made through a GM engineer. Internally, the sound files are stored in Global Document Management (GDM) at the following link:

<https://documents.naeng.gm.com/gdm3/drl/objectId/0b0163bc80fb1768>

**3.2.2** Optionally, a flash memory or similar device capable of storing approximately 100 MB of data can be used to drive the vehicle's audio system through the a USB or other input port, if so equipped.

**3.2.3** Sound Pressure Level (SPL) Meter (Radio Shack 33-2055 or equivalent per <http://www.radioshack.com>).

**3.3 Test Vehicle/Test Piece.** This test requires a full vehicle equipped with an entertainment system capable of receiving audio input from CD, USB, or other external device.

The vehicle shall be equipped with production design intent components. If the vehicle trim is not well attached and in good condition, the testing shall not be performed.

#### 3.4 Test Time.

Calendar time: 1 day

Test time: 1 to 4 hours

Coordination time: 1 hour

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

**3.6 Personnel/ Skills.** A skilled technician or an engineer can perform this test procedure. Test personnel shall have a working knowledge of:

**3.6.1** Squeak and Rattle (S&R) root cause analysis.

**3.6.2** Use of sound level meter. (Some learning may be required if no sound level meter is available and involves listening for the onset of distortion. However, it is advised to use a sound meter as squeaks and rattles greatly depend on the volume level set and reducing the volume level might decrease the chances of detection. On the contrary, increasing the volume level until distortion is noticed can bring out the squeaks and rattles which are not otherwise problematic.)

**3.6.3 Hearing Requirements.** Auditors for S&R testing must satisfy the Hearing Acuity Standard for S&R evaluators as per GM R&D Report AS-598, which can be found in the GM Library (see 2.3).

### 4 Procedure

**4.1 Preparation.** Record all pertinent vehicle and entertainment system information. Verify that the entertainment system is functioning properly.

**4.2 Conditions.** The vehicle interior must be production intent and in good condition to perform this test. The vehicle should be free of any test equipment that may affect the evaluation. All vehicle windows should be in the up position

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during the testing. If the vehicle is equipped with a convertible top, targa top, or sunroof, it should be in the closed cabin position unless otherwise requested.

The standard method to be used is described in this section. Any deviation from the specified method either due to lack of equipment or facilities shall be duly documented on the evaluation sheet.

**4.2.1 Environmental Conditions.** The test shall be performed at three (3) different temperatures, 0 °C, 20 °C and 32 °C. The vehicle shall be soaked one (1) additional hour after the interior of the vehicle has been brought to the specified temperatures. If the test cannot be done at all the three (3) temperatures, it shall be properly indicated in the evaluation sheet, and the temperature(s) at which the test is done shall be recorded.

**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 CD Layout.** The S&R test CD (available at the S&R laboratory at the Milford Proving Grounds) has five (5) BLWN tracks that are each 20 s long with different octave band center frequencies. The  $\frac{1}{3}$  octave center frequencies of the five (5) tracks are 31.5 Hz, 63 Hz, 125 Hz, 250 Hz and 500 Hz in that order. The five (5) tracks are repeated twice on the CD. The BLWN tracks are followed by sine sweeps with five (5) different frequency bandwidths including 20 Hz thru 40 Hz, 40 Hz thru 80 Hz, 80 Hz thru 160 Hz, 160 Hz thru 320 Hz and 320 Hz thru 640 Hz. The five (5) SS tracks are repeated twice on the CD. The remaining tracks on the CD are monotones at selected frequencies. A complete index of the tracks has been provided in Appendix B, Table B1. Since squeaks and rattles in vehicles are predominantly caused by low-frequency vibration, audio frequencies above 640 Hz have not been included.

### 4.3 Instructions.

**4.3.1 Sound Setup.** Set the sound meter for 60 dB range (50 dB to 70 dB) fast response and “A” weighting. While sitting inside the vehicle with the engine and all accessories turned off, record the ambient sound level to check if it is below the required level of 52 dB(A) (if < 50 dB(A), the digital display might read LO). If it is greater than 52 dB (A) and there is no way to reduce the background noise, another location or time shall be chosen to conduct the test.

**4.3.1.1** Turn the vehicle ignition to accessory position. Automatic Tone Control (ATC) shall be set for neutral or flat response. Graphic equalizer must be set for flat response or at the center position. Care must be taken to ensure that the CD player is set to Continuous mode and not Random or Shuffle. All accessories must be in the off position. Adjust bass to maximum. Adjust midrange, treble, balance, fade and any other settings to neutral or center position.

**4.3.1.2** Set the sound meter for 80 dB range (70 dB to 90 dB) fast response and “A” weighting. Load the Test CD or mp3 storage device into the CD player, USB port, or other appropriate receptacle in vehicle. While playing the 5<sup>th</sup> track, labeled BLWN 500 Hz, hold the sound meter approximately at the driver’s right ear position, and adjust the volume level of the entertainment system until the sound meter reads 85 dB (A) RMS. If 85 dB (A) is not possible, set to the maximum possible level.

**4.3.1.3** Once the level is set, the volume should not be changed for the duration of the test. If it is changed, reset the level using the sound level meter. Depending on the configuration of the system, it is possible that the sub-woofer might distort at low frequencies (1<sup>st</sup>, 6<sup>th</sup>, 11<sup>th</sup> or 16<sup>th</sup> track). In such cases the evaluator must be aware of the distortion and must not reduce the volume to remove the distortion.

**4.3.2 Testing.** Because of the setup performed, the CD (or mp3 storage device) must be started from the beginning. This can be done by ejecting the CD once and pushing it back in, or by using the Seek button until the display indicates Track 1, labeled BLWN 31.5 Hz.

Once the audio tracks start playing, some keen listening is required to identify parts that S&R. All the components with resonant frequencies within the octave band will be excited, and if they are not designed or secured properly, the components will start to S&R. Hand pressure may be used to assist locating and identifying the resonating components by touching and pressing gently to see if the S&R is consistent. A specific track may be repeated to re-excite a particular problem location in order to identify it. In addition, sine sweeps and monotones may be used to pinpoint squeaks and/or rattles, as described in 4.3.3.

Some S&Rs are generated by hidden components (water deflector, lock rods, etc.) and may require the removal of trim components to locate the problem. However, as a word of caution, removing trim components or changing the

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