



Air Induction System Mechanical Vibration Durability Test for Body Mounted Components

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. The purpose of this test is to evaluate the structural durability performance of air induction components when subjected to loads and temperatures that are representative of what they would experience when mounted in a vehicle.

1.2 Foreword. Not applicable.

1.3 Applicability. This standard is applicable to air induction systems mounted to the body of all passenger cars, sport utility vehicles, and trucks equipped with an air induction system.

2 References

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

2.1 External Standards/Specifications.

ISO 17025

ISO/TS 16949

2.2 GM Standards/Specifications.

GMW3425

GMW15019 (ID)

GMW15980

GMW16671

Note: (ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

Air Induction program specific Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. All tests must be run by a ISO/TS16949 or ISO 17025 approved lab and be able to maintain an ambient room temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

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 An electrodynamic vibration machine capable of vibrating at a frequency range of 6 Hz to 1000 Hz and that is in good working order.

3.2.2 An environmental chamber capable of maintaining operating temperatures ranging from $-40\text{ }^{\circ}\text{C}$ to $120\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$. It must also be capable of holding a specified temperature $\pm 2\text{ }^{\circ}\text{C}$ for a minimum of 3 h. The test chamber may be fitted with an observation window, so that test pieces may be examined without opening the chamber and interrupting the test.

3.2.3 An accelerometer (typical input range: $\pm 25\text{G}$, 2 Hz to 1000 Hz).

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3.2.4 Calibration. The test equipment shall be in good working order and shall have a valid calibration record no more than one year old. Calibration dates shall be recorded on test log sheet and documented in final test report.

3.2.5 Test Fixture. Test fixtures shall hold test parts in the in-vehicle installed position. Aluminum or stainless steel is a suitable material for the fixture. The fixture, when coupled with the test sample or equivalent mass and center of gravity, shall not have a resonant frequency between 10 Hz and 250 Hz in any axis. Upon request of GM engineer, actual vehicle parts may be used as part of test fixturing.

3.3 Test Vehicle/Test Piece. A test sample consists of a full air induction system including air box, inlet duct, outlet duct, mass air flow sensor, and any noise attenuators. Any positive crankcase ventilation (PCV), secondary air injection (SAI), etc., ports shall have the design intent mating part installed. Test parts must be made from production intent material.

3.4 Test Time. The following is an estimate of the amount of time needed to perform this procedure on one sample. Total duration of test will depend on the number of samples tested.

Calendar time:	3 days/sample/life
Test hours:	72 hours/sample/life
Coordination hours:	16 hours

3.5 Test Required Information.

3.5.1 The GM engineer will advise supplier whether to use the standard vibration profile as listed in this standard, or to use a custom vibration profile that is developed at GM based on a Road Load Data Acquisition (RLDA) per GMW15019. If a custom profile is chosen, the profile shall be documented in the test report.

3.6 Personnel/Skills. Not applicable

4 Procedure

4.1 Preparation.

4.1.1 Schedule test facility to coincide with availability of test parts.

4.1.2 Design and manufacture test fixtures that will hold the entire air induction system in-vehicle installed position. If requested by GM engineer, include actual vehicle parts in the fixture design. Mounting interfaces should be exactly the same as in vehicle per math data.

4.1.3 Inspect test parts to ensure they have been manufactured properly.

4.1.3.1 Fasteners shall be tightened to the minimum of the torque specification.

4.1.4 Pre-Test Leak Check. Assemble air induction system and run a pre-test leak check on each air induction system that will be tested. (Reference GMW16671).

4.1.4.1. Install plug/nipple assembly into clean air duct outlet. Clamp plug into duct using production clamp, torqued to minimum torque spec. Seal inlet of dirty air snorkel with air tight plate. Final assembly should include air filter element installed in the air box in production orientation.

4.1.4.2 Place assembly into environmental chamber with ends fixed in the in car position and vacuum source attached to the vacuum plug nipple. Environmental chamber to be at ambient temperature ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$).

4.1.4.3 At ambient temperature, apply an air induction vacuum (VAC) kPa vacuum ± 0.1 kPa and measure the leak rate.

Note: VAC kPa vacuum is the air induction system static flow restriction at maximum air flow rate +5.0 kPa. Reference the Air Induction program specific SSTs for exact value.

4.1.4.4 Record measured leak rate. The assembly must meet the leak rate specified in the SSTs.

4.2 Conditions.

4.2.1 Environmental Conditions.

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.

4.3 Instructions.

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4.3.1 Install air induction assembly onto test fixture in vehicle position on vibration table. (See Figure A1 for example test setup). Connect all associated hoses to their designated ports (PCV and/or SAI) and constrain other end of the hose on the vibration table in the as installed in-vehicle position.

4.3.2 Conduct a vibration test in vertical axis using vibration profile in Table 1. Test profile must be agreed upon between supplier and GM responsible engineer. A custom vibration profile can be developed using data from a RLDA that is taken on a representative vehicle. This vibration profile will be provided by a GM engineer.

4.3.3 The vibration test shall have a superimposed 8 h thermal cycle as defined in Table 4.

4.3.4 The test specimen should be inspected at least 3 times every 8 h shift (or as specified by the GM responsible engineer) for structural integrity. Note any cracks or loose connections.

4.3.5 Repeat 4.3.1 thru 4.3.4 for the remaining 2 directional axis (lateral and fore/aft), using the applicable vibration profile from Table 2 and Table 3.

4.3.6 Perform a post-test leak check as described in 4.1.4.1. Document leak test results on test log.

4.4 Random Vibration Profile. The following random vibration profiles are suitable for testing of body mounted air boxes in passenger vehicles. They are intended to simulate 160 000 km (100 000 mi) of customer usage based on GMW3425 for Cars in Developing Road Regions and GMW15980 for Full Size Trucks/SUVs.

If the vehicle program being tested has a mileage target different than 160 000 km (100 000 mi), adjust the test time appropriately. For example, for a vehicle with 240 000 km (150 000 mi) target life, multiply the test time by 1.5 which would be $1.5 \times 8 = 12$ h/test axis.

4.4.1 Vertical. Vertical Vibration, 8 h, $G_{rms} = 1.60$ (15.7 m/s^2).

Table 1: Random Vibration Profile in Vertical Direction

FREQ (Hz)	Power Spectral Density (PSD) (m/s^2) ² /Hz	PSD (G^2/Hz)
6	0.96236	0.01000
10	9.62361	0.10000
13	9.62361	0.10000
18	1.73225	0.01800
70	1.73225	0.01800
140	0.14435	0.00150
260	0.14435	0.00150
1000	0.01444	0.00015

FREQ = Frequency

4.4.2 Lateral. Lateral Vibration, 8 h, $G_{rms} = 1.52$ (14.9 m/s^2).

Table 2: Random Vibration Profile in Lateral Direction

FREQ (Hz)	PSD (m/s^2) ² /Hz	PSD (G^2/Hz)
6	0.28871	0.00300
10	4.81181	0.05000
15	1.25107	0.01300
100	1.25107	0.01300
250	0.10586	0.00110
1000	0.02887	0.00030

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