



General Specification for Vehicular Horns

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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 specification covers the requirements for horns for installation in General Motors Company (GM) vehicles. This document should be referenced on, and is thus an extension of engineering parts drawings covering these products.

1.2 Applicability. The horn subsystem is required on all vehicles. Its purpose includes one or more of the following:

- An alerting device to be used by the operator of the vehicle to alert persons outside the vehicle to the vehicle's position or motion.
- An annunciating device to inform the operator of the vehicle to some condition, or change of condition of the vehicle, e.g., alarm enabled.
- An alerting device for the purpose of warning away intruders, or for providing an audible vehicle locator.
- Although not a primary mission of the horn, it is recognized that it is also used as a celebratory noise maker, e.g., parades, wedding processions, and should be capable of not being damaged by a reasonable amount of such usage.
- An alarm device for an anti-theft system.

1.3 Remarks. Electrical-Mechanical and Electronic classes of horns are covered by this specification. Acoustic amplification may be provided by a trumpet-type projector, whether straight or curved. Unless otherwise specified, the requirements of this specification apply equally to horns of both classes. This specification does not cover horn or horn assemblies that use air, or compressed air, to generate the sound, except by specific reference from another document. See 6.1 Glossary for horn definitions.

Note: The horn is not a safety device. It is not so classified in any known regulation, world-wide. The horn is a sound signaling device. It is often referred to as a "warning" device, but in the context alerting people around the vehicle, as described in 1.2 Applicability.

2 References

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

2.1 External Standards/Specifications.

AIAG DFMEA	GSO 99	ISO 16750-2	UN R28
AIAG PFMEA	IEC 60068-2-1	ISO 16750-4	USCAR 150-S-002-1-A01
AIAG PPAP	IEC 60068-2-27	ISO/TS 16949	USCAR 150-S-003-1-C01
CONTRAN 35/98	IEC 60068-2-30	KMVSS 53	
FMVSS 302	IEC 60068-2-38	KNVCA 38	
GB 15742-2001	IEC 60068-2-64	SAE J377	

2.2 GM Standards/Specifications.

GMW3059	GMW3103	GMW3431	GMW15357
GMW3091	GMW3116	GMW14872	GMW15725
GMW3097	GMW3191	GMW15272	

2.3 Additional References.

- GP 10
- New York Administrative Code, Section 1403.3 – 5.17
- Part Drawings
- Release Drawings

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities. All data based on laboratory testing shall be from a laboratory accredited to GM standards. See General Procedure (GP) 10 in 2.3 Additional References. Documents verifying accreditation shall be available for inspection.

3.1.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.2 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.

3.1.2 Equipment. When not otherwise specified, the test equipment requirements of SAE J377 4.1.1 On-Vehicle Test Equipment Defaults and 4.2.1 Component Level Test Equipment Defaults shall be used.

3.1.3 Test Vehicle/Test Piece.

3.1.3.1 Production Part Approval. The Production Part Approval Process (PPAP) shall be completed in accordance with and in the format prescribed by the joint industry standard, PPAP, published by Automotive Industry Action Group (AIAG), or its successor document. The default submission level shall be used unless otherwise specified by the purchasing documents.

3.1.3.1.1 Part Approval Submission. Where sample submission is required for appearance or dimensional verification, GM sample submission procedures as outlined in the AIAG PPAP or subsequent publications shall be followed.

3.1.3.1.2 Visual Inspection and Dissection. The part shall be visually inspected for defects in appearance, manufacture, or assembly. Rattles, tightness of attachments, smoothness of operation, and workmanship shall be included in the inspection. Dimensions, mass, and finishes as specified in this specification and the applicable GM drawings are to be checked. Refer to 4.12.13 Dimensional.

3.1.4 Test Time.

3.1.4.1 Electrical Mechanical Horn

Calendar time:	67 days
Test hours:	1150 hours
Coordination hours:	24 hours

3.1.4.2 Electronic Horn

Calendar time:	86 days
Test hours:	1466 hours
Coordination hours:	24 hours

3.1.5 Test Required Information.

3.1.5.1 Development Tests. Development tests are tests used to evaluate specific areas of design. They are a tool for evaluating original designs, design alternatives, proposed improvements, cost reduction proposals, or for field problem analysis. Development tests may be severe. Development tests often accelerate testing by exaggerating specific environments. Failures under a development test are expected. Such failure does not necessarily indicate inadequacy of design. Any failures must, however, be evaluated and the results and any actions documented.

3.1.5.2 Validation Tests. All horns must be validated at the component and system levels prior to their release for vehicle level testing. Validation tests are those tests required to demonstrate that the horn or horn system can meet the requirements of Section 4 for the life of the horn. These component validation, or design release tests, must be satisfactorily completed before authorization for start of production and before quantities are made exhibiting a GM logo or part number.

3.1.5.3 Reliability/Durability Tests. Sample sizes, specification parameters to be monitored, and test sequence shall be determined by the test plan developed under 4.3.5 Mandatory Detailed Test Plan. Where new parts differ from parts previously tested and fully qualified under this specification, by details that affect only styling, re-testing may be waived by the purchase agreements.

3.1.5.4 Test Content and Sequence. Figure B1 Test Matrix for Electrical-Mechanical Horn and Figure B2 Test Matrix for Electronic Horn, in Appendix B, gives the sample size and test sequence to be used for validation. Where basic horns are validated as separate items, the test schedule for assemblies consisting of those validated basic horns together with brackets and/or jumper harnesses may be abbreviated by the GM Development/Validation Engineer to include only those parameters related to the added bracket(s) and/or harness(es).

3.1.6 Personnel/Skills. General familiarity with laboratory equipment, e.g., electrical measurement equipment, like voltage and resistance meters, hot/cold chambers, etc. Familiarity with sound pressure measuring equipment.

3.2 Preparation. As specified by the required tests.

3.3 Conditions.

3.3.1 Environmental Conditions. When not otherwise specified, the test environment of SAE J377 4.1.2 On-Vehicle Test Environment Defaults, and 4.2.2 Component Level Test Environment Defaults shall be used.

3.3.2 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.

3.4 Instructions. All tests must be accomplished in accordance with the procedures and methods outlined in this or referenced documents unless otherwise specified. Specific forms shall be used where required.

3.5 Data. All original data shall be retained with the master file copy of any final laboratory or test report. Comments, if included, are to be based on fact, and should not include opinions.

3.6 Safety.

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Test Results. As specified in Section 4.

4 Requirements and Procedure

4.1 Regulatory Requirements. The horn shall comply with the following requirements. The responsibility is with the supplier of the horn or horn system. Requirements of national governments shall apply even if not explicitly stated below. Specific national requirements may be waived under specific purchase orders or engineering part drawings. Vehicles not destined for sale outside a specific geographical area, e.g., North America or Korea, may be exempted from meeting sound level requirements outside that area, and from the related sound level requirements of SAE J377. All horns must meet China Compulsory Certification (CCC) GB 15742-2001 and have the CCC marking visible.

4.1.1 United States. All states require a horn or other warning signal audible from a distance of 61 m (200 ft). No device shall emit an unreasonably loud or harsh sound or a whistle. No vehicle shall use any siren, whistle or bell, except as otherwise permitted.

4.1.1.1 New York. New York City Administrative Code, Article V, Section 1403.3 - 5.17. New York City requires vehicles sold within its boundaries to have a maximum sound pressure level of 98 dB(A), a weighting filter decibel measured at a distance of 15.2 m (50 ft). This is equivalent to 104.6 dB(A) at 7 m (23 ft).

4.1.2 Canada. Individual provincial regulations require a horn on every vehicle audible from a distance of 60 m (196.8 ft).

4.1.3 Europe, China, Indonesia, Confederation of Independent States (formerly Russia). The United Nations (UN) Economic Commission for Europe Regulation 28 (UN R28). These regulations consist of two parts. The first part requires performance certification for the basic horn at a bench level. Certification is the responsibility of the horn or horn system supplier and is indicated on qualified horns by special markings, referred to as "e" or "E" marking. The second part requires the vehicle to meet a minimum sound level of 87 dB(A) and a maximum of 112 dB(A) measured at 7 m (23 ft). This test is performed with engine off at a battery voltage of 13 V.

4.1.4 Japan. Japan has adopted UN R28 for all horn requirements. In addition, the vehicle's sound pressure level must be greater than or equal to 90 dB(A) and less than or equal to 110 dB(A) measured at a 2 m (6.6 ft) distance from the front end and 0.5 m (1.6 ft) to 1.5 m (4.9 ft) in height.

4.1.5 Gulf States. Gulf States Standard (GSO) GSO 99 Road Vehicles - Sound Signaling Devices Technical Specifications. The requirements of this regulation are at the component level only and are met under the more stringent UN R28.

4.1.6 Brazil. Conselho Nacional de Transito (CONTRAN) 35/98. This regulation is almost identical to the vehicle level requirements of UN R28 with the exception of a maximum sound pressure level of 104 dB(A).

4.1.7 Taiwan. Per Taiwan Safety Inspection Specifications, Taiwan adopted UN R28.

4.1.8 India. Vehicle level requirements are identical to UN R28. Type approval tests are run with an unassisted battery at $13\text{ V} \pm 0.5\text{ V}$, therefore, the source voltage may be one half volt lower than that used for an UN R28 test.

4.1.9 Republic of Korea. Korea Motor Vehicle Safety Standard (KMVSS) KMVSS 53 and Korea Noise and Vibration Control Act (KNVCA) KNVCA 38. Vehicle sound pressure level must be greater than or equal 90 dB(A) and less than or equal to 110 dB(A) measured at a 2 m (6.6 ft) distance from the front end of the vehicle and $1.2\text{ m} (3.9\text{ ft}) \pm 0.05\text{ m} (0.16\text{ ft})$ in height with engine off.

4.2 Part Drawing Requirements. The part drawing shall show all views to clearly define dimensions not contained herein, the device part number and labeling requirements, and any parameters necessary to fully define the product on a purchased part level.

4.3 Pre-Release Requirements. Prior to validation testing, i.e., design release, the component supplier shall comply with the following requirements.

4.3.1 Design Failure Mode & Effects Analysis (DFMEA). A DFMEA at the piece part level shall be completed and made available for inspection. The DFMEA shall identify critical characteristics that should be controlled during processing. The DFMEA shall be completed in accordance with and in the format prescribed by the joint industry standard, Potential Failure Mode and Effects Analysis, published by the AIAG, or its successor document.

4.3.2 Process Failure Mode & Effects Analysis (PFMEA). A PFMEA shall be completed and made available for inspection. The PFMEA shall identify critical processing that could produce non-conforming material, and must address critical characteristics identified during the DFMEA. The PFMEA shall be completed in accordance with and in the format prescribed by the joint industry standard, Potential Failure Mode and Effects Analysis, published by AIAG, or its successor document.

4.3.3 Process Control Plan. A process control plan including control characteristics shall be completed and made available for inspection. This process control plan will identify Key Product Characteristics (KPC), the Key Control Characteristics (KCC) necessary to address KPCs, and the method of controlling the KCCs.

4.3.4 Internal Part Approval. The supplier will have an established part approval plan for all component parts. This will include, as applicable, dimensional checking reports, certifications or inspection reports for all process control characteristics for all internal parts, and machine/shift setup checks.

4.3.5 Mandatory Detailed Test Plan. The supplier shall provide a test plan that describes:

- How the horn is set up and mounted in the test equipment.
- What operational mode the horn was in during the test.
- How the functions of the horn are monitored during and after the test.

The supplier, GM Lead Engineer, and GM Development/Validation Engineer need to review the completed test plan to assure the content is acceptable. A cover page template and instructions are found under Section D1 GMW15575 Horn Test Plan Report in Appendix D.

4.4 Test Sample Performance and Failure Determination. Unless otherwise specified, all samples shall be checked for proper performance before and after each test segment and after the complete test sequence. Performance shall be determined by a minimum of one (1) actuation of 15 s On and 15 s Off and a minimum of three (3) actuations of 1 s On and 1 s Off at an input voltage of 13 V. Sound Pressure Level (SPL) shall be measured during any of the 1 s actuations. Failure shall be defined as one of the following:

- A reduction in SPL from the initial value greater than 5 dB(A), or
- A change in fundamental frequency which results in the unit being outside its manufacturing tolerance of ± 20 Hz, or
- A significant change in tone quality with a signal to noise ratio (SNR) value below 18. Paragraph 6.1 Glossary contains an SNR definition.

A vehicle level test failure will be determined should the vehicle fail to produce a sound level in the specified range. Regarding performance degradation, tone stability is required, but some loss of tone clarity or amplitude may be accepted by the GM Lead Engineer and GM Development/Validation Engineer.

4.5 Test Sample Size, Selection, Allocation, Identification and Disposition.

4.5.1 Test Sample Size. Unless otherwise specified by purchasing documents, sample sizes are as specified by the required tests.

4.5.2 Test Sample Selection. Production samples shall be selected at random from pieces that have been subjected to all normal processing and handling including final packing, excluding final sealing of the shipping container.

4.5.3 Test Sample Allocation. Samples shall be allocated as shown in the test matrix in Figure B1: Test Matrix for Electrical-Mechanical Horn and Figure B2: Test Matrix for Electronic Horn, in Appendix B. Each lot of samples must successfully complete each test in the order shown unless otherwise noted.

4.5.4 Test Sample Identification. All samples used for any type of testing, with exception of production audit samples, shall be permanently marked with a serial number for identification, either at the point of manufacture or at the testing location.

4.5.5 Test Sample Disposition. When samples are no longer needed for test, whether they have been actually subjected to testing or not, they shall be scrapped. The only exception shall be for production audit samples that are not subjected to any intrusive examination or testing, that have been subjected to less than 10 cycles of actuation, and that have been returned to the output stream within one day of the shift of manufacture.

4.6 Functionality. At normal voltage the horn shall be capable of producing an audible output lasting a minimum of four (4) minutes, i.e., continuous duty.

4.7 Life Expectancy. For the purposes of this specification, the life shall be as defined by the following Intended Usage and Life Expectation. For reference purposes this life consists of at least the following:

- Nominal Duty Cycles for Electrical-Mechanical Horn: 100 000 cycles of 1.0 s On, 4.0 s Off.
- Nominal Duty Cycles for Electronic Horn: 1 000 000 cycles of 1.0 s On, 4.0 s Off (High Usage Applications).

4.8 Appearance. Appearance shall be in accordance with the applicable release drawings. As a guideline, it is recommended that the horn be mounted in such a position that it does not need to be painted or otherwise aesthetically treated.

4.9 Mechanical Requirements. Unless otherwise stated, failure or degradation of performance is defined in Section 4.4 Test Sample Performance and Failure Determination.

4.9.1 Mounting Orientation. These devices shall be fully functional at all orientations. However, actual mounting orientation shall be determined to minimize the possibility of water or debris damage to the horn, i.e., high and protected from direct splash (High P/DS).

4.9.2 Mounting Torque. The bracket shall be designed to withstand a mounting bolt or nut torque of 25 Nm without damage or deformation. When an anti-rotation key is incorporated, applying this torque to the bracket shall not cause the key to deform and allow the bracket to turn.

4.9.3 Materials. Materials shall conform to the requirements of GMW3059. When intended for use inside the passenger compartment, the material used in the construction of any parts covered by this specification shall meet the flammability requirements of United States Federal Motor Vehicle Safety Standard (FMVSS) FMVSS 302.

4.9.4 Bracket Attachment to Horn. The assembly shall meet the requirements of SAE J377 6.2 Mounting.

4.9.5 Identification. The horn or assembly will be labeled in accordance with SAE J377 6.7 Identification. All horns must meet China Compulsory Certification (CCC) GB 15742-2001 and have the CCC marking visible.

4.9.6 Recyclability/Recoverability. The horn shall be made to the maximum extent possible with materials that can be disassembled to identifiable recyclable or recoverable components. Ease of disassembly shall be considered in the design. Recyclability/Recoverability shall be in accordance with GMW3116.

4.10 Electrical and Audible Requirements. Unless otherwise stated, failure or degradation of performance is defined in Section 4.4 Test Sample Performance and Failure Determination.

4.10.1 Polarity. The horn shall be designed to have the polarity as specified by Paragraph 4.10.4 Terminations. The mounting and metallic pieces of the horn shall not be connected to the electrical circuits. In all devices, any exposed metallic case, shell, or bracket is to be at vehicle ground potential.

4.10.2 Voltage Range. The horn shall be designed to work with voltages in the range of 9 V to 16 V, as measured at the horn terminals as specified by SAE J377 7.2 Operating Voltage Range. Refer to Section 4.10.4 Terminations. For reference this range is generally described in Table 1: Voltage Range.

Table 1: Voltage Range

9.0 V to 11.4 V	Some performance degradation allowed but no damage or permanent degradation may occur.
11.5 V to 15.5 V	Must meet all requirements.
15.6 V to 16.0 V	Some performance degradation allowed but no damage or permanent degradation may occur.

4.10.3 Recommended Fusing and Wiring. The horn is intended to be wired with a maximum total Direct Current (DC) resistance of 0.1 Ω . It is recommended that they be on an isolated circuit fused at 10 A for one horn, 15 A for two (2) horns, and 25 A for four (4) horns.

Note: Recommended wiring resistance is based on the stall current required to start an electromechanical horn. The circuit must provide at least 9 V at the horn terminals when the battery voltage is at 11 V, under a 30 A starting transient.

4.10.4 Terminations. Unless otherwise specified by the assembly drawing, the following applies.

4.10.4.1 Two (2) Terminal Horn. For a two (2) terminal horn, the standard horn connector is defined by USCAR 150-S-002-1-A01. For this connection, terminal one (1) is ground and terminal two (2) is battery positive terminal (B+). Terminal one (1) is the terminal closest to the connector latch.

4.10.4.2 Three (3) Terminal Horn. For a three (3) terminal horn, the standard horn connector is defined by USCAR 150-S-003-1-C01. For this connection, terminal one (1) is ground, terminal two (2) is control, and terminal three (3) is B+.

4.10.4.3 All connections shall meet the requirements of SAE J377 6.3 Terminations. See also Paragraph 4.17 Serviceability and Service Parts Requirements.

4.10.4.4 The horn components shall not use their mounting as a primary ground.

4.10.5 Current Draw. The horn shall be nominally rated at no greater than 6.0 A per horn at 13.0 V. Nominal current draw shall be specified on the drawing. For three-terminal horn, the control (trigger) circuit shall not require greater than 100 mA per horn. Instantaneous starting current can reach 30 A for a dual-horn installation, see paragraph 4.10.3. This starting inrush lasts less than 3 ms, but is critical to proper operation.

4.10.6 Readiness. The horn shall be in a constant state of readiness. Response time shall meet the requirements of SAE J377 7.5 Readiness Response Time.

4.10.7 Parasitic Load. If designed to be supplied continuously with vehicle power and operated by a separate trigger, signal, or control connection, a single horn shall draw no more than 0.2 mA in its non-operating state throughout the temperature range of -25 °C to +75 °C. If supplied continuously with vehicle power, no sound shall be emitted upon application or disconnection of that power, unless a trigger or control is also present.

4.10.8 Connection Sequence. The horn shall not be damaged by the sequence of connections to any of its terminals.

4.10.9 Insulation Resistance.

4.10.9.1 Electrical-Mechanical Horn. The isolation between any terminal and case ground shall meet the requirements of SAE J377 7.3 Grounding, Insulation Resistance.

4.10.9.2. Electronic Horn. The isolation between any terminal and case ground shall be > 10 MΩ using test methods according to ISO 16750-2 Insulation Resistance. For situations where the standard test voltage of 500 V does not fit the part's rating voltage, a modified voltage will be necessary as noted below. All functions of the horn shall perform as designed, refer to Section 4.4 Test Sample Performance and Failure Determination, after the test. Additionally, there shall be no evidence of structural damage to the horn during the visual inspection and dissection per 3.1.5.1.2 Visual Inspection and Dissection.

Notes:

- Circuit boards with inductive loads: A test voltage < 100 V is suitable for electronic components to prevent damage to susceptible parts such as capacitors.
- Inductive components: A test voltage > 300 V is suitable for components such as motors.

4.10.10 Electromagnetic Compatibility. The horn shall meet the requirements for EMC as specified below. The supplier will evaluate the horn or horn assembly according to the general process described in GMW3103 General Specification for Electrical/Electronic Components and Subsystems; Electromagnetic Compatibility; Global EMC Component/Subsystem Validation Acceptance Process.

4.10.10.1 Electrical-Mechanical Horn. Where the method of producing sound uses a simple series circuit comprised of a coil and a set of contacts actuated directly by a diaphragm, the horn shall be tested per GMW3097 General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility, Requirement Part as a development test only.

4.10.10.2 Electronic Horn. No specific criteria have been developed at this time for this type of horn. All data are to be reported on the test to the GM Development/Validation Engineer. Where vehicle level testing shows interaction of the horn with other devices, GM may require the addition of a suppression device if that is shown to be the optimum method of eliminating the potential interaction. It is GM's intent that only one suppression device type and value be used for all similar horn from the same manufacturer requiring such suppression.

4.10.10.3 Both Electrical-Mechanical and Electronic Horns. Where the method of producing sound uses any means other than full current carrying contacts, the horn shall meet the requirements of GMW3103, GMW3097, and GMW3091, General Specification for Vehicles, Electromagnetic Compatibility (EMC), Requirement Part. Any deviations from the specified criteria are to be reported to the GM Development/Validation Engineer for evaluation of the effect and determination of the need for any design changes.

4.10.11 Fundamental Frequency. The fundamental frequency of the horn and its tolerance range shall be as specified on the drawing. If a tolerance range is not specified on the drawing it shall be per the supplier's normal manufacturing tolerance.

4.10.12 Sound Pressure Level and Harmonic Frequency Content. The horn assembly, without the sound deadeners like splash shield, shall meet a sound pressure level of 107 dB(A) to 118 dB(A) at 2 m (6.6 ft) and SAE J377 5.0 On-Vehicle Performance Requirements. Final acceptability of the horn and its installation will be dependent on vehicle level witness testing in accordance with applicable governmental regulations, if required,

based on the potential destination country. The vehicle level sound pressure level testing must be done with the battery in circuit. The tone quality of the horn will be measured using SNR. The SNR shall be greater than 18 for the horn tone.

4.10.13 Variability. Variability of the horn tone will be in accordance with SAE J377 7.9 Variability. The On/Off time for 5 cycles shall be 10 s On, 50 s Off.

4.10.14 Adjustments. The horn shall not require adjustment at any time after shipment from the manufacturer's plant, throughout the full life expectancy. See also paragraph 4.17 Serviceability and Service Parts Requirements.

4.11 Mechanical Validation Test Requirements. Unless otherwise stated, failure or degradation of performance is defined in Section 4.4 Test Sample Performance and Failure Determination.

4.11.1 Noise and Rattles. The horn and its bracket, if applicable, shall not exhibit any rattles or noise under vibration or shock when tested according to Sections 4.11.2 Vibration and 4.11.3 Shock.

4.11.2 Vibration.

4.11.2.1 In all of the following vibration tests, horns shall be mechanically connected to the mounting surface of the test fixture to represent vehicle mounting orientation and attachment methods. The horn's actual integral mounting provisions, e.g., mounting tabs, snap fits, clips, etc., that interface to the vehicle structure, e.g., vehicle frame, bracket, etc., shall be utilized in the test mounting. The proper size, type of mounting devices, attachment interfaces, mounting torque, and associated tolerance of fixing bolts or other attachment devices shall be used.

Harness connection fixture points shall be representative of the production-intent vehicle harness routing from the horn connector up to the location of the first design-representative tie down point. As a default, the first tie down point on the harness shall be 100 mm away from the horn connector. After that point, the harnesses shall be tied down securely so that they do not influence the vibration input to the test samples.

The test fixture, when loaded with the test samples, shall be shown to provide a vibration level that is representative of the test input at **all** horn mounting locations as measured on the test fixture using the five criteria below. The integrity of the energy level shall be verified through a transmissibility demonstration to the GM Development/Validation Engineer and documented in the test report.

Cross-axis acceleration shall be measured for **all** horn samples, close to the fixing points, to ensure that the cross-axis acceleration does not contain high, narrow peaks that are beyond criteria four (4) and five (5) below. The cross-axis motion is the motion of the two axes that are orthogonal to the direction of the drive axis.

1. The natural resonant frequency of the loaded fixture shall be measured and shall not fall within the frequency range of the test profile.
2. The true value of the mechanical shock input, as measured at **all** horn samples, shall be within 10% of the intended values.
3. The true value of the random vibration input, as measured at **all** horn samples, shall be within 20% of the intended values.
4. For random vibration, the cross-axis acceleration for **all** horn samples in the two axes that are orthogonal to the direction of the drive axis shall be less than or equal to 0.45 times the acceleration G_{RMS} , i.e., 0.2 times the power spectral density, of the drive axis at any frequency.
5. For mechanical shock, the positive or negative peak acceleration for **all** horn samples, perpendicular to the intended shock direction, shall not exceed 30% of the value of the peak acceleration of the nominal pulse in the intended direction.

4.11.2.1.1 The horn assembly, with bracket or splash shield if applicable, shall meet the requirements of SAE J377 8.5 Vibration.

4.11.2.1.2 As a development test only, production intent units, with brackets, shall be evaluated for their resonant frequency. Units will be vibrated at their resonant frequency, in each plane, for a minimum of 60 minutes at 19.6 m/s^2_{RMS} (2 G_{RMS}). There is no known correlation between this test and actual usage. Its purpose is to expose potential weaknesses so they can be evaluated. Results must be reported to the GM Development/Validation Engineer.

4.11.2.2 Additional Tests for Electronic Horns.

4.11.2.2.1 Vibration with Thermal Cycling, Random Vibration, and Mounting Location Sprung Masses. The electronic horn without bracket shall be subjected to the vibration profile defined in Figure 1 Random