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U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE

FOR

FMVSS 141

Minimum Sound Requirements for Hybrid and Electric Vehicles

ENFORCEMENT
Office of Vehicle Safety Compliance
Mail Code: NEF-210
1200 New Jersey Avenue, SE
Washington, DC 20590

OVSC LABORATORY TEST PROCEDURE NO. 141

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PREFACE

NHTSA undertook rulemaking pursuant to the Pedestrian Safety Enhancement Act of 2010 (PSEA) to create a new Federal motor vehicle safety standard (FMVSS) setting minimum sound level requirements for low-speed operation of hybrid and electric vehicles. NHTSA established FMVSS No. 141, *Minimum Sound Requirements for Hybrid and Electric Vehicles* at 49 CFR 571.141. The standard is intended to reduce the risk of pedestrian crashes, especially for the blind and visually impaired, and to satisfy the mandate in the PSEA. FMVSS No. 141 requires certain vehicles to produce sounds meeting the requirements of this standard: hybrid and electric low speed vehicles (LSVs); hybrid and electric vehicles with gross vehicle weight ratings (GVWRs) of 4,536 kg or less that are passenger cars, multipurpose passenger vehicles, trucks, buses.

APPENDICES

Appendix A, Quiet Vehicle Compliance Tool User Guide
(PDF document)

Appendix B, Quiet Vehicle Compliance Tool source code
(PDF document portfolio)

Appendix C, Quiet Vehicle Compliance Tool installation package, Version 2.0.2.0
(zip file containing software tool)

REVISION CONTROL LOG
FOR OVSC LABORATORY
TEST PROCEDURES

TP-141
Minimum Sound Requirements for Hybrid and Electric Vehicles

TEST PROCEDURE		**FMVSS 141**		**DESCRIPTION**
REV. No.	**DATE**	**AMENDMENT**	**EFFECTIVE DATE**	
00	11/19/18	81FR90416 and 83FR8182	02/13/2017 and 04/27/2018	Final Rules. Draft test procedure released on NHTSA website.
N/A	N/A	85 FR 54273	08/28/2020	Interim final rule/request for comments. Phase-in period extended. No changes to performance requirements or test procedure.
01	10/16/2020	N/A	N/A	Technical revisions to laboratory test procedure. Added optical sensors as triggers detectable by the compliance tool software. For updates to compliance tool see software documentation in appendices. Clarifying edits based on internal feedback and indicant tests. Reformatted multiple areas.

1. PURPOSE AND APPLICATION

This document is provided by the National Highway Traffic Safety Administration (NHTSA), Office of Vehicle Safety Compliance (OVSC) for the purpose of presenting procedures for uniform testing and providing suggestions for the use of specific equipment for contracted testing laboratories. It contains requirements based on the test procedures specified in the Federal Motor Vehicle Safety Standard(s) (FMVSS) and any applicable safety Regulations. The OVSC test procedures include requirements that are general in scope to provide flexibility for contracted laboratories to perform compliance testing and are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment which will assist in procuring the required compliance test data. These test procedures do not constitute an endorsement or recommendation for use of any particular product or testing method.

Prior to conducting compliance testing, contracted laboratories are required to submit a detailed test procedure to the Contracting Officer's Representative (COR) to demonstrate concurrence with the OVSC laboratory test procedure and the applicable FMVSS. If any contractor views any part of an OVSC laboratory test procedure to be in conflict with a FMVSS or observes deficiencies in a laboratory test procedure, the contractor is required to advise the COR and resolve the discrepancy prior to the start of compliance testing or as soon as practicable. The contractor's test procedure must include a step-by-step description of the methodology and detailed check-off sheets. Detailed check-off sheets shall also be provided for the testing instrumentation including a complete listing of the test equipment with make and model numbers. The list of test equipment shall include instrument accuracy and calibration dates. All equipment shall be calibrated in accordance with the manufacturer's instructions. There shall be no contradictions between the laboratory test procedure and the contractor's in-house test procedure. Written approval of the in-house test procedures shall be obtained from the COR before initiating the compliance test program.

NOTE: The OVSC Laboratory Test Procedures, prepared for the limited purpose of use by independent laboratories under contract to conduct compliance tests for the OVSC, are not rules, regulations or NHTSA interpretations regarding the meaning of a FMVSS. **The OVSC Laboratory Test Procedures do not carry the force or effect of the law nor are they intended to bind the public in any way, except that they may be binding on a government contractor consistent with the terms of their contract.** The laboratory test procedures are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC laboratory test procedures do not include all of the various FMVSS minimum performance requirements. In addition, the laboratory test procedures may specify test conditions that are less severe than the minimum requirements of the standard. The laboratory test procedures

may be modified by the OVSC at any time without notice, and the COR may direct or authorize contractors to deviate from these procedures, as long as the tests are performed in a manner consistent with the standard itself and within the scope of the contract. Laboratory test procedures may not be relied upon to create any right or benefit in any person. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits its certification tests to those described in the OVSC laboratory test procedures.

2. GENERAL REQUIREMENTS

To reduce the risk of pedestrian crashes, especially for the blind and visually impaired, and to satisfy the mandate in the Pedestrian Safety Enhancement Act (PSEA) of 2010, FMVSS No. 141, *Minimum Sound Requirements for Hybrid and Electric Vehicles*, establishes minimum sound requirements for hybrid and electric vehicles. The standard requires certain hybrid and electric vehicles to produce sounds meeting the performance requirements of the standard: hybrid and electric low speed vehicles (LSVs); hybrid and electric vehicles with gross vehicle weight ratings (GVWRs) of 4,536 kg or less that are passenger cars, multipurpose passenger vehicles, trucks, buses. For the purposes of this standard, hybrid vehicles include only those hybrid vehicles that are capable of propulsion in any forward or reverse gear without the vehicle's internal combustion engine operating. Applicable vehicles must meet specified audible alert requirements for detection and directivity during critical operating scenarios including: stationary, reverse, and constant speeds up to 30 km/h. Applicable vehicles must also meet relative volume change requirements that signify vehicle acceleration and deceleration. Furthermore, any two vehicles of the same make, model, model year, body type, and trim level must use the same pedestrian alert system and sound under the same test conditions.

METRIC SYSTEM OF MEASUREMENT

Section 5164 of the Omnibus Trade and Competitiveness Act (Pub. L. 100-418) establishes that the metric system of measurement is the preferred system of weights and measures for trade and commerce in the United States. Executive order 12770 directs Federal agencies to comply with the Act by converting regulatory standards to the metric system after September 30, 1992. In a final rule published on March 15, 1990 (60 FR 13639), NHTSA completed the first phase of metrication, converting English measurements in several regulatory standards to the metric system. Since then, metrication has been applied to other regulatory standards (63 FR 28912).

Accordingly, the OVSC laboratory test procedures include revisions to comply with governmental directives in using the metric system. Regulatory standards converted to metric units are required to use metric measurements in the test procedures, whereas standards using English units are allowed to use English measurements or to use English measurements in combination with metric equivalents in parentheses.

All final compliance test reports are required to include metric measurements for standards using metrication.

NOTE: The methodology for rounding measurement in the test reports shall be made in accordance with ASTM E29-06b, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications."

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test vehicles and Government Furnished Property (GFP) from unauthorized personnel during the entire compliance testing program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test vehicles and GFP. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Acquisition Management, within two working days after the incident. A letter containing specific details of the security problem shall be sent to the IPM (with copy to the COR) within 48 hours.

The contractor shall protect and segregate the data that evolves from compliance testing before and after each vehicle test. No information concerning the vehicle safety compliance testing program shall be released to anyone except the COR, unless specifically authorized by the COR or the COR's Division Chief.

NOTE: No individuals, other than contractor personnel directly involved in the compliance testing program or OVSC personnel, shall be allowed to witness any vehicle or equipment item compliance test or test dummy calibration unless specifically authorized by the COR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire vehicle compliance testing area, test fixtures and instrumentation in a neat, clean and painted condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COR prior to conducting the first compliance test. Tests shall be completed at intervals as required in the contract. If not specified, the first test shall be conducted within 6 weeks after receiving the first delivered unit. Subsequent tests shall be completed in no longer that 1 week intervals unless otherwise specified by the COR.

Scheduling of tests shall be adjusted to permit vehicles (or equipment, whichever applies) to be tested to other FMVSSs as may be required by the OVSC. All compliance testing shall be coordinated with the COR in order to allow monitoring by the COR and/or other OVSC personnel if desired. The contractor shall submit a monthly test status report and a vehicle status report (if applicable) to the COR. The vehicle status report shall be submitted until all vehicles are disposed of. The status report forms are provided in the forms section.

6. TEST DATA DISPOSITION

The Contractor shall make all preliminary compliance test data available to the COR on location within 30 minutes after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be available to the COR in accordance with the contract schedule or if not specified within two working days. Additionally, the Contractor shall analyze the preliminary test results as directed by the COR.

All backup data sheets, strip charts, recordings, plots, technicians' notes, etc., shall be either sent to the COR or destroyed at the conclusion of each delivery order, purchase order, etc.

TEST DATA LOSS

A. INVALID TEST DESCRIPTION

An invalid compliance test is one, which does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedures and Statement of Work applicable to the test.

B. INVALID TEST NOTIFICATION

The Contractor shall notify NHTSA of any test not meeting all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test, by telephone, within 24 hours of the test and send written notice to the COR within 48 hours of the test completion.

C. RETEST NOTIFICATION

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the Contractor that a retest is required. The retest shall be completed within 2 weeks after receipt of notification by the Contracting Officer that a retest is required.

D. WAIVER OF RETEST

NHTSA, in its sole discretion, reserves the right to waive the retest requirement. This provision shall not constitute a basis for dispute over the NHTSA's waiving or not waiving any requirement.

E. TEST VEHICLE

NHTSA shall furnish only one vehicle for each test ordered. The Contractor shall furnish the test vehicle required for the retest. The retest vehicle shall be equipped as the original vehicle. The original vehicle used in the invalid test shall remain the property of NHTSA, and the retest vehicle shall remain the property of the Contractor. The Contractor shall retain the retest vehicle for a period not exceeding 180 days if it fails the test. If the retest

vehicle passes the test, the Contractor may dispose of it upon notification from the COR that the test report has been accepted.

F. TEST REPORT

No test report is required for any test that is determined to be invalid unless NHTSA specifically decides, in writing, to require the Contractor to submit such report. The test data from the invalid test must be safeguarded until the data from the retest has been accepted by the COR. The report and other required deliverables for the retest vehicle are required to be submitted to the COR within 3 weeks after completion of the retest.

G. DEFAULT

The Contractor is subject to the default and subsequent reprocurement costs for non-delivery of valid or conforming tests (pursuant to the Termination For Default clause in the contract).

H. NHTSA'S RIGHTS

None of the requirements herein stated shall diminish or modify the rights of NHTSA to determine that any test submitted by the Contractor does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test.

7. GOVERNMENT FURNISHED PROPERTY (GFP)

GFP consist of test vehicles and test equipment. The GFP is authorized by contractual agreement. The contractor is responsible for the following.

A. ACCEPTANCE OF TEST VEHICLES

The contractor has the responsibility of accepting each GFP test vehicle whether delivered by a new vehicle dealership or another vehicle transporter. In both instances, the Contractor acts on behalf of the OVSC when signing an acceptance of the GFP test vehicle delivery order. When a GFP vehicle is delivered, the contractor must verify:

1) All options listed on the "window sticker" are present on the test vehicle.
2) Tires and wheel rims are new and the same as listed.
3) There are no dents or other interior or exterior flaws in the vehicle body.
4) The vehicle has been properly prepared and is in running condition.
5) The glove box contains an owner's manual, warranty document, consumer information, and extra set of keys.
6) Proper fuel filler cap is supplied on the test vehicle (if equipped).
7) Spare tire, jack, lug wrench and tool kit (if applicable) is located in the vehicle cargo area.
8) The VIN (vehicle identification number) on the vehicle condition report matches the VIN on the vehicle.
9) The vehicle is equipped as specified by the COR.

A Vehicle Condition form will be supplied to the Contractor by the COR when the test vehicle is transferred from a new vehicle dealership or between test contracts. The upper half of the form is used to describe the vehicle as initially accepted. The lower half of the Vehicle Condition form provides space for detailed description of the post-test condition. The contractor must complete a Vehicle Condition form for each vehicle and deliver it to the COR with the Final Test Report or the report will NOT be accepted for payment.

If the test vehicle is delivered by a government contracted transporter, the contractor should check for damage which may have occurred during transit. GFP vehicle(s) shall not be driven by the contractor on public roadways unless authorized by the COR.

B. NOTIFICATION OF COR

The COR must be notified within 24 hours after a vehicle (and/or equipment item) has been delivered. In addition, if any discrepancy or damage is found at the time of delivery, a copy of the Vehicle Condition form shall be sent to the COR immediately.

8. CALIBRATION OF TEST INSTRUMENTS

Before the Contractor initiates the vehicle safety compliance test program, a test instrumentation calibration system must be implemented and maintained in accordance with established calibration practices. The calibration system shall include the following as a minimum:

A. Standards for calibrating the measuring and test equipment shall be stored and used under appropriate environmental conditions to assure their accuracy and stability.

B. All measuring instruments and standards shall be calibrated by the Contractor, or a commercial facility, against a higher order standard at periodic intervals not exceeding 12 months for instruments and 12 months for the calibration standards except for static types of measuring devices such as rulers, weights, etc., which shall be calibrated at periodic intervals not to exceed two years. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.

Accelerometers shall be calibrated every 12 months or after a test failure or after any indication from calibration checks that there may be a problem with the accelerometer whichever occurs sooner.

C. All measuring and test equipment and measuring standards shall be labeled with the following information:

1) Date of calibration

2) Date of next scheduled calibration

3) Name of the technician who calibrated the equipment

D. A written calibration procedure shall be provided by the Contractor, which includes as a minimum the following information for all measurement and test equipment:

1) Type of equipment, manufacturer, model number, etc.

2) Measurement range

3) Accuracy

4) Calibration interval

5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)

6) The actual procedures and the forms used to perform the calibrations

E. Records of calibration for all test instrumentation shall be kept by the Contractor in a manner that assures the maintenance of established calibration schedules.

F. All such records shall be readily available for inspection when requested by the COR. The calibration system shall need the acceptance of the COR before vehicle safety compliance testing commences.

G. Test equipment shall receive a system functional check out using a known test input immediately before and after the test. This check shall be recorded by the test technician(s) and submitted with the final report.

H. The Contractor may be directed by NHTSA to evaluate its data acquisition system.

Further guidance is provided in the International Standard ISO 10012-1, "Quality Assurance Requirements for Measuring Equipment" and American National Standard ANSI/NCSL Z540-1, "Calibration Laboratories and Measuring and Test Equipment General Requirements."

NOTE: In the event of a failure to meet the standard's minimum performance requirements additional calibration checks of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration will be at the COR's discretion and shall be performed without additional cost.

9. SUGGESTED TEST EQUIPMENT

A. Acoustic sound measurement system for measuring the sound pressure level must be a sound level meter or equivalent measurement system meeting the requirements of Class 1 instruments per IEC 61672-1 (Bruel & Kjaer North America "B&K" Pass-by System was used in the development of this procedure). Three microphones are required for this procedure.

B. Acoustic sound measurement system sound calibrator that fulfills the requirements of Class 1 sound calibrators per IEC 60942.

C. Quiet Vehicle Compliance Tool (see Appendices A-C) to conduct the analysis of the valid sound files, including ambient sound files, for compliance to FMVSS No. 141. The Quiet Vehicle Compliance Tool is a government supplied MATLAB based program with parameters set in accordance with the following table:

Parameter	**Settings**
General Settings:	
Re-Sampling Frequency*	44.1 kHz.
Processing Window	Test Scenario Dependent.
Acoustic Weighting	A.
Overall Sound Pressure Level Settings:	
Frequency span	24000 Hz.
Overall Averaging	None.
Averaging time	None.
One-Third Octave Band Analysis Settings:	
Bandwidth (Fractional Octave)	1/3—Base 10 Exact.
Upper Nominal Center Frequency	5000 Hz.
Lower Nominal Center Frequency	315 Hz.
Type of Octave Band Averaging	Exponential.
Type of Time Weighting	Fast.
Averaging Time	1/4 seconds.
Tau (Time Constant)	1/8 seconds (Fast).

*The compliance tool is designed to sample at a rate of 65,536 Hz, but re-samples signals at 44.1 kHz to allow for the use of lower sampling frequencies.

D. Speed measurement device to measure vehicle speed during the constant speed pass-by tests must be capable of continuous measurement of speed within ± 0.5 km/ h over the entire measurement zone (which is defined as the portion of the test track between lines AA' and BB').

E. Two optical sensors compatible with the sound measurement system to mark the region of interest in the recording during pass-by testing.

F. Meteorological instrumentation meeting the following specifications: ± 1 ºC or less for a temperature measuring device; ± 1.0 m/s for a wind speed-measuring device; ± 5 hPa for a barometric pressure measuring device; ± 5 % for a relative humidity measuring device.

G. Measurement devices for test site setup (e.g. tape measure).

H. Vehicle scale

10. PHOTOGRAPHIC DOCUMENTATION

DIGITAL PHOTOGRAPHS

The contractor shall take digital photographs of the test execution procedures. Photographs shall be taken in color and contain clear images. A tag, label or placard identifying the test item, NHTSA number (if applicable) and date shall appear in each photograph and must be legible. Each photograph shall be labeled as to the subject matter. The required resolution for digital photographs is a minimum of 1,600 x 1,200 pixels. Digital photographs are required to be created in color and in a JPG format. Glare or light from any illuminated or reflective surface should be minimized while taking photographs.

The test reports should include enough photographs to describe the testing in detail and should be organized in a logical succession of consecutive pictures. The digital photographs should be included in the test report as 203 mm x 254 mm or 215.9 mm x 279 mm (8 x 10 or 8 ½ x 11 inch) pictures. All photographs are required to be included in the test report in the event of a test failure. Any failure must be photographed at various angles to assure complete coverage. Upon request, the photographs should be sent to the COR on a CD or DVD and saved in a "read only" format to ensure that the digital photographs are the exact pictures taken during testing and have not been altered from the original condition.

PHOTOGRAPHIC VIEWS

As a minimum, the following test photographs shall be included in each vehicle final test report, submitted by the contractor:

A. ¾ Frontal – left side view of the test vehicle
B. ¾ Rear – right side view of the test vehicle
C. Vehicle certification label
D. Vehicle placard (titled, "Tire and Loading Information")
E. Tire inflation pressure label, if provided (optional label)
F. Close-up view(s) of test instrumentation mounted on the outside of the vehicle
G. Close-up view(s) of test instrumentation mounted on the inside of the vehicle
H. View(s) of microphone setup for stationary testing
I. View(s) of microphone and sensor setup for pass-by testing
J. Wide view of full test area set up for pass-by testing
K. Any damage or apparent test failure that cannot be seen in the above photographs

11. DEFINITIONS

BAND OR ONE-THIRD OCTAVE BAND
One of thirteen one-third octave bands having nominal center frequencies ranging from 315 to 5000 Hz. These are Bands 25 through 37 as defined in Table A1, Mid-Band Frequencies for One-Third-Octave-Band and Octave-Band Filters in the Audio Range, of ANSI S1.11-2004: "Specification for Octave-Band and Fractional-Octave Band Analog and Digital Filters".

BAND SUM
The combination of Sound Pressure Levels (SPLs) from selected bands that produce an SPL representing the sound in all of these bands. Band sum is calculated with the following equation (where SPL_i is the sound pressure level in each selected band):

$$Band\ Sum = 10 \log_{10} \sum_{i=1}^{n} 10^{(SPL_i/10)}$$

BODY TYPE
The general configuration or shape of a vehicle distinguished by such characteristics as the number of doors or windows, cargo-carrying features and the roofline (e.g., sedan, fastback, hatchback).

dBA
A-weighted sound pressure level in decibels. In this procedure dBA is used for overall, one-third octave, and band sum levels. dB is used only when no standard weighting affects the value (e.g. when differences between one-third octave band levels are reported).

ELECTRIC VEHICLE
A motor vehicle with an electric motor as its sole means of propulsion.

FRONT PLANE
A vertical plane tangent to the leading edge of the vehicle during forward operation.

HYBRID VEHICLE
A motor vehicle which has more than one means of propulsion for which the vehicle's propulsion system can propel the vehicle in the normal travel mode in at least one forward drive gear or reverse without the internal combustion engine operating.

REAR PLANE
A vertical plane tangent the leading edge of the rear of the vehicle during operation in reverse.

REFERENCE SOUND PRESSURE (P_o)
The reference sound pressure is 20 micro-Pascals for airborne sound.

SOUND PRESSURE LEVEL (SPL)
Logarithm of the ratio of a given sound pressure (P) to the reference sound pressure (P_o).

$$SPL = 20 \log_{10} \left(\frac{P}{P_o} \right) \text{, in dB}$$

TRIM LEVEL
A subset of vehicles within the same model designation with the same body type which are alike in their general level of standard equipment, such as a "base" trim level of a vehicle model. Vehicles with only minor trim differences that are unlikely to affect vehicle-emitted sound are not considered different for the purposes of this safety standard.

12. PRETEST REQUIREMENTS

12.1 GENERAL TEST PREPARATION

A. Verify COR approval of Contractor's in-house test procedure.

B. Verify the training of technicians for performance of this test.

C. Verify the calibration status of all test equipment.

D. Verify availability of document that indicates sound pad test surface meets the requirements of ISO 10844:1994, ISO 10844:2011, or ISO 10844:2014.

E. Review applicable revision of FMVSS 141.

F. Review vehicle Owner's Manual (or equipment mfg. instructions).

12.2 TEST FACILITY AND CONDITIONS

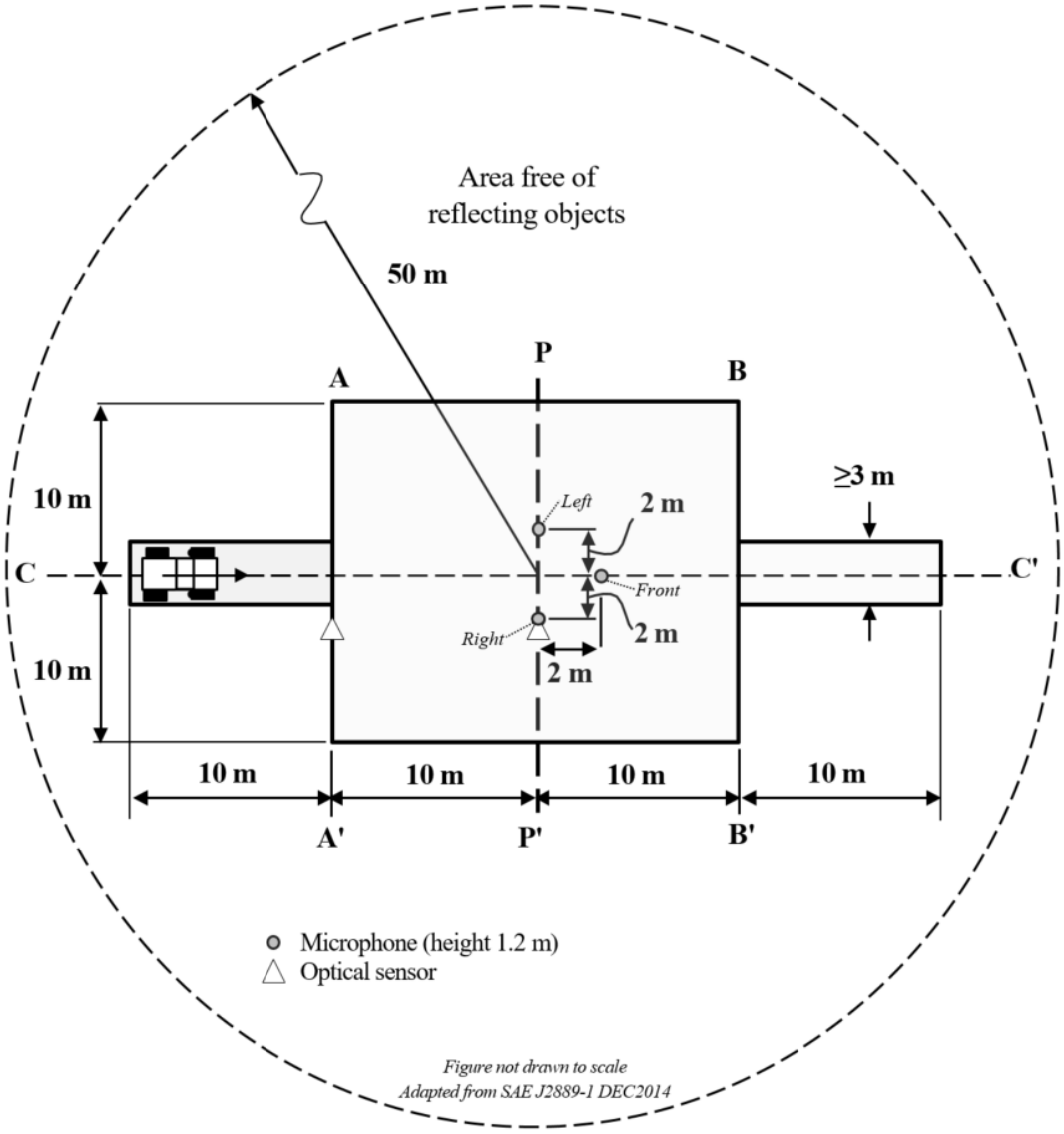


Figure 1: Test site dimensions. Adapted from SAE J2889-1. Modifications include addition of a front microphone used only during stationary/directivity measures and optical sensors to record trigger signals for pass-by tests.

A. Facility Layout

1) The test track and microphone positions must be configured as shown in Figure 1.

2) The distance from each microphone on the line PP' to the perpendicular reference line CC' on the test track shall be 2.0m ± 0.05m.

3) Each microphone shall be located at a height of 1.2m ± 0.02m above the ground level. For the left and right microphones, the reference direction for free field conditions as specified in IEC 61672-1 shall be horizontal and directed perpendicularly towards the path of the vehicle, i.e., line CC'.

4) Sensors shall be placed at A-A' and P-P' as shown in Figure 1 to detect when the vehicle crosses each of those positions during pass-by recordings. The sensors shall record trigger signals on a single channel available to the compliance tool software marking the beginning and end of the analyzed data interval. Note that these triggers are not intended to directly initiate/end recording because additional data should be collected before the vehicle passes A-A' and after the vehicle passes P-P' to enable appropriate processing of the data. At the option of the tester, the start and end of the recording may be triggered by additional sensors placed at appropriate distances from P-P', or the recording start/end may be managed by other means (e.g. manually starting and stopping the recordings).

5) Test set up for directivity measurement shall include an additional microphone placed on the line CC', 2m ± 0.05m forward of the line PP' at a height of 1.2m ± 0.02m above ground level. For this third microphone, the reference direction for free field conditions shall be horizontal and directed along the path of the vehicle line CC'.

6) The test surface shall meet the requirements of ISO 10844:1994, ISO 10844:2011, or ISO 10844:2014.

7) The area within a 50m radius around the sound pad should be free of large reflecting objects (e.g., trees or buildings).

B. Facility Conditions

1) The ambient temperature shall be between 5 °C (41 °F) and 40 °C (104 °F).

2) The maximum wind speed at the microphone height shall be no greater than 5 m/s (11mph), including gusts.

3) The test track surface shall be dry with no precipitation.

4) The test track shall be clean of rocks and other debris.

5) Testing should occur under conditions that minimize ambient sound at the facility[1]. Background noise will be measured and reported.

[1] In NHTSA's experience, this may involve taking measures such as testing at night.

12.3 TEST VEHICLE INSPECTION AND TEST PREPARATION (DATA SHEET 1)

A. Inspect test vehicle. Document all required test vehicle information.

B. Check vehicle fluids and adjust to the proper levels for operation.

C. Document vehicle installed tire size including make and model. All tires must be new. The vehicle must be tested with the tires installed on the vehicle at the time of initial vehicle sale. From the vehicle's Placard or optional Tire Inflation Pressure Label, identify the vehicle's designated tire size(s). Notify COR if any tire size installed on the vehicle is different from the manufacturers recommended tire size specified on the vehicle labels and request further guidance before proceeding.

D. Ensure the vehicle does not make any unintended sounds that are not characteristic of normal vehicle operation while stationary or in motion (e.g. squeaky brakes). Notify COR if anything out of the ordinary is identified.

E. Measure vehicle curb weight and vehicle test weight. Test weight, including the driver and instrumentation, shall be evenly distributed between the left and right side of the vehicle and will not exceed the vehicle's GVWR or GAWR: (1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the vehicle test weight is the unloaded vehicle weight plus 180 kg (396 pounds); (2) For LSVs, the test weight is the unloaded vehicle weight plus 78 kg (170 pounds).

F. During or prior to conditioning, inspect the owner's manual and vehicle controls for each of the gear and mode (e.g. eco mode, sport mode, automated parking/driving features, etc.) options available to provide forward/reverse propulsion. Qualitatively observe whether any of the gear selections or modes substantially alter the sound emitted from the vehicle to help inform selection of gears/modes for the test. Communicate with the COR for guidance if any gear/mode appears to substantially alter the sound emitted from the vehicle in a manner that might affect test results.

G. Tires are conditioned by driving the test vehicle around a circle 30 meters (100 feet) in diameter at a speed that produces a lateral acceleration of 0.5 to 0.6 g for three clockwise laps followed by three counterclockwise laps.

H. Vehicle's electric propulsion batteries, if any, shall have a state of charge sufficiently high to enable all key functionalities per the manufacturer's specifications. Propulsion batteries shall be within their component-temperature window to enable all key functionalities that could reduce vehicle noise emissions. Any other type of rechargeable energy storage system shall be ready to operate during the test. If propulsion batteries must be recharged during testing to ensure internal combustion engine does not activate, manufacturer instructions will be followed.

12.4 TEST INSTRUMENTATION SETUP AND CHECK

A. Instrument vehicle and configure test track equipment.

B. Ensure test equipment is secured so as not to shift position during tests, and any associated wires or cables must be secured inside of the test vehicle.

C. Check test track instrumentation functionality and positioning.

D. Check vehicle onboard instrumentation functionality and positioning.

E. Calibrate acoustical measurement equipment and document calibration.

12.5 PRE-TEST CHECKLIST (DATA SHEETS 2, 3, 4, 5 and 6)

Document each of the following items before each test series (i.e., stationary, reverse, 10, 20 and 30 km/h pass-by tests):

A. Document environmental conditions (i.e., ambient temperature, wind speed and track surface conditions).

B. Verify all vehicle's doors are shut and locked and windows and roof openings are shut.

C. Verify all accessory equipment (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.) that can be shut down, are shut off. Propulsion battery cooling fans and pumps and other components of the vehicle's propulsion battery thermal management system are not considered accessory equipment. During night time testing test vehicle headlights may be activated.

D. Verify all tires are free of all debris and each tire's cold tire inflation pressure set to: (1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the inflation pressure specified on the vehicle placard in FMVSS No. 110; (2) For LSVs, the inflation pressure recommended by the manufacturer for GVWR; if none is specified, the maximum inflation pressure listed on the sidewall of the tires.

E. Verify that the vehicle's propulsion system has sufficient fuel / battery levels as applicable.

13. COMPLIANCE TEST EXECUTION

Personnel supervising and/or performing the compliance test program shall be thoroughly familiar with the requirements, test conditions, and equipment for the test to be conducted. Testing will be accomplished as indicated below. Test personnel shall make note of all discrepancies and deviations from the applicable FMVSS and this Laboratory Test Procedure.

13.1 STATIONARY TEST (DATA SHEET 2)

A. Document ambient environment conditions (i.e., temperature, wind speed, dry track).

B. Verify all tires are inflated to the manufacturer recommended inflation pressure. Record tire pressure, fuel level, and battery levels as applicable.

C. Verify that there are no external environmental sounds that can interfere with collection of acoustic data. Ready driver, test personnel, vehicle onboard equipment, and test site instrumentation for the commencement of audio collection.

D. Immediately before beginning the first stationary test, use acoustic sound measurement system to measure the ambient sound for at least 30 seconds. Collect separate ambient sounds from the left, right, and front microphones.

E. Position test vehicle with the front plane at the line PP', the vehicle centerline on the line CC'. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake.

F. Place and secure wheel chocks in front of both front wheels to secure vehicle against forward movement.

G. Activate the test vehicle's propulsion system. Power-off all auxiliary electrical systems (e.g., air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.). These systems should remain off during compliance testing.

H. For vehicles equipped with a Park position for the gear selector, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake and then place the vehicle's gear selector in each gear that may provide forward propulsion, including neutral. Observe any changes in noise emission qualitatively in each of the gear positions and driving modes (e.g. eco or sport modes). If the vehicle seems, based on the judgement of the tester to emit less sound in a particular gear/mode, select that gear for testing. Otherwise, select a single gear/mode for testing at the discretion of the tester. For vehicles not equipped with a Park position for the gear selector, i.e., vehicles with a manual transmission, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake, disengage the manual clutch (fully depress and hold the clutch pedal), and place the vehicle's gear selector in any forward gear, following the same selection process described above. Record the gear selected for testing on the datasheet.

I. Using the acoustic sound measurement system, record sound levels for a duration of 10 seconds using all three microphones. During the test, the test technician should closely observe real-time the SPL values versus time plot of the acoustic sound file and make note of any extraneous unwanted noises (e.g. chirping birds, overhead planes, trains, car doors being closed, etc.) that were measured and recorded along with the vehicle's alert sound. If the test technician believes the sound file collected has been contaminated, that sound recording should be discarded and the test should be repeated. Each set of sound files measured and recorded that the test technician believes are not contaminated are considered valid and should be saved.

J. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake. Deactivate the vehicle's propulsion system.

K. Save the recorded sound data collected in step I (one channel corresponding to each of the three microphones used during the test). Valid data files should identify microphone position and chronological order as collected. For stationary files that combine data from each microphone into a single file (unless noted otherwise in the test report), the first channel shall be the left (driver side) microphone, the second channel shall be the right (passenger side) microphone, and the third channel shall be the front microphone.

L. Repeat steps "G" through "K" seven times, identifying each completed test sequentially (e.g. Test 1 – Test 8).

M. Verify that at least four valid test results within 2.0 dBA have been collected using acoustic sound measurement system. If at least four of the eight tests yield valid test results within 2.0 dB, proceed to step "N". If not, repeat steps "G" through "K" until a total of at least four valid test results have been acquired, continuing to number tests sequentially.

N. Remove the vehicle from the test area bounded by the lines AA' and BB'. Using the acoustic sound measurement system, measure the ambient sound for at least 30 seconds immediately following the completion of the last test of the stationary test series. Collect separate ambient measurements from the left, right, and front microphones.

O. Save the ambient sound recordings for the Test Series. Files that combine all microphones shall follow the structure specified above in step K.

P. Using the computer based "Quiet Vehicle Compliance Tool" (refer to section 13.7) verify if the stationary test condition alert sound meets either the 2-band or 4-band 1/3 octave band requirements of FMVSS No. 141.

13.2 REVERSE TEST (DATA SHEET 3)

A. Document ambient environment conditions (i.e., temperature, wind speed, dry track).

B. Verify all tires are inflated to the manufacturer recommended inflation pressure. Record tire pressure, fuel level, and propulsion battery levels as applicable.

C. Verify that there are no external environmental sounds that can interfere with collection of acoustic data. Ready driver, test personnel, vehicle onboard equipment, and test site instrumentation for the commencement of audio collection.

D. Immediately before beginning the first reverse test, use acoustic sound measurement system to measure the ambient sound for at least 30 seconds. Collect separate ambient sound measurements from the left and right microphones.

E. Position test vehicle with the rear plane at the line PP', the vehicle centerline on the line CC'. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake.

F. Place and secure wheel chocks behind both rear wheels to secure vehicle against rearward movement.

G. Activate the test vehicle's propulsion system. Power-off all auxiliary vehicle systems that can be turned off (e.g., air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.). These systems should remain off during compliance testing.

H. For vehicles equipped with a Park position for the gear selector, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake and then place the vehicle's gear selector in ''Reverse''. For vehicles not equipped with a Park position for the gear selector, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake, disengage the manual clutch (fully depress and hold the clutch pedal), and place the vehicle's gear selector in Reverse.

I. Using the acoustic sound measurement system, record sound levels for a duration of 10 seconds using both microphones. During the test, the test technician should closely observe in real-time the SPL-versus-time plot of the acoustic sound and make note of any extraneous, unwanted noises (e.g. chirping birds, planes, trains, car doors being closed, etc.) that were recorded. If the test technician believes a sound file is contaminated, that sound recording should be discarded and the test should be repeated. Each set of sound files recorded that the test technician believes are not contaminated are considered valid and should be saved for analysis.

J. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake. Deactivate the

vehicle's propulsion system.

K. Save the recorded sound data collected in step I. Valid sound files should be properly identified by microphone position and in chronological order as collected. For reverse files that combine data from each microphone into a single file (unless noted otherwise in the test report), the first channel shall be the left (driver side) microphone and the second channel shall be the right (passenger side) microphone.

L. Repeat steps "G" through "K" seven times, identifying each completed test sequentially (e.g. Test 1 – Test 8).

M. Verify that at least four valid test results within 2.0 dBA have been collected using acoustic sound measurement system. If at least four of the eight tests yield valid test results within 2.0 dB, proceed to step "N". If not, repeat steps "G" through "K" until a total of at least four valid test results have been acquired, continuing to number tests sequentially.

N. Remove vehicle from the test area bounded by the lines AA' and BB'. Using the acoustic sound measurement system measure the ambient sound for at least 30 seconds immediately following the completion of the last test of the reverse test series. Collect separate ambient sounds files from the left and right microphones.

O. Save the ambient sounds measurements for the Test Series. Files that combine all microphones shall follow the structure specified above in step K.

P. Using the computer based "Quiet Vehicle Compliance Tool" (refer to section 13.7) verify if the reverse test condition alert sound meets either the 2-band or 4-band 1/3 octave band requirements of FMVSS No. 141.

13.3 CONSTANT SPEED PASS-BY TEST- GREATER THAN 0 km/h BUT LESS THAN 20 km/h (DATA SHEET 4)

A. Position test vehicle with the front plane at least 10m in front of the line AA', the vehicle centerline on the line CC'. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake.

B. Power-off all auxiliary vehicle electrical systems (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.) and deactivate vehicle propulsion system.

C. Document ambient environment conditions (i.e., temperature, wind speed, dry track).

D. Verify all tires are free of all debris and inflated to the manufacturer recommended inflation pressure. Record tire pressure, fuel level, and propulsion battery levels as applicable.

E. Verify that there are no external environmental sounds that can interfere with collection of acoustic data. Ready driver, test personnel, vehicle onboard equipment, and test site

instrumentation for the commencement of audio collection. The left and right microphones and two optical sensors are required for this test, as depicted in Figure 1. The front microphone should not be used.

F. Immediately before beginning the first constant-speed pass-by test, use acoustic sound measurement system to measure the ambient sound for at least 30 seconds. Collect separate ambient sound measurements from the left and right microphones.

G. Activate the test vehicle's propulsion system. Electrical systems (e.g., air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.) not being utilized for compliance test are to remain powered off.

H. For vehicles equipped with a Park position for the gear selector, while the starting system is active, apply and maintain a full application of the service brake, disengage the vehicle parking brake and then place the vehicle's gear selector in ''Drive". For vehicles not equipped with a Park position for the gear selector, while the starting system is active, apply and maintain a full application of the service brake, disengage the vehicle parking brake, disengage the manual clutch (fully depress and hold the clutch pedal), and place the vehicle's gear selector in any forward gear. Record the gear position and driving mode selected.

I. *Execute pass-by tests at a target speed of 11km/h (± 1 km/h) and collect acoustic sound files*. Drive the vehicle forward, accelerating to the target speed and crossing line AA' at the target speed while maintaining the vehicle centerline along the line CC'. Using acoustic sound measurement system and data acquisition system, measure and record the optical sensor data, the sound collected through the microphones, and the vehicle's speed throughout the measurement zone between lines AA' and PP' (sound collected between AA' and PP' will be evaluated for compliance based on trigger signals from the optical sensors). Bring the vehicle to a complete stop after the rear plane of the vehicle has crossed the line BB'. End sound collection.

J. Review whether target speed was maintained within the ± 1 km/h tolerance from the line AA' to the line PP'. If the target speed was not maintained within tolerance, the data shall be considered invalid.

K. Return vehicle to starting position as designated in "A" above. For vehicles equipped with a Park position, place the vehicle's gear selector in ''Park'' and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in ''Neutral'' and engage the parking brake.

L. Save the recorded sound data collected in step "I". Valid sound files should be properly identified by microphone position and in chronological order as collected. For pass-by files that combine data from each microphone and optical sensor into a single file (unless noted otherwise in the test report), the first channel shall be the left (driver side) microphone, the second channel shall be the right (passenger side) microphone, and the third channel shall be the data from both trigger sensors – each channel shall be

temporally synchronized and sampled at the same frequency.

M. Repeat steps “H” through “L” until eight valid test runs have been recorded, identifying each completed test sequentially (e.g. Test 1 – Test 8).

N. Verify that at least four valid test results within 2.0 dBA have been collected using acoustic sound measurement system. If at least four of the eight tests yield valid test results within 2.0 dB, proceed to step “O”. If not, repeat steps “H” through “L” until a total of at least four valid test results have been acquired, continuing to number tests sequentially.

O. Using the acoustic sound measurement system measure the ambient sound for at least 30 seconds immediately following the completion of the constant speed pass-by test series. Collect separate ambient sound data from the left and right microphones.

P. Save the ambient sound data to appropriate computer based data file for the Test Series.

Q. Using the computer based *Quiet Vehicle Compliance Tool* (refer to section 13.7) verify if the pass-by test condition alert sound meets either the 2-band or 4-band 1/3 octave band requirements of FMVSS No. 141.

R. Repeat steps A – Q for other constant test speeds between 0 km/h and 20 km/h (±1 km/h), as directed by COR.

13.4 CONSTANT SPEED PASS-BY TEST- EQUAL TO OR GREATER THAN 20 km/h BUT LESS THAN 30 km/h (DATA SHEET 5)

A. Repeat steps A-Q in 13.3, while instead operating the vehicle at 21km/h ± 1km/h during audio capture. Additional pass-by test speeds may be tested in this range, as directed by the COR. Record the test setup and data processing with the Quiet Vehicle Compliance Tool (refer to section 13.7) on Data Sheet 5.

13.5 CONSTANT SPEED PASS-BY TEST- AT 30 km/h (DATA SHEET 6)

A. Repeat steps A-Q in 13.3, while instead operating the vehicle at 31km/h ± 1km/h during audio capture. Record the test setup and data processing with the Quiet Vehicle Compliance Tool (refer to section 13.7) on Data Sheet 6.

13.6 RELATIVE VOLUME CHANGE (DATA SHEET 7)

A. Using the computer based “Quiet Vehicle Compliance Tool” (refer to section 13.7) verify if the test vehicle alert sound meets the relative volume change requirements of FMVSS No. 141. Record the results on Data Sheet 7.

13.7 ACOUSTIC SOUND FILE PROCESSING

Data collected in the sections above will be post-processed utilizing the NHTSA Quiet Vehicle Compliance Tool to determine compliance with the 2 and/or 4 band alert and relative volume change requirements. This tool was developed using MATLAB code and is made available to our contracted test laboratory, and the public, as an executable file. Refer to APPENDICES A-C for related documentation.

The tool was developed to be used by the test technician after execution of all test series (i.e., stationary, reverse, and pass-by tests) have been completed. Figure 2 is a flow diagram depicting the process used by the tool to determine if four valid test runs within 2.0 dB have been completed.

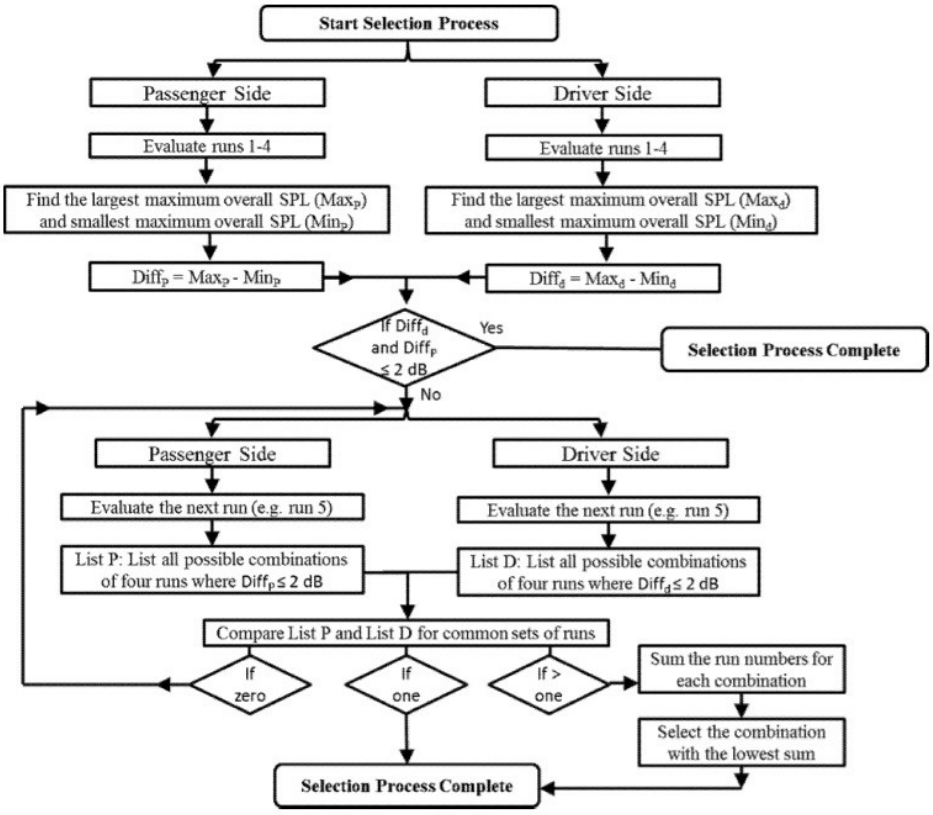


Figure 2: Selection process to determine "first four valid test runs within 2.0 dBA"

For each test run, a valid left (driver's side) and a valid right (passenger side) sound recording must exist. For each side, the maximum overall SPL must be determined. The four test runs to be used for the compliance evaluation are the first four valid test runs collected that have four left side signals within 2.0 dBA maximum overall SPL and four right side signals within 2.0 dBA maximum overall SPL. The left and right side must come from the same set of four test runs.

In order for the tool to process the files appropriately, the first step is completed by the technician:

Step 1: The technician numbers each valid sound measurement test run sequentially in the chronological order it was completed on the test track– e.g., Run 1, Run 2, Run 3, … Run N. Each test run must have a file or files corresponding to the left (driver's side) and right (passenger side) acoustic sound signals.

The test run selection process is depicted in Figure 2, and subsequent steps described in greater detail in Appendix A. Note that there are several key points of interest in the analysis of the data:

- The one-third octave band levels to be used for compliance are the levels corresponding to the point in time of the maximum overall sound pressure level of a vehicle measurement. To clarify, for NHTSA's compliance evaluations, the agency will not use the maximum sound pressure level in each one-third octave band if the maximum occurs at any other point over the measurement time interval.
- For ambient correction purposes, the ambient one-third octave band levels are the levels at the point in time of the minimum overall ambient sound pressure level.

When analysis is complete by the tool, the technician fills out the corresponding data sheets for each data collection section with results for inclusion in the final reports. See REPORTS and DATA SHEETS below for more information.

14. POST TEST REQUIREMENTS

After the required tests are completed, the contractor shall:

A. Restore vehicle to original condition

B. Verify all instrumentation, data sheets and photographs

C. Complete the Vehicle Condition report form including a word description of its post test condition

D. Copy applicable pages of the vehicle Owner's Manual for attachment to the final test report. Specifically, provide a copy of information related to:

a. Pedestrian alert/warning systems
b. Driving modes (e.g. sport, eco, automated parking features, etc.) and gear selection

E. Move the test vehicle to a secure area, and

F. Place all original records in a secure and organized file awaiting test data disposition.

15. REPORTS

15.1 MONTHLY STATUS REPORTS

The contractor shall submit a monthly Test Status Report and a Vehicle Status Report to the COR. The Vehicle Status Report shall be submitted until all vehicles are disposed of. Samples of the required Monthly Status Reports are contained in the report forms section.

15.2 APPARENT NONCOMPLIANCE

Any indication of a test failure shall be communicated by telephone to the COR within 24 hours with written notification mailed within 48 hours (Saturdays and Sundays excluded). A Notice of Test Failure (see report forms section) with a copy of the particular compliance test data sheet(s) and preliminary data plot(s) shall be included.

In the event of a test failure, a post test calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COR's discretion and shall be performed without additional costs to the OVSC.

15.3 FINAL TEST REPORTS

15.3.1 COPIES

In the case of an apparent test failure, electronic copies in both Word and PDF formats of the Final Test Report shall be submitted to the COR for acceptance within three weeks of test completion. The Final Test Report format to be used by all contractors can be found below.

Where there has been no indication of an apparent noncompliance, electronic copies in both Word and PDF formats of each Final Test Report shall be submitted to the COR for acceptance within three weeks of test completion. No payment of contractor's invoices for conducting compliance tests will be made prior to the Final Test Report acceptance by the COR. Contractors are requested to NOT submit invoices before the COR is provided with copies of the Final Test Report.

Contractors are required to submit the first Final Test Report in draft form within one week after the compliance test is conducted. The contractor and the COR will then be able to discuss the details of both test conduct and report content early in the compliance test program.

Contractors are required to PROOF READ all Final Test Reports before submittal to the COR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

15.3.2 REQUIREMENTS

The Final Test Report and associated documentation (including photographs) are relied upon as the chronicle of the compliance test. The Final Test Report will be released to the public domain after review and acceptance by the COR.

For these reasons, each final report must be a complete document capable of standing by itself. The contractor should use DETAILED descriptions of all compliance test events. Any events that are not directly associated with the standard but are of technical interest should also be included. The contractor should include as much DETAIL as possible in the report. Instructions for the preparation of the first three pages of the final test report are provided for standardization.

15.3.3 FIRST THREE PAGES

A. FRONT COVER
The information required on the cover is as follows:

(1) Final Report Number such as 141-ABC-XX-01 where

141 is the FMVSS tested
ABC are the initials for the laboratory
XX is the Fiscal Year of the test program
001 is the Group Number (001 for the 1st test, 002 for the 2nd test, etc.)

(2) Final Report Title and Subtitle such as

SAFETY COMPLIANCE TESTING FOR FMVSS 141
Minimum Sound Requirements for Hybrid and Electric Vehicles
* * * * * * * * * * * * * * * * * *
XYZ Car Manufacturer
Make and Model
NHTSA No. CX1401

(3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090

NOTE: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

(4) Date of Final Report completion

(5) The words “FINAL REPORT”

(6) The sponsoring agency’s name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NEF-210
1200 New Jersey Ave., SE
Washington, DC 20590

B. FIRST PAGE AFTER FRONT COVER

When a contract test laboratory is reporting, a disclaimer statement and an acceptance signature block for the COR shall be provided as follows:

> This publication is distributed by the National Highway Traffic Safety Administration in the interest of information exchange. Opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof.
>
> If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement.

Prepared By: _____

Approved By: _____*

Approval Date: _____*

FINAL REPORT ACCEPTANCE BY OVSC:*

Accepted By: _____

Acceptance Date: _____

* These lines not required when OVSC staff writes the Test Report

C. SECOND PAGE AFTER FRONT COVER

A completed Technical Report Documentation Page (Form DOT F1700.7) shall be completed for those items that are applicable with the other spaces left blank. Sample data for the applicable block numbers of the title page follows.

Block 1 – REPORT NUMBER

141-ABC-XX-001

Block 2 – GOVERNMENT ACCESSION NUMBER

Leave blank

Block 3 – RECIPIENT'S CATALOG NUMBER

Leave blank

Block 4 – TITLE AND SUBTITLE

Final Report of FMVSS 141 Compliance Testing of 20XX XYZ, NHTSA No. CX1401

Block 5 – REPORT DATE

March 1, 20XX

Block 6 – PERFORMING ORGANIZATION CODE

ABC

Block 7 – AUTHOR(S)

John Smith, Project Manager / Bill Doe, Project Engineer

Block 8 – PERFORMING ORGANIZATION REPORT NUMBER

ABC-DOT-XXX-001

Block 9 – PERFORMING ORGANIZATION NAME AND ADDRESS

ABC Laboratories
405 Main Street
Detroit, MI 48070

Block 10 – WORK UNIT NUMBER

Leave blank

Block 11 – CONTRACT GRANT NUMBER

DTNH22-XX-D-XXXXX

Block 12 – SPONSORING AGENCY NAME AND ADDRESS

U.S. Department of Transportation
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NEF-210
1200 New Jersey Ave., SE
Washington, DC 20590

Block 13 – TYPE OF REPORT AND PERIOD COVERED

Final Test Report
Month Day to Month Day, 20XX

Block 14 – SPONSORING AGENCY CODE

NEF-210

Block 15 – SUPPLEMENTARY NOTES

Leave blank

Block 16 – ABSTRACT

Compliance tests were conducted on the subject MY #### [VEHICLE MAKE AND MODEL] in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-141-## for the determination of FMVSS 141 compliance.

Test failures identified were as follows:

None

NOTE: Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COR.

Block 17 – KEY WORDS

Compliance Testing
Safety Engineering
FMVSS 141

Block 18 – DISTRIBUTION STATEMENT

Copies of this report are available from the following:

National Highway Traffic Safety Administration
Technical Information Services Division, NPO-411
1200 New Jersey Avenue SE (Room E12-100)
Washington DC 20590

e-mail: tis@nhtsa.dot.gov
FAX: 202-493-2833

Block 19 – SECURITY CLASSIFICATION OF REPORT

Unclassified

Block 20 – SECURITY CLASSIFICATION OF PAGE

Unclassified

Block 21 – NUMBER OF PAGES

Add appropriate number

Block 22 – PRICE

Leave blank

15.3.4 TABLE OF CONTENTS

The final test report Table of Contents shall include the following as a minimum:

Section 1 – Purpose of Compliance Test

Section 2 – Test Procedure and Discussion of Results

Section 3 – Compliance Test Data

Section 4 – Test Equipment List and Calibration Information

Section 5 – Photographs

Section 6 – Vehicle Owner's Manual (applicable pages) and other documentation

Section 7 – Notice of Test Failure (if applicable)

16. DATA SHEETS

The data sheets begin on the following page. Results are recorded on data sheets 1-7 for individual requirements. The outcome of the test is summarized on the DATA SUMMARY SHEET.

DATA SHEET 1 (Sheet 1 of 2)
TEST VEHICLE INSPECTION AND TEST PREPARATION

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____

VIN:_____ MANUFACTURE DATE:_____

GVWR:_____KG FRONT GAWR:_____ KG REAR GAWR_____KG

SEATING POSITIONS: FRONT_____ MID _____ REAR _____

ODOMETER READING AT START OF TEST: _____ Miles (Kilometers)

PROPULSION SYSTEM(S) & ENERGY:

☐ Electric
☐ Hybrid Electric
☐ Plug-in Hybrid Electric
☐ Other (describe): _____

Fluids checked and at proper levels?
☐ Yes ☐ No

ENGINE/MOTOR LOCATION:

☐ Front ☐ Rear ☐ Mid ☐ Other (describe): _____

TRANSMISSION TYPE:

☐ Automatic ☐ Manual ☐Other (describe): _____

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:

Front Axle_____ Rear Axle _____

Inflation Pressure (kPa) _____ Inflation Pressure (kPa) _____

INSTALLED TIRE SIZE(S) ON VEHICLE:

From Tire Sidewall	Front Axle	Rear Axle
Manufacturer & Tire Name	_____	_____
Tire Size Designation	_____	_____

Are installed tire sizes same as labeled tire sizes? ☐ Yes ☐ No
If no, contact COR for further guidance.

DATA SHEET 1 (Sheet 2 of 2)
TEST VEHICLE INSPECTION AND TEST PREPARATION

VEHICLE CURB WEIGHT (Kg):

Front axle _____ Rear Axle _____

Total Vehicle _____

VEHICLE TEST WEIGHT with Driver and Instrumentation (Kg):

Front axle _____ Rear Axle _____

Total Vehicle _____

Test Weight exceeds vehicle ratings (GAWRs and GVWR)?
☐ Yes ☐ No
If yes, contact COR for guidance.

TIRE CONDITIONING:
Tires are set to manufacturer recommended cold inflation pressure.

Front Axle (kPa)	Rear Axle (kPa)
Right Front _____	Right Rear_____
Left Front _____	Left Rear _____

Tires have been conditioned as required?
☐ Yes ☐ No

ASSESSMENT OF VEHICLE OPERATIONAL CONDITIONS
Do any of the gear/mode configurations substantially alter the sound emitted from the vehicle in a manner that might affect test results under a given critical operating condition? ☐ Yes ☐ No

REMARKS:

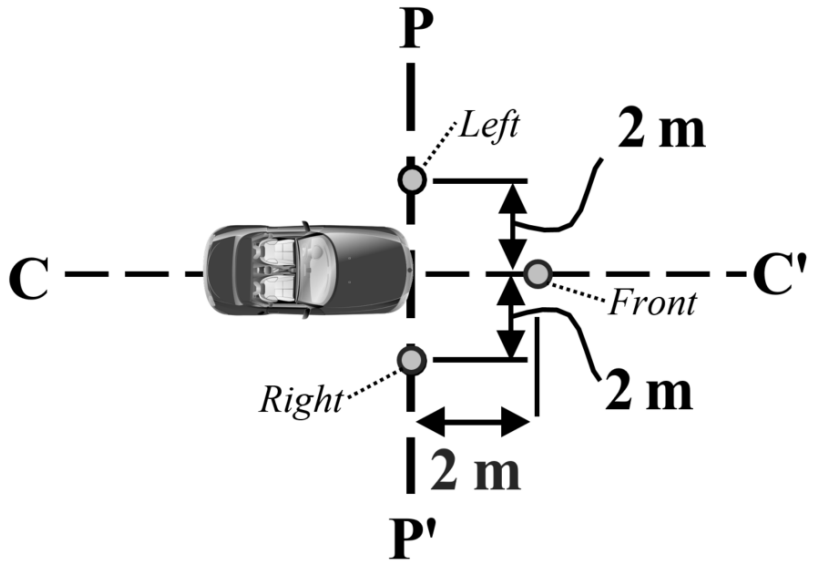
RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 2 (Sheet 1 of 6)
STATIONARY TEST

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____



TEST CONDITIONS:

Propulsion energy sources (as applicable)

Battery level (specify units): _____ Fuel level: _____%

Measured Tire Pressures (kPa): LF_____ LR_____

RF_____ RR_____

Tires treads are free and clear of rocks and debris? ☐Yes ☐No

Wind Speed _____m/sec < 5m/sec? ☐Yes ☐No

Ambient Temperature _____ C°, 5C° to 40C°? ☐Yes ☐No

Test Surface is dry and free of cracks and debris? ☐Yes ☐No

Test vehicle windows and doors are closed? ☐Yes ☐No

All electrical accessories are turned off? ☐Yes ☐No

Record gear position and driving mode (as applicable): _____

DATA SHEET 2 (Sheet 2 of 6)
STATIONARY TEST

FIRST FOUR VALID TESTS WITHIN 2.0 dBA OVERALL SPL

	Microphone Maximum SPL (dBA)			
	Sequence #	Left, Driver	Right, Passenger	Front, Center
Valid Test 1				
Valid Test 2				
Valid Test 3				
Valid Test 4				
Difference between max and min SPL for each microphone				

Is the difference between the maximum and minimum SPL values within each microphone's set of values less than or equal to 2.0 dBA? Must be "Yes" or discuss situation with the COR before proceeding.

☐Yes ☐No

IDENTIFICATION OF THE QUIETEST SIDE OF TEST VEHICLE

LEFT/DRIVER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Left side average overall ambient-corrected SPL = _____dBA

RIGHT/PASSENGER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Right side average overall ambient-corrected SPL = _____dBA

Quietest side of vehicle (if same select side used for analysis):

☐ Left (Driver) ☐Right (Passenger)

DATA SHEET 2 (Sheet 3 of 6)
STATIONARY TEST

QUIETEST SIDE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥ Min SPL?
315						**39.0**	☐Y ☐N
400						**39.0**	☐Y ☐N
500						**40.0**	☐Y ☐N
630						**40.0**	☐Y ☐N
800						**41.0**	☐Y ☐N
1000						**41.0**	☐Y ☐N
1250						**42.0**	☐Y ☐N
1600						**39.0**	☐Y ☐N
2000						**39.0**	☐Y ☐N
2500						**37.0**	☐Y ☐N
3150						**34.0**	☐Y ☐N
4000						**32.0**	☐Y ☐N
5000						**31.0**	☐Y ☐N

FOUR-BAND STATIONARY COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 2 (Sheet 4 of 6)
STATIONARY TEST

TWO-BAND STATIONARY COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meet the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**40.0**	☐Yes ☐No
1000-3150			**40.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 44 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 2 (Sheet 5 of 6)
DIRECTIVITY TEST

FRONT MICROPHONE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥Min SPL?
315						**39.0**	☐Y ☐N
400						**39.0**	☐Y ☐N
500						**40.0**	☐Y ☐N
630						**40.0**	☐Y ☐N
800						**41.0**	☐Y ☐N
1000						**41.0**	☐Y ☐N
1250						**42.0**	☐Y ☐N
1600						**39.0**	☐Y ☐N
2000						**39.0**	☐Y ☐N
2500						**37.0**	☐Y ☐N
3150						**34.0**	☐Y ☐N
4000						**32.0**	☐Y ☐N
5000						**31.0**	☐Y ☐N

FOUR-BAND DIRECTIVITY COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs for directivity? ☐Yes ☐No

DATA SHEET 2 (Sheet 6 of 6)
DIRECTIVITY TEST

TWO-BAND DIRECTIVITY COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meet the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**40.0**	☐Yes ☐No
1000-3150			**40.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 44 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements for directivity? ☐Yes ☐No

REMARKS:

Overall result for STATIONARY: PASS if 1) the quietest side met *either* the four-band or two-band requirements *AND* 2) the directivity results met *either* the four-band or two-band requirements.

☐ PASS ☐ FAIL

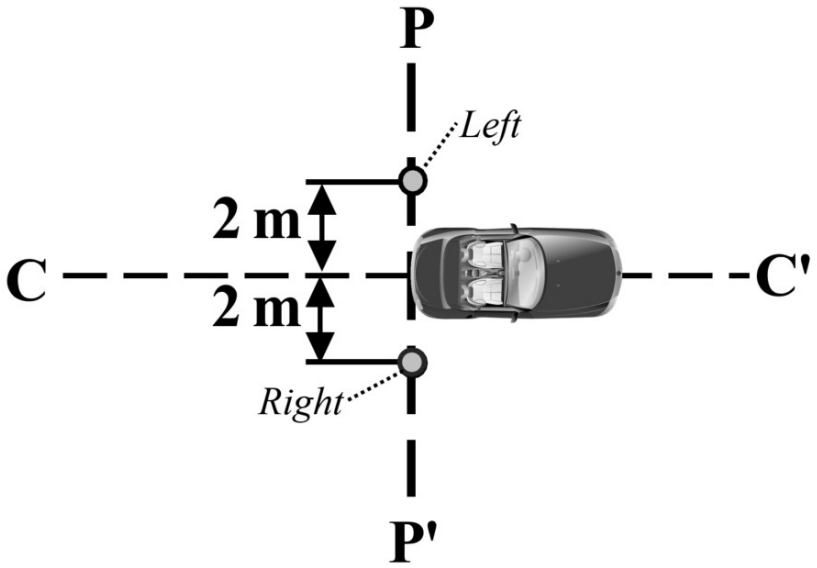
RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 3 (Sheet 1 of 4)
REVERSE TEST

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____



TEST CONDITIONS:

Propulsion energy sources (as applicable)

Battery level (specify units): _____ Fuel level: _____%

Measured Tire Pressures (kPa): LF_____ LR_____

RF_____ RR_____

Tires treads are free and clear of rocks and debris? ☐Yes ☐No

Wind Speed _____m/sec < 5m/sec? ☐Yes ☐No

Ambient Temperature _____ C°, 5C° to 40C°? ☐Yes ☐No

Test Surface is dry and free of cracks and debris? ☐Yes ☐No

Test vehicle windows and doors are closed? ☐Yes ☐No

All electrical accessories are turned off? ☐Yes ☐No

Record gear position and driving mode (as applicable): _____

DATA SHEET 3 (Sheet 2 of 4)
REVERSE TEST

FIRST FOUR VALID TESTS WITHIN 2.0 dBA OVERALL SPL

Microphone Maximum SPL dBA			
	Sequence #	Left, Driver	Right, Passenger
Valid Test 1			
Valid Test 2			
Valid Test 3			
Valid Test 4			
Difference between max and min SPL for each microphone			

Is the difference between the maximum and minimum SPL values on each the left side and right side of the vehicle less than or equal to 2.0 dBA? (Must be "Yes" or discuss situation with the COR before proceeding.)

☐Yes ☐No

IDENTIFICATION OF THE QUIETEST SIDE OF TEST VEHICLE

LEFT/DRIVER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Left side average overall ambient-corrected SPL = _____dBA

RIGHT/PASSENGER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Right side average overall ambient-corrected SPL = _____dBA

Quietest side of vehicle (if same, select side used for analysis):

☐ Left (Driver) ☐Right (Passenger)

DATA SHEET 3 (Sheet 3 of 4)
REVERSE TEST

QUIETEST SIDE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥ Min SPL?
315						**42.0**	☐Y ☐N
400						**41.0**	☐Y ☐N
500						**43.0**	☐Y ☐N
630						**43.0**	☐Y ☐N
800						**44.0**	☐Y ☐N
1000						**44.0**	☐Y ☐N
1250						**45.0**	☐Y ☐N
1600						**41.0**	☐Y ☐N
2000						**42.0**	☐Y ☐N
2500						**40.0**	☐Y ☐N
3150						**37.0**	☐Y ☐N
4000						**35.0**	☐Y ☐N
5000						**33.0**	☐Y ☐N

FOUR-BAND REVERSE COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 3 (Sheet 4 of 4)
REVERSE TEST

TWO-BAND REVERSE COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meets the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**40.0**	☐Yes ☐No
1000-3150			**40.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 48 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements on the quietest side of the vehicle? ☐Yes ☐No

REMARKS:

Overall result for REVERSE: PASS if the quietest side met *either* the four-band or two-band requirements.

☐ PASS ☐ FAIL

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 4 (Sheet 1 of 4)
CONSTANT SPEED PASS-BY TEST (11 ± 1 km/h)

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____

TEST CONDITIONS:

Propulsion energy sources (as applicable)

Battery level (specify units): _____ Fuel level: _____%

Measured Tire Pressures (kPa): LF_____ LR_____

RF_____ RR_____

Tires treads are free and clear of rocks and debris? ☐Yes ☐No

Wind Speed _____m/sec < 5m/sec? ☐Yes ☐No

Ambient Temperature _____ C°, 5C° to 40C°? ☐Yes ☐No

Test Surface is dry and free of cracks and debris? ☐Yes ☐No

Test vehicle windows and doors are closed? ☐Yes ☐No

All electrical accessories are turned off? ☐Yes ☐No

Record gear position and driving mode (as applicable)

Gear position: _____

Driving mode: _____

DATA SHEET 4 (Sheet 2 of 4)
CONSTANT SPEED PASS-BY TEST (11 ± 1 km/h)

FIRST FOUR VALID TESTS WITHIN 2.0 dBA OVERALL SPL

	Microphone Maximum SPL dBA			
	Sequence #	Test Speed	Left, Driver	Right, Passenger
Valid Test 1				
Valid Test 2				
Valid Test 3				
Valid Test 4				
Difference between max and min SPL for each microphone				

Is the difference between the maximum and minimum SPL values on each the left side and right side of the vehicle less than or equal to 2.0 dBA? Must be "Yes" or discuss situation with the COR before proceeding.

☐Yes ☐No

IDENTIFICATION OF THE QUIETEST SIDE OF TEST VEHICLE

LEFT/DRIVER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Left side average overall ambient-corrected SPL = _____dBA

RIGHT/PASSENGER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Right side average overall ambient-corrected SPL = _____dBA

Quietest side of vehicle (if same, select side used for analysis):

☐ Left (Driver) ☐Right (Passenger)

DATA SHEET 4 (Sheet 3 of 4)
CONSTANT SPEED PASS-BY TEST (11 ± 1 km/h)

QUIETEST SIDE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥ Min SPL?
315						**45.0**	☐Y ☐N
400						**44.0**	☐Y ☐N
500						**46.0**	☐Y ☐N
630						**46.0**	☐Y ☐N
800						**47.0**	☐Y ☐N
1000						**47.0**	☐Y ☐N
1250						**48.0**	☐Y ☐N
1600						**44.0**	☐Y ☐N
2000						**45.0**	☐Y ☐N
2500						**43.0**	☐Y ☐N
3150						**40.0**	☐Y ☐N
4000						**38.0**	☐Y ☐N
5000						**36.0**	☐Y ☐N

FOUR-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 4 (Sheet 4 of 4)
CONSTANT SPEED PASS-BY TEST (11 ± 1 km/h)

TWO-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meets the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dB	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**42.0**	☐Yes ☐No
1000-3150			**42.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 51 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements on the quietest side of the vehicle? ☐Yes ☐No

REMARKS:

Overall result for 11 ± 1 km/h PASS-BY: PASS if the quietest side met *either* the four-band or two-band requirements.

☐ PASS ☐ FAIL

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 5 (Sheet 1 of 4)
CONSTANT SPEED PASS-BY TEST (21 ± 1 km/h)

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____

TEST CONDITIONS:

Propulsion energy sources (as applicable)

Battery level (specify units): _____ Fuel level: _____%

Measured Tire Pressures (kPa): LF_____ LR_____

RF_____ RR_____

Tires treads are free and clear of rocks and debris? ☐Yes ☐No

Wind Speed _____m/sec < 5m/sec? ☐Yes ☐No

Ambient Temperature _____ C°, 5C° to 40C°? ☐Yes ☐No

Test Surface is dry and free of cracks and debris? ☐Yes ☐No

Test vehicle windows and doors are closed? ☐Yes ☐No
All electrical accessories are turned off? ☐Yes ☐No

Record gear position and driving mode (as applicable)

Gear position: _____

Driving mode: _____

DATA SHEET 5 (Sheet 2 of 4)
CONSTANT SPEED PASS-BY TEST (21 ± 1 km/h)

FIRST FOUR VALID TESTS WITHIN 2.0 dBA OVERALL SPL

	Microphone Maximum SPL dBA			
	Sequence #	Test Speed	Left, Driver	Right, Passenger
Valid Test 1				
Valid Test 2				
Valid Test 3				
Valid Test 4				
Difference between max and min SPL for each microphone				

Is the difference between the maximum and minimum SPL values on each the left side and right side of the vehicle less than or equal to 2.0 dBA? Must be "Yes" or discuss situation with the COR before proceeding.

☐Yes ☐No

IDENTIFICATION OF THE QUIETEST SIDE OF TEST VEHICLE

LEFT/DRIVER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Left side average overall ambient-corrected SPL = _____dBA

RIGHT/PASSENGER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Right side average overall ambient-corrected SPL = _____dBA

Quietest side of vehicle (if same, select side used for analysis):

☐ Left (Driver) ☐Right (Passenger)

DATA SHEET 5 (Sheet 3 of 4)
CONSTANT SPEED PASS-BY TEST (21 ± 1 km/h)

QUIETEST SIDE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥ Min SPL?
315						**52.0**	☐Y ☐N
400						**51.0**	☐Y ☐N
500						**52.0**	☐Y ☐N
630						**53.0**	☐Y ☐N
800						**53.0**	☐Y ☐N
1000						**54.0**	☐Y ☐N
1250						**54.0**	☐Y ☐N
1600						**51.0**	☐Y ☐N
2000						**51.0**	☐Y ☐N
2500						**50.0**	☐Y ☐N
3150						**47.0**	☐Y ☐N
4000						**45.0**	☐Y ☐N
5000						**43.0**	☐Y ☐N

FOUR-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 5 (Sheet 4 of 4)
CONSTANT SPEED PASS-BY TEST (21 ± 1 km/h)

TWO-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meet the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**47.0**	☐Yes ☐No
1000-3150			**47.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 57 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements for directivity? ☐Yes ☐No

REMARKS:

Overall result for 21 ± 1 km/h PASS-BY: PASS if the quietest side met *either* the four-band or two-band requirements.

☐ PASS ☐ FAIL

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 6 (Sheet 1 of 4)
CONSTANT SPEED PASS-BY TEST (31 ± 1 km/h)

VEHICLE MAKE/MODEL/BODY STYLE:_____

NHTSA No.:_____ TEST DATE:_____

TEST CONDITIONS:

Propulsion energy sources (as applicable)

Battery level (specify units): _____ Fuel level: _____%

Measured Tire Pressures (kPa): LF_____ LR_____

RF_____ RR_____

Tires treads are free and clear of rocks and debris? ☐Yes ☐No

Wind Speed _____m/sec < 5m/sec? ☐Yes ☐No

Ambient Temperature _____ C°, 5C° to 40C°? ☐Yes ☐No

Test Surface is dry and free of cracks and debris? ☐Yes ☐No

Test vehicle windows and doors are closed? ☐Yes ☐No

All electrical accessories are turned off? ☐Yes ☐No

Record gear position and driving mode (as applicable)

Gear position: _____

Driving mode: _____

DATA SHEET 6 (Sheet 2 of 4)
CONSTANT SPEED PASS-BY TEST (31 ± 1 km/h)

FIRST FOUR VALID TESTS WITHIN 2.0 dBA OVERALL SPL

	Microphone Maximum SPL dBA			
	Sequence #	Test Speed	Left, Driver	Right, Passenger
Valid Test 1				
Valid Test 2				
Valid Test 3				
Valid Test 4				
Difference between max and min SPL for each microphone				

Is the difference between the maximum and minimum SPL values on each the left side and right side of the vehicle less than or equal to 2.0 dBA? Must be "Yes" or discuss situation with the COR before proceeding.

☐Yes ☐No

IDENTIFICATION OF THE QUIETEST SIDE OF TEST VEHICLE

LEFT/DRIVER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Left side average overall ambient-corrected SPL = _____dBA

RIGHT/PASSENGER SIDE

Valid Test 1 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 2 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 3 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Valid Test 4 – MAX overall SPL _____dBA; Ambient corrected value: _____dBA

Right side average overall ambient-corrected SPL = _____dBA

Quietest side of vehicle (if same, select side used for analysis):

☐ Left (Driver) ☐Right (Passenger)

DATA SHEET 6 (Sheet 3 of 4)
CONSTANT SPEED PASS-BY TEST (31 ± 1 km/h)

QUIETEST SIDE 1/3 OCTAVE BAND SPLs (dBA) FOR FOUR VALID TEST RUNS (AMBIENT CORRECTED)

1/3 octave band center frequency, Hz	Valid Test 1 corrected SPL	Valid Test 2 corrected SPL	Valid Test 3 corrected SPL	Valid Test 4 corrected SPL	Average corrected SPL	Minimum Required SPL	Avg ≥ Min SPL?
315						**56.0**	☐Y ☐N
400						**55.0**	☐Y ☐N
500						**57.0**	☐Y ☐N
630						**57.0**	☐Y ☐N
800						**58.0**	☐Y ☐N
1000						**58.0**	☐Y ☐N
1250						**59.0**	☐Y ☐N
1600						**55.0**	☐Y ☐N
2000						**55.0**	☐Y ☐N
2500						**54.0**	☐Y ☐N
3150						**51.0**	☐Y ☐N
4000						**49.0**	☐Y ☐N
5000						**47.0**	☐Y ☐N

FOUR-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values against the minimum SPL requirement for each one-third octave band. Determine if any four one-third octave bands meeting the required standard are non-adjacent to each other AND that span a range of at least nine one-third octave bands in the range of 315 Hz to 5000 Hz. Complete following table with one set of four one-third octave bands that meet these requirements.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No
			☐Yes ☐No

Four-band compliance result: Four non-adjacent 1/3 octave bands spanning at least nine bands meet the minimum SPLs on the quietest side of the vehicle? ☐Yes ☐No

DATA SHEET 6 (Sheet 4 of 4)
CONSTANT SPEED PASS-BY TEST (31 ± 1 km/h)

TWO-BAND PASS-BY COMPLIANCE

Compare the average corrected SPL values and identify which one-third octave bands meet the minimum SPL requirement. Select the band with the highest SPL of the 315 to 800 Hz bands, and select the band with the highest SPL of the 1000 to 3150 Hz bands. The selected bands must be non-adjacent AND span no fewer than three one-third octave bands in the range of 315 Hz to 3150 Hz. If the highest bands are the 800Hz and 1000Hz bands, examine the second highest band in either range may be used if it meets all other requirements. Complete following table with one set of two one-third octave bands that meet these requirements and each meet the minimum requirements.

Frequency band range, Hz	1/3 octave band center frequency, Hz	Average corrected SPL, dBA	Minimum required SPL, dBA, for selected band	Meets or Exceeds Standard
315-800			**52.0**	☐Yes ☐No
1000-3150			**52.0**	☐Yes ☐No

Calculate the Band sum of the one-third octave bands selected.

$$Band\ Sum = 10\log_{10}\sum_{i=1}^{2} 10^{(SPL_i/10)}$$

BAND SUM = _____ (Must be at least 62 dBA)

Two-band compliance result: Two 1/3 octave bands spanning at least three bands meet the minimum SPLs and band sum requirements on the quietest side of the vehicle? ☐Yes ☐No

REMARKS:

Overall result for 31 ± 1 km/h PASS-BY: PASS if the quietest side met *either* the four-band or two-band requirements.

☐ PASS ☐ FAIL

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SHEET 7 (Sheet 1 of 5)
RELATIVE VOLUME CHANGE REQUIREMENT

Stationary Test Data

Normalize the levels of the 13 one-third octave bands, and use these values to calculate the normalized band sum.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA (Data Sheet 2)		SPLs from FMVSS 141 Table 1		Normalized Band Level, dB
315		-	**39.0**	=	
400		-	**39.0**	=	
500		-	**40.0**	=	
630		-	**40.0**	=	
800		-	**41.0**	=	
1000		-	**41.0**	=	
1250		-	**42.0**	=	
1600		-	**39.0**	=	
2000		-	**39.0**	=	
2500		-	**37.0**	=	
3150		-	**34.0**	=	
4000		-	**32.0**	=	
5000		-	**31.0**	=	

Use the following equation to calculate the Normalized Band Sum:

$$Normalized\ Band\ Sum = 10\log_{10}\left(\sum_{i=1}^{13} 10^{\frac{Normalized\ Band\ Level_i}{10}}\right)$$

Normalized Band Sum (Stationary Operating Scenario)**:** _____ **dB**

DATA SHEET 7 (Sheet 2 of 5)
RELATIVE VOLUME CHANGE REQUIREMENT

11 ± 1 km/h Test Data

Normalize the levels of the 13 one-third octave bands, and use these values to calculate the normalized band sum.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA (Data Sheet 4)		SPLs from FMVSS 141 Table 1		Normalized Band Level, dB
315		-	**39.0**	=	
400		-	**39.0**	=	
500		-	**40.0**	=	
630		-	**40.0**	=	
800		-	**41.0**	=	
1000		-	**41.0**	=	
1250		-	**42.0**	=	
1600		-	**39.0**	=	
2000		-	**39.0**	=	
2500		-	**37.0**	=	
3150		-	**34.0**	=	
4000		-	**32.0**	=	
5000		-	**31.0**	=	

Use the following equation to calculate the Normalized Band Sum:

$$Normalized\ Band\ Sum = 10 \log_{10} \left(\sum_{i=1}^{13} 10^{\frac{Normalized\ Band\ Level_i}{10}} \right)$$

Normalized Band Sum (11 ± 1 km/h Operating Scenario)**:** _____ **dB**

DATA SHEET 7 (Sheet 3 of 5)
RELATIVE VOLUME CHANGE REQUIREMENT

21 ± 1 km/h Test Data

Normalize the levels of the 13 one-third octave bands, and use these values to calculate the normalized band sum.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA (Data Sheet 5)		SPLs from FMVSS 141 Table 1		Normalized Band Level, dB
315		-	**39.0**	=	
400		-	**39.0**	=	
500		-	**40.0**	=	
630		-	**40.0**	=	
800		-	**41.0**	=	
1000		-	**41.0**	=	
1250		-	**42.0**	=	
1600		-	**39.0**	=	
2000		-	**39.0**	=	
2500		-	**37.0**	=	
3150		-	**34.0**	=	
4000		-	**32.0**	=	
5000		-	**31.0**	=	

Use the following equation to calculate the Normalized Band Sum:

$$Normalized\ Band\ Sum = 10\log_{10}\left(\sum_{i=1}^{13} 10^{\frac{Normalized\ Band\ Level_i}{10}}\right)$$

Normalized Band Sum (21 ± 1 km/h Operating Scenario)**:** _____ **dB**

DATA SHEET 7 (Sheet 4 of 5)
RELATIVE VOLUME CHANGE REQUIREMENT

31 ± 1 km/h Test Data

Normalize the levels of the 13 one-third octave bands, and use these values to calculate the normalized band sum.

1/3 octave band center frequency, Hz	Average corrected SPL, dBA (Data Sheet 6)		SPLs from FMVSS 141 Table 1		Normalized Band Level, dB
315		-	**39.0**	=	
400		-	**39.0**	=	
500		-	**40.0**	=	
630		-	**40.0**	=	
800		-	**41.0**	=	
1000		-	**41.0**	=	
1250		-	**42.0**	=	
1600		-	**39.0**	=	
2000		-	**39.0**	=	
2500		-	**37.0**	=	
3150		-	**34.0**	=	
4000		-	**32.0**	=	
5000		-	**31.0**	=	

Use the following equation to calculate the Normalized Band Sum:

$$Normalized\ Band\ Sum = 10\log_{10}\left(\sum_{i=1}^{13} 10^{\frac{Normalized\ Band\ Level_i}{10}}\right)$$

Normalized Band Sum (31 ± 1 km/h H Operating Scenario)**:** _____ **dB**

DATA SHEET 7 (Sheet 5 of 5)
RELATIVE VOLUME CHANGE REQUIREMENT

Critical Operating Speed Intervals
Between:

Stationary and 10 km/h

Normalized Band Sum 10 KM/H _____ dB – Normalized Band Sum Stationary _____ dB

= Relative Volume Change _____ dB

Relative Volume Change ≥ 3dB ? ☐Yes ☐No

10 km/h and 20 km/h

Normalized Band Sum 20 KM/H _____ dB – Normalized Band Sum 10 KM/H _____ dB

= Relative Volume Change _____ dB

Relative Volume Change ≥ 3dB ? ☐Yes ☐No

20 km/h and 30 km/h

Normalized Band Sum 30 KM/H _____ dB – Normalized Band Sum 20 KM/H _____ dB

= Relative Volume Change _____ dB

Relative Volume Change ≥ 3dB ? ☐Yes ☐No

REMARKS:

Overall result for relative volume change: PASS if the relative volume change is greater than or equal to 3dB in each of the three critical operating scenario comparisons above.

☐ PASS ☐ FAIL

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

DATA SUMMARY SHEET

VEHICLE MAKE/MODEL/BODY STYLE:_____

VEHICLE NHTSA NO.: _____ VIN: _____

VEHICLE TYPE: _____ DATE OF MANUFACTURE: _____

LABORATORY:_____

REQUIREMENTS	**PASS/FAIL**
Vehicle Stationary (Data Sheet 2) Requirement for stationary AND directivity conditions; four-band OR two-band alert sounds (S5.1.1, S5.1.1.2, S5.2)	☐ PASS ☐ FAIL
Reverse (Data Sheet 3) Requirement for reverse condition; four-band OR two-band alert sounds (S5.1.2, S5.2)	☐ PASS ☐ FAIL
Constant Pass-By Speeds Greater Than 0 km/h but Less Than 20 km/h (Data Sheet 4, 11 ± 1 km/h) Requirement for constant speed pass-by conditions; four-band OR two-band alert sounds. (S5.1.3, S5.2)	☐ PASS ☐ FAIL
Constant Pass-By Speeds Greater Than or Equal to 20 km/h but Less Than 30 km/h (Data Sheet 5, 21 ± 1 km/h) Requirement for constant speed pass-by conditions; four-band OR two-band alert sounds. (S5.1.4, S5.2)	☐ PASS ☐ FAIL
Constant Pass-By Speed at 30 km/h (Data Sheet 6, 31 ± 1 km/h) Requirement for constant speed pass-by conditions; four-band OR two-band alert sounds. (S5.1.5, S5.2)	☐ PASS ☐ FAIL
Relative Volume Change (Data Sheet 7) Requirement for minimum change in volume from one critical operating condition to the next; four-band OR two-band alert sounds (S5.4, Table 7)	☐ PASS ☐ FAIL
OVERALL RESULT (PASS only if all sections above PASS)	☐ **PASS** ☐ **FAIL**

RECORDED BY:_____ DATE: _____

APPROVED BY:_____ DATE: _____

17. FORMS

LABORATORY NOTICE OF TEST FAILURE TO OVSC

FMVSS NO.:141 TEST DATE:_____ LABORATORY:_____

CONTRACT NO.: _____ DELV. ORDER NO: _____

LAB. PROJECT ENGINEER'S NAME: _____

TEST SPECIMEN DESCRIPTION:

VEHICLE NHTSA NO.: _____ VIN: _____

PART NO.: _____ MFR: _____

TEST FAILURE DESCRIPTION:

FMVSS REQUIREMENT, PARAGRAPH §_____:

NOTIFICATION TO NHTSA (COR): _____

DATE: _____ BY: _____

REMARKS:

MONTHLY TEST STATUS REPORT
FMVSS 141

DATE OF REPORT: _____ Test Program:_____

Contract Number:_____ Fiscal Year:_____ Laboratory:_____

NHTSA No.	Date Of Delivery	Initial Odometer Reading	Test Date	Pass Or Fail	Date of Final Report	Vehicle Condition Report Date	Invoice No.	Invoice Date	Final Odometer Reading	Date Vehicle Is Disposed