



SURFACE VEHICLE RECOMMENDED PRACTICE

J2889™-1

NOV2015

Issued 2011-09
Revised 2015-11

Superseding J2889-1 DEC2014

Measurement of Minimum Noise Emitted by Road Vehicles

RATIONALE

Updated to correct equations in Table 2 as well as the correct modifier in Appendix A's Item #5.

FOREWORD

This SAE Standard is derived from SAE J2805 which itself is derived from ISO 362-1. This SAE Standard retains relevant descriptions and requirements for measurement facilities, equipment, ambient conditions and other factors from SAE J2805.

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Documents

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1. SCOPE

This SAE Standard is derived from SAE J2805 and specifies an engineering method for measuring the sound emitted by M and N category road vehicles at standstill and low speed operating conditions.. The specifications reproduce the level of sound which is generated by the principal vehicle sound sources consistent with stationary and low speed vehicle operating conditions relevant for pedestrian safety. The method is designed to meet the requirements of simplicity as far as they are consistent with reproducibility of results under the operating conditions of the vehicle.

The test method requires an acoustic environment which is only obtained in an extensive open space or in special designed indoor facilities replicating the conditions of an extensive open space. Such conditions usually exist during:

- Measurements of vehicles for regulatory certification.
- Measurements at the manufacturing stage.
- Measurements at official testing stations.

The results obtained by this method give an objective measure of the sound emitted under the specified conditions of test. It is necessary to consider the fact that the subjective appraisal of the annoyance, perceptibility, and/or detectability of different motor vehicles or classes of motor vehicles due to their sound emission are not simply related to the indications of a sound measurement system. As annoyance, perceptibility, and/or detectability are strongly related to personal human perception, physiological human condition, culture, and environmental conditions, there are large variations and therefore these terms are not useful as parameters to describe a specific vehicle condition.

Spot checks of vehicles chosen at random rarely occur in an ideal acoustic environment. If measurements are carried out on the road in an acoustic environment which does not fulfill the requirements stated in this SAE Standard, the results obtained may deviate appreciably from the results obtained using the specified conditions.

In addition, this standard provides an engineering method to assess the performance of external sound generation systems intended for the purpose of providing acoustic information to pedestrians on a vehicle's operating condition. This information is reported as objective criteria related to the external sound generation system's sound pressure level, frequency content, and changes in sound pressure level and frequency content as a function of vehicle speed. As such, these measures can provide pedestrians with information on the location, speed, direction of travel, acceleration, and deceleration behavior of a vehicle. Annex A contains background information relevant in the development of this SAE Standard.

2. REFERENCES

2.1 Applicable Documents

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1715 Hybrid Electric Vehicle (HEV) & Electric Vehicle (EV) Terminology

SAE J2805 Measurement of Noise Emitted by Accelerating Road Vehicles

2.1.2 ISO Publications

Available at <http://webstore.ansi.org/>

ISO 362-1:2007 Measurement of noise emitted by accelerating road vehicles - Engineering method - Part1: M and N Categories

ISO 10844:2014 Acoustics - Test surface for road vehicle noise measurements

ISO 26101:2012 Acoustics - Test methods for qualification of free-field environments

2.1.3 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 60942:2003 Electroacoustics - Sound calibrators

IEC 61672-1:2002 Electroacoustics - Sound level meters - Part 1: Specifications

2.1.4 ANSI/ASA Publications

Available at <http://webstore.ansi.org/>

ANSI/ASA S1.11-2014 /Part1 / IEC 61260-1:2014 AMERICAN NATIONAL STANDARD Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications

3. DEFINITIONS

For the purposes of this document, the following terms and definitions apply.

3.1 REFERENCE POINT

Point depending on the test purpose.

3.1.1 Reference point for gear selector indicating forward motion

The front end of the vehicle.

3.1.2 Reference point for gear selector indicating rearward motion

The rear end of the vehicle.

3.2 EXTERNAL SOUND GENERATION SYSTEM

System that provides an acoustic signal to the external environment of the vehicle for the purpose to provide information to pedestrians.

3.3 HIGHEST AUDIBLE FREQUENCY

Highest audible frequency of an external sound generation system as defined by the manufacturer.

3.4 COMPONENT

External sound generation system intended to emit sound information which can be tested separate from the vehicle.

3.5 CURB MASS

Complete shipping mass of a vehicle fitted with all equipment necessary for normal operation plus the mass of the following elements for M1, N1 and M2 having a maximum authorized mass not exceeding 3 500 kg:

- lubricants, coolant (if needed), washer fluid;
- fuel (tank filled to at least 90 % of the capacity specified by the manufacturer);
- other equipment if included as basic parts for the vehicle, such as spare wheel(s), wheel chocks, fire extinguisher(s), spare parts and tool kit

NOTE: The definition of curb (kerb) mass can vary from country to country, but in this SAE Standard, it refers to the definition contained in ISO 1176.

3.6 MASS IN RUNNING ORDER

Nominal mass of an N2, N3 or M2 vehicle having a maximum authorized mass greater than 3 500 kg, or an M3 vehicle as determined by the following conditions:

- a. the mass is taken as the sum of the unladen vehicle mass and the driver's mass;
- b. in the case of category M2 and M3 vehicles that include seating positions for additional crewmembers, their mass is incorporated in the same way and equal to that of the driver

NOTE 1 TO ENTRY: The driver's mass is calculated in accordance with ISO 2416.

3.7 FULL VEHICLE OPERATION

Operation of a vehicle with all systems and components operating as per the manufacturer's specification for normal road use.

3.8 SIMULATED VEHICLE OPERATION

Operation of a vehicle with some systems or components disabled to reduce noise interference during testing. Simulated vehicle operation may include external signals applied to the vehicle to simulate actual in-use signals.

3.9 LOWEST FREQUENCY OF INTEREST

Frequency below which there is no signal content relevant to the measurement of sound emission for the vehicle under test.

4. SYMBOLS AND ABBREVIATED TERMS

Table 1 - Lists symbols and the paragraph they are first used.

Symbol	Unit	Clause	Explanation
AA'	-	7.1.5.1	Line perpendicular to vehicle travel which indicates beginning of zone to record sound pressure level during test
BB'	-	7.1.5.1	Line perpendicular to vehicle travel which indicates end of zone to record sound pressure level during test
CC'	-	7.1.1	Centreline of vehicle travel
f_{audible}	Hz	7.1.6.4	Highest audible frequency of external sound generation system
$f_{i, \text{speed}}$	Hz	7.2.7.1	Single frequency component of external sound generation system at a given vehicle speed
$f_{i, \text{ref}}$	Hz	7.2.7.1	Single frequency component of external sound generation system at reference vehicle speed
del_f	%	7.2.4.3	Frequency shift expressed in percent of a reference frequency.
Δf	Hz	7.2.3	Frequency resolution of narrowband analysis used to measure frequency spectrums for the purpose of determining frequency shift information.
f_s	Hz	7.1.6.4	Sampling frequency used by digital signal processing system
j	-	6.3.2	Index for single test run within stopped or slow speed cruise test conditions
$L_{\text{st, fwd}}$	dB	7.1.8	Vehicle A-weighted sound pressure level in stationary forward condition.
$L_{\text{sta, rev}}$	dB	7.1.8	Vehicle A-weighted sound pressure level in stationary reverse condition.
L_{stop}	dB	7.1.8	Vehicle A-weighted sound pressure level
L_{crs}	dB	7.1.10	Cruise vehicle A-weighted sound pressure level
$L_{\text{crs, 10}}$	dB	7.1.10	Cruise vehicle A-weighted sound pressure level at a vehicle speed of 10 km/h.
$L_{\text{crs, 20}}$	dB	7.1.10	Cruise vehicle A-weighted sound pressure level at a vehicle speed of 20 km/h.
$L_{\text{crs, 30}}$	dB	7.1.10	Cruise vehicle A-weighted sound pressure level at a vehicle speed of 30 km/h.
L_{corr}	dB	6.3.2	Background noise correction
$L_{\text{test, } j}$	dB	6.3.2	A-weighted sound pressure level result of jth test run

Symbol	Unit	Clause	Explanation
$L_{\text{testcorr},j}$	dB	6.3.2	A-weighted sound pressure level result of j th test run corrected for background noise
L_{bgn}	dB	6.3.1	Background A-weighted sound pressure level.
$L_{\text{bgn,p-p}}$	dB	6.3.2	Range of maximum to minimum value of the representative background noise A-weighted sound pressure level over a defined time period.
L_x	dB		A-weighted sound pressure level for any stationary or cruise condition for use in assessment of measurement uncertainty.
ΔL	dB	6.3.2	A-weighted sound pressure level of j th test result minus the A-weighted background noise level ($\Delta L = L_{\text{test},j} - L_{\text{bgn}}$)
N	-	7.2.3	Block size of digital sample used for discrete Fourier transform or autopower spectrum analysis
PP'	-	7.1.5.2	Line perpendicular to vehicle travel which indicates location of microphones
$v_{AA'}$	km/h	5.2	Vehicle velocity when vehicle reference point in forward motion passes line AA'. See 3.1.1 for definition of reference point.
$v_{BB'}$	km/h	5.2	Vehicle velocity when vehicle reference point or rear of vehicle in forward motion passes line BB'. See 3.1.1 for definition of reference point.
$v_{PP'}$	km/h	5.2	Vehicle velocity when reference point in forward motion passes line PP'. See 3.1.1 for definition of reference point.
v_{ref}	km/h	7.2.4.4	Reference vehicle velocity used for calculating frequency shift percentage.
v_{test}	km/h	7.1.5.3	Target vehicle test velocity
AA'	-	7.1.5.1	Line perpendicular to vehicle travel which indicates beginning of zone to record sound pressure level during test

5. INSTRUMENTATION

5.1 Instruments for Acoustic Measurement

5.1.1 General

The apparatus used for measuring the sound pressure level shall be a sound level meter or equivalent measurement system meeting the requirements of Class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in IEC 61672-1.

The entire measurement system shall be checked by means of a sound calibrator that fulfills the requirements of Class 1 sound calibrators according to IEC 60942.

Measurements shall be carried out using the time weighting "F" of the acoustic measurement instrument and the "A" frequency weighting also described in IEC 61672-1. When using a system that includes a periodic monitoring of the A-weighted sound pressure level, a reading should be made at a time interval not greater than 30 ms.

The instruments shall be maintained and calibrated in accordance to the instructions of the instrument manufacturer.

5.1.2 Calibration

At the beginning and at the end of every measurement session, the entire acoustic measurement system shall be checked by means of a sound calibrator as described in 5.1.1. Without any further adjustment, the difference between the readings shall be less than or equal to 0.5 dB. If this value is exceeded, the results of the measurements obtained after the previous satisfactory check shall be discarded.

5.1.3 Compliance with requirements

Compliance of the sound calibrator with the requirements of IEC 60942 shall be verified once a year. Compliance of the instrumentation system with the requirements of IEC 61672-1 shall be verified at least every 2 years. All compliance testing shall be conducted by a laboratory which is authorized to perform calibrations traceable to the appropriate standards.

5.2 Instrumentation for Speed Measurements

The road speed of the vehicle shall be measured with instruments meeting specification limits of at least ± 0.5 km/h when using continuous measuring devices.

If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least ± 0.2 km/h.

These requirements are only valid for full vehicle testing.

NOTE: Independent measurements of speed are when two or more separate devices will determine the v_{AA} , v_{BB} and v_{PP} values. A continuous measuring device will determine all required speed information with one device

5.3 Meteorological Instrumentation

The meteorological instrumentation used to monitor the environmental conditions during the test shall meet the specifications of:

- ± 1 °C 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.

6. ACOUSTIC ENVIRONMENT, METEOROLOGICAL CONDITIONS, AND BACKGROUND NOISE

6.1 Test Site

6.1.1 General

The specifications for the test site provide the necessary acoustic environment to carry out the full vehicle or component level tests documented in this SAE standard. Outdoor and indoor test environments that meet the specifications of this SAE Standard provide equivalent acoustic environments and produce results that are equally valid.

6.1.2 Outdoor testing

The test site shall be substantially level. The test track construction and surface shall meet the requirements of ISO 10844:2011, ISO 10844:2014, or ISO 10844:1994.

Within a radius of 50 m around the center of the track, the space shall be free of large reflecting objects such as fences, rocks, bridges or buildings. The test track and the surface of the site shall be dry and free from absorbing materials such as powdery snow, or loose debris.

In the vicinity of the microphone, there shall be no obstacle that could influence the acoustic field and no person shall remain between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading.

6.1.3 This sub clause specifies conditions applicable when testing a full vehicle, either operating as it would on the road with all systems operational, or operating in a mode where only the external sound generation system is operational.

The test facility shall have a cutoff frequency, as defined in ISO 26101, lower than the lowest frequency of interest.

In the vicinity of the microphone, there shall be no obstacle that could influence the acoustic field and no person shall remain between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading. Microphones shall be located as specified in Figure 1.

NOTE: It is expected that users of this standard will understand that valid measurements can only be made when the cut-off frequency is lower than the lowest frequency of interest. A specific numerical requirement for cut-off frequency is not given due to the range of variation of appropriate cut-off frequencies depending upon the measured vehicle.

6.1.4 Indoor external sound generation system testing

This sub clause specifies conditions applicable when testing only the external sound generation system separate from the vehicle.

The test facility shall meet the requirements of ISO 26101.

The test facility shall have a cutoff frequency lower than the lowest frequency of interest.

In the vicinity of the microphone, there shall be no obstacle that could influence the acoustic field and no person shall remain between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading. Microphones shall be located as specified in 7.2.4.1.1

6.2 Meteorological Conditions

6.2.1 General

Metrological conditions are specified to provide a range of normal operating temperatures and to prevent abnormal readings due to extreme environmental conditions.

A value representative of temperature, relative humidity, and barometric pressure shall be recorded during the measurement interval.

6.2.2 Outdoor measurements

The meteorological instrumentation shall deliver data representative for the test site and shall be positioned adjacent to the test area at a height representative of the height of the measuring microphone.

The measurements shall be made when the ambient air temperature is within the range from 5 to 40 °C.

The ambient temperature may of necessity be restricted to a narrower temperature range such that all key vehicle functionalities that can reduce vehicle noise emissions (e.g., start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) are enabled per manufacturer's specifications.

The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.

6.2.3 Indoor measurements

The measurements shall be made when the ambient air temperature is within the range from 5 to 40 °C.

The ambient temperature may of necessity be restricted to a narrower temperature range such that all key vehicle functionalities that can reduce vehicle noise emissions (e.g., start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) are enabled per manufacturer's specifications.