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Acoustics — Measurement of minimum noise emitted by road vehicles

Acoustique — Mesurage du bruit minimal émis par les véhicules routiers

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16254 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

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Introduction

The advent of road transport vehicles that rely, in whole or in part, on alternative drive trains (e.g., electromotive propulsion) are serving to reduce both air and noise pollution and their adverse impacts on citizens throughout the world. However, the environmental benefits achieved to date by these “hybrid or pure electric” road vehicles have resulted in the unintended consequence of removing a source of audible signal that is used by various groups of pedestrians, (e.g., in particular blind and low vision persons), to detect the approach, presence and/or departure of road vehicles.

Therefore, this International Standard has been developed to provide a method to measure the minimum noise emission of road vehicles, as well as to quantify the characteristics of any external sound-generation system installed for the purpose of conveying acoustic information about the approach, presence and/or departure of the vehicle to nearby pedestrians.

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Acoustics — Measurement of minimum noise emitted by road vehicles

1 Scope

This International Standard is derived from ISO 362-1:2007 and specifies an engineering method for measuring the minimum noise emitted by road vehicles. The specifications reproduce the level of noise which is generated by the principal vehicle noise sources consistent with minimal noise emission in urban traffic. 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. 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 noise 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 noise emission are not simply related to the indications of a noise 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 International Standard, the results obtained may deviate appreciably from the results obtained using the specified conditions.

In addition, this International 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, acceleration, and deceleration behavior of a vehicle.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 362-1:2007, *Acoustics – Engineering method for the measurement of noise emitted by accelerating road vehicles – Part 1: Vehicles of categories M and N (Document presently under revision, expect document to be republished in 2013)*

ISO 10844, *Acoustics – Test surface for road vehicle noise measurements*

ISO 3745:2012, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Precision methods for anechoic and hemi-anechoic rooms*

ISO 26101, *Acoustics – Test methods for qualification of free-field environments*

IEC 60942, *Electroacoustics – Sound calibrators*

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

IEC 61260-1, *Electroacoustics – Octave band and fractional octave band filters – Part 1: Specifications*

3 Terms and 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 Engine

Internal combustion power source without detachable accessories

3.3 External sound generation system

Audio system which provides an additional audio signal to the external environment of the vehicle

3.4 Highest audible frequency

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

4 Symbols and abbreviated terms

Table 1 — Symbols and abbreviations 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	Centerline of vehicle travel
$f_{audible}$	Hz	7.1.6.4	Highest audible frequency of external sound generation system
$f_{i,speed}$	Hz	7.2.7.1	Index for single frequency component of external sound generation system at a given vehicle speed
$f_{i,ref}$	Hz	7.2.7.1	Index for 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_{stop}	dB	7.1.8	Stopped vehicle A-weighted sound pressure level
L_{crs}	dB	7.1.10	Cruise vehicle A-weighted sound pressure level
L_{cm}	dB	7.1.9	Commencing motion vehicle A-weighted sound pressure level
L_{corr}	dB	6.3.2	Background noise correction
$L_{test,j}$	dB	6.3.2	A-weighted sound pressure level result of j th test run

$L_{\text{testcorr},j}$	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.
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 reference point passes line AA'. See clause 3.2 for definition of reference point.
V_{BB}	km/h	5.2	Vehicle velocity when reference point or rear of vehicle passes line BB'. See clause 3.2 for definition of reference point.
V_{PP}	km/h	5.2	Vehicle velocity when reference point passes line PP'. See clause 3.2 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

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 fulfils 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 rotational speed of the engine shall be measured with an instrument meeting specification limits of at least $\pm 2\%$ or better at the engine speeds required for the measurements being performed.

The road speed of the vehicle shall be measured with instruments meeting specification limits of at least $\pm 0,5$ km/h when using continuous measuring devices.

If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least $\pm 0,2$ 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;
- $\pm 1,0$ 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 International Standard. Outdoor and indoor test environments that meet the specifications of this International 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 or ISO 10844:1994.