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Measurement of noise emitted by accelerating road vehicles — Engineering method —

Part 3:
Indoor testing M and N categories

Mesurage du bruit émis par les véhicules routiers en accélération — Méthode d'expertise —

Partie 3: Compatibilité entre les essais de véhicules routiers à l'intérieur et en plein air

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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 whom 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 Electro technical Commission (IEC) on all matters of electro technical 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 362-3 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 362 consists of the following parts, under the general title *Acoustics — Engineering method for the measurement of noise emitted by accelerating road vehicles*:

— *Part 1: M and N categories*

— *Part 2: L category*

— *Part 3: Indoor testing of M and N categories*

Introduction

The exterior sound emission of a vehicle is one of a lot of requirements which a manufacturer has to consider during design and development of new vehicles. The basic demands come from the environmental need to decrease the sound emission in all relevant driving conditions. However there is an upcoming pressure that vehicles shall not be too quiet to prevent that they become dangerous for pedestrians who may overhear them.

All these demands together require an efficient development of a test site which is independent of weather conditions or other influence factors throughout the whole year. In many countries the meteorological conditions are such adverse that outdoor testing on a classical proving ground is only possible in very limited periods of the year. While this was acceptable in the past, the increasing work load in the future will make it impossible to carry out the whole development of a vehicle on one test track at a very particular place. Performing sound emission tests on various test tracks increase highly the uncertainty and multiply the work of a manufacturer.

The target of this International Standard is to define specifications for an indoor noise test bench and a work procedure to achieve a precision and testing results for indoor testing comparable to a certified type approval test track that is within the run-to-run variation of the actual valid exterior noise test described in ISO 362-1, i.e. the test standard that is used as the type approval test for vehicles.

An indoor test bench requires tight specifications for the building as such, the acoustical treatment, the microphone arrays, the roller bench, the adjustment for the dynamic behavior of the vehicle on the roller bench, the preconditioning of the vehicle and the thermal conditions of testing. Special treatment is necessary to achieve all rolling sound components of the tyre that is comparable to the rolling sound on road surface as specified in ISO 10844 and used for type approval purposes.

It may be foreseen that in the future some sound emission of a vehicle, like for pedestrian safety, will be verified in an indoor test bench, because the typical natural background noise today prohibits such testing on classical test tracks (for example the sound emission of electric vehicles).The specification set in this International Standard can be transferred to a future minimum noise test procedure.

This International Standard provides all necessary specifications and procedures to achieve comparability between today classical testing on outdoor test tracks and future indoor facilities. The standard takes into account all relevant ISO standards for equipment, measurement uncertainty and test procedures.

Measurement of noise emitted by accelerating road vehicles — Engineering method — Part 3: Indoor testing M and N categories

1 Scope

This part of ISO 362 specifies an engineering method for measuring the noise emitted by road vehicles of categories M and N by using a semi anechoic chamber.

The specifications are intended to achieve an acoustical correlation between testing the exterior noise of road vehicles in a semi anechoic chamber and the outdoor testing as described in ISO 362-1.

This part of ISO 362 provides all necessary specifications and procedures of the indoor-testing to obtain results which are comparable to typical run-to-run variations of measurements on today's type approval test

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.

NOTE 1 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 noise annoyance of different classes of motor vehicles is not simply related to the indications of a sound measuring system. As annoyance is strongly related to personal human perception, physiological human conditions, culture and environmental conditions, there is a large variation and it is therefore not useful as a parameter to describe a specific vehicle condition.

NOTE 2 If measurements are carried out in rooms which do not fulfill the requirements stated in this International Standard, the results obtained can deviate from the results using the specified conditions.

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, *Measurement of noise emitted by accelerating road vehicles – Engineering method – Part 1: M and N categories*[1)]

ISO 1176, *Road vehicles – Masses – Vocabulary and codes*

ISO 2416, *Passenger cars – Mass distribution*

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

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

ISO 5725, (all parts), *Accuracy (trueness and precision) of measurement methods and results*

ISO 10844, *Specification of test tracks for the purpose of measuring noise emitted by road vehicles*

1) Under development

IEC 60942, *Electro acoustics – Sound calibrators*

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

ISO/IEC Guide 98-3: *Uncertainty in measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 362-1, ISO 1176, ISO 2416, and the following apply.

3.1
pre-acceleration
application of acceleration control device prior to the virtual position AA' for the purpose of achieving stable acceleration between AA' and BB'

Note 1 to entry: See Figure 1.

3.2
virtual test track length l_{PB}
virtual length of test track used in the calculation of acceleration from points PP' to BB'

Note 1 to entry: See Figure 1.

3.3
virtual test track length l_{AB}
virtual length of test track used in the calculation of acceleration from points AA' to BB'

Note 1 to entry: See Figure 1.

4 Symbols and abbreviated terms

Table 1 lists the symbols used in this document and the clause where they are used for the first time.

Table 1 — Symbols and abbreviated terms used, and corresponding clauses

Symbol	Unit	Clause	Explanation
AA'	—	3.1	line perpendicular to vehicle travel which indicates beginning of zone in which to record sound pressure level during test
a_{PTN}	m/s^2	B.4	vehicle acceleration at the power train noise measurement
α, β	—	B.3.2	coefficients of free rolling noise
BB'	—	3.1	line perpendicular to vehicle travel which indicates end of zone in which to record sound pressure level during test
C	dB/°C	B.2.4	temperature correction coefficient
Cor	dB	C.4	Correction for tyre road noise in variant B
d_{absorb}	M	7.2	thickness of absorbing elements
d_{roller}	M	5.1.1	diameter of dyno roller
h	%	C.2	air humidity
k_P	—	5.5	partial power factor
k_{wot}, k_{crs}			weighting factors
l_{veh}	M	7.2	length of vehicle
l_{PB}	M	3.2	virtual length of test section for calculation of acceleration from PP' to BB'
l_{AB}	M	3.3	virtual length of test section for calculation of acceleration from AA' to BB'
L_{wot}	dB	A.2.3.1	reported vehicle sound pressure level at wide-open-throttle
L_{crs}	dB	A.2.3.2	reported vehicle sound pressure level at constant speed
L_{TRN}	dB	10.2.4	tyre road noise sound pressure level (outdoor prognosis / indoor)
L_{TVN}	dB	10.2.4	total vehicle noise sound pressure level (outdoor prognosis / indoor)
L_{FRN}	dB	B.3.1	free rolling noise sound pressure level (outdoor prognosis / indoor)
ΔL_{TI}	dB	B.2.3	torque influence sound pressure level (outdoor prognosis / indoor)
L_{PTN}	dB	10.2.4	power train noise sound pressure level (outdoor prognosis / indoor)
M_{wheel}	N m	C.2	torque on the wheel
$m_{fa\ load\ unladen}$	kg	9.4.2.1	unloaden front axle load
$m_{ac\ ra\ max}$	kg	9.4.2.1	maximum rear axle capacity
$m_{ra\ load\ unladen}$	kg	9.4.2.1	unloaden rear axle load
m_d	kg	9.4.2.1	mass of driver
m_{kerb}	kg	9.4.2.1	kerb mass of the vehicle
$m_{fa\ load\ laden}$	kg	9.4.2.1	laden front axle load
$m_{ra\ load\ laden}$	kg	9.4.2.1	laden rear axle load
m_{ref}	kg	9.4.2.1	kerb mass + 75 kg for the driver
m_{ro}	kg	9.4.2.1	mass in running order
m_t	kg	9.4.2.1	virtual or actual physical test mass of the vehicle, that is used as an input for simulating the vehicle transient behaviour by the dynamometer control system
m_{target}	kg	9.4.2.1	target mass of the vehicle
$m_{unladen}$	kg	9.4.2.1	unloaden vehicle mass

m_{xload}	kg	9.4.2.1	extra loading
n_{dyn}	rpm	C.2	engine speed during wide-open-throttle (wot) tests
n_{stat}	rpm	C.2	engine speed during cruise tests and in the approach of wot tests
$n_{roller\ AA'\ test,\ i}$	rpm	5.1.1	Revolutions per minute of the dyno roller
p_{air}	hPa	C.2	barometric air pressure
PP'	—	3.2	line perpendicular to vehicle travel which indicates location of microphones
ϑ	°C	B.1.4	measured temperature of test track surface
r_0	m	7.3.2.3	reference path length of the center measurement position
r_x	m	7.3.2.3	path length to the microphone at distance x
s	m	C.2	x-position of vehicle when the gas pedal is pushed down
$T_{exhaust}$	°C	C.2	temperature of exhaust system
T_{intake}	°C	C.2	of intake air
T_{air}	°C	C.2	air temperature
T_{track}	°C	C.2	temperature of the test track surface
TEX_{track}		C.2	texture of the test track surface
$v_{AA'test\ i}$	km/h	5.1.1	vehicle speed when reference point passes line AA' (see 5.1 for definition of reference point)
$v_{BB'}$	km/h	10.3	vehicle speed when reference point or rear of vehicle passes line BB' (see 5.1 for definition of reference point)
$v_{PP'}$	km/h	10.3	vehicle speed when reference point passes line PP' (see 5.1 for definition of reference point)
v_{test}	km/h	9.5.1.2	target vehicle test speed
v_{PTN}	km/h	B.4	vehicle speed at the power train noise measurement indoor
v_{TRN}	km/h	B.3.3	vehicle speed at the tyre road noise measurement outdoor
v_{dyn}	km/h	C.2	vehicle speed during wide-open-throttle tests
v_{stat}	km/h	C.2	vehicle speed during cruise tests and in the approach of wot tests
w_{room}	m	7.2	width of the room
w_{veh}	m	7.2	width of the vehicle
x	m	10.2.4	vehicle position in the (virtual) test track
x_{micro}	m	7.3.2.3	position of the microphone in the arrays in driving direction
γ, δ, ε	—	B.3.3	coefficients of the exactly torque influence
$\lambda_{cut\ off}$	m	7.2	wavelength of cut-off frequency
ζ	—	B.3.2	coefficient of standard torque influence
$\Delta_{max}L$		C.2	maximum total deviation of sound pressure level
$\sigma_{L_{urban}}$		C.2	standard deviation of L_{urban}

5 Specification of the acceleration for vehicles of categories M1 and M2 having a maximum authorized mass not exceeding 3 500 kg, and of category N1

5.1 General

5.1.1 Applicability and conditions

All accelerations are calculated using different vehicle speeds of the vehicle during the test. All vehicle speeds are calculated from the number of revolutions of the roller, as follows (1, example for AA'):

$$v_{\mathrm{AA'\ test}\ i} = \frac{3{,}6}{60} \cdot \pi \cdot d_{\mathrm{roller}} \cdot n_{\mathrm{rollerAA'\ test}\ i} \quad (1)$$

where:

$v_{\mathrm{AA'\ test\ i}}$	is the vehicle speed when reference point passes line AA'
d_{roller}	is the diameter of the dyno roller
$n_{\mathrm{rollerAA'\ test}\ i}$	are the revolutions per minute of the dyno roller

The virtual line AA' indicates the beginning of the test track, PP' indicates the virtual position of the two pass-by-microphones and BB' indicates the end of the test track.

The simulated vehicle speed at AA' ($v_{AA'}$) or PP' ($v_{PP'}$) is defined by the roller speed, when the reference point of the vehicle passes the virtual line AA' or PP'. The simulated vehicle speed at BB'($v_{BB'}$) is defined when the rear of the vehicle passes the virtual line BB'. The method used for the determination of the acceleration shall be indicated in the test report.

Due to the large variety of technologies, it is necessary to consider different modes of calculation. New technologies (such as continuously variable transmission) and older technologies (such as automatic transmission) which have no electronic control require a more specific treatment for a proper determination of the acceleration. The given possibilities for calculation of the acceleration shall cover these needs.

5.1.2 Calculation of total engine power

As defined in 5.1.2 of ISO 362-1.

5.1.3 Battery state of charge

As defined in 5.1.3 of ISO 362-1.

5.2 Calculation of acceleration

5.2.1 Calculation procedure for vehicles with manual transmission, automatic transmission, adaptive transmission and continuously variable transmission (CVT) tested with locked gear ratios

As defined in 5.2.1 of ISO 362-1.

5.2.2 Calculation procedure for vehicles with automatic transmission, adaptive transmission and CVT tested with non-locked gear ratios

As defined in 5.2.2 of ISO 362-1.