INTERNATIONAL STANDARD

ISO 362-1

First edition
2007-07-01

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

Part 1: M and N categories

Mesurage du bruit émis par les véhicules routiers en accélération — Méthode d'expertise —
Partie 1: Catégories M et N

Reference number
ISO 362-1:2007(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 362-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This first edition of ISO 362-1, together with ISO 362-2, cancels and replaces ISO 362:1998 and ISO 7188:1994, which have been technically revised.

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

— *Part 1: M and N categories*

— *Part 2: L category*

Introduction

An extensive review was conducted of actual in-use vehicle operations, beginning with data from the TUV Automotive study in the early 1990s, and continuing with data developed through other committee members from 1996 through 2000. It includes nearly 100 vehicles operated on a variety of urban roads in Europe and Asia. The primary focus of the in-use measurements was to determine how vehicles are driven with a variety of vehicles, driving behaviours and traffic situations. The in-use behaviour determined from these studies was successfully correlated to urban traffic use in the United States by evaluation of the fuel economy test cycles used by the United States Environmental Protection Agency (USEPA). The resulting test specifications are therefore valid for all global urban use conditions.

The procedure defined here provides a measure of the sound pressure level from vehicles under controlled and repeatable conditions. The definitions have been made according to the needs of vehicle categories. In cases of vehicles other than very heavy trucks and buses, the working group found that attempts to conduct a partial load test as in actual use resulted in considerable run-to-run variability that significantly interfered with the repeatability and reproducibility of the test cycle. Therefore, two primary operating conditions (i.e. a wide-open-throttle acceleration phase, and a constant speed phase) were used to guarantee simplicity. The combination was found to be equivalent to the partial throttle and partial power (engine load) actually used.

As a further consequence of the investigation of the needs for an efficient test, it was decided to design a test which is independent of vehicle design and therefore safe and adaptable for future technologies, as well as for future traffic conditions. The test guarantees an excitation of all relevant noise sources, and the final test result will reflect a combination of these sources as a compromise between normal urban use and “worst case”.

In 2004, the given test for M and N category vehicles was evaluated for technical accuracy and practical considerations by test programmes carried out by the Japan Automobile Standards Internationalization Center (JASIC), the European Automotive Manufacturers Association (ACEA), and the Society of Automotive Engineers, Inc. (SAE) in the United States. Over 180 vehicles were included in these tests. The reports of these test programmes were considered prior to preparation of this part of ISO 362.

This part of ISO 362 was developed following demands for a new test procedure:

— “The test procedure (ISO 362) doesn't reflect realistic driving conditions” (1996 EU Green Paper).

— “In the case of motor vehicles, other factors are also important such as the dominance of tyre noise above quite low speeds (50 km/h)” (1996 EU Green Paper).

— “A new measurement procedure should require that the major noise sources of a vehicle be measured” (2001 Noise Emission of Road Vehicles – I-INCE).

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

Part 1: 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 under typical urban traffic conditions. It excludes vehicles of category L1 and L2, which are covered by ISO 9645, and vehicles of category L3, L4 and L5 covered by ISO 362-2.

The specifications are intended to reproduce the level of noise generated by the principal noise sources during normal driving in urban traffic (see Annex A).

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 acoustical environment that is only obtained in an extensive open space. Such conditions are usually provided for

— type approval measurements of a vehicle,

— measurements at the manufacturing stage, and

— measurements at official testing stations.

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 measurement 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 Spot checks of vehicles chosen at random are rarely made in an ideal acoustical environment. If measurements are carried out on the road in an acoustical environment which does not fulfil the requirements stated in this International Standard, the results obtained can deviate appreciably from the results obtained using the specified conditions.

2 Normative references

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

ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes*

ISO 2416:1992, *Passenger cars — Mass distribution*

ISO 5725:1994 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

ISO 10844:1994, *Acoustics — Specification of test tracks for the purpose of measuring noise emitted by road vehicles*

ISO Guide 98:1995, *Guide to the expression of uncertainty in measurement (GUM)*

IEC 60942:2003, *Electroacoustics — Sound calibrators*

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

3 Terms and definitions

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

3.1 Vehicle mass

3.1.1
kerb 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 kerb mass may vary from country to country, but in this part of ISO 362 it refers to the definition contained in ISO 1176.

3.1.2
maximum authorized mass
kerb mass plus the maximum allowable payload

3.1.3
target mass
actual vehicle mass used during test as determined by Table 3

NOTE Test mass for N2 and N3 vehicles can be lower than the target mass due to axle-loading limitations.

3.1.4
test mass
actual vehicle mass used during test as determined by Table 3

NOTE Test mass for N2 and N3 vehicles can be lower than the target mass due to axle-loading limitations.

3.1.5
unladen vehicle mass
nominal mass of a complete 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) mass of the vehicle includes the bodywork and all factory-fitted equipment, electrical and auxiliary equipment for normal operation of the vehicle, including liquids, tools, fire extinguisher, standard spare parts, chocks and spare wheel, if fitted;

b) the fuel tank is filled to at least 90 % of rated capacity and the other liquid-containing systems (except those for used water) are filled to 100 % of the capacity specified by the manufacturer

3.1.6
driver mass
nominal mass of a driver

3.1.7
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 The driver's mass is calculated in accordance with ISO 2416.

3.1.8
maximum axle (group of axles) capacity
permissible mass corresponding to the maximum mass to be carried by the axle (group of axles) as defined by the vehicle manufacturer, not exceeding the axle manufacturer's specifications

3.1.9
unladen axle (group of axles) load
actual mass carried by the axle (group of axles) in an unladen condition

NOTE The unladen vehicle mass is equal to the sum of the unladen axles (group of axles) load.

3.1.10
extra loading
mass which is to be added to the unladen vehicle mass

3.1.11
laden axle (group of axles) load
actual mass carried by the axle (group of axles) in a laden condition

3.2
power-to-mass ratio index
PMR
dimensionless quantity used for the calculation of acceleration according to the equation

$$\mathrm{PMR} = \frac{P_\mathrm{n}}{m_\mathrm{t}} \times 1\,000 \qquad (1)$$

where

P_n is the numerical value of engine power, expressed in kilowatts;

m_t is the numerical value of the test mass, expressed in kilograms

3.3
rated engine speed
S
engine speed at which the engine develops its rated maximum net power as stated by the manufacturer

NOTE 1 If the rated maximum net power is reached at several engine speeds, S used in this part of ISO 362 is the highest engine speed at which the rated maximum net power is reached.

NOTE 2 ISO 80000-3 defines this term as “rated engine rotational frequency”. The term “rated engine speed” was retained due to its common understanding by practitioners and its use in government regulations.

3.4 Vehicle categories

3.4.1
category L
motor vehicles with fewer than four wheels

NOTE United Nations Economic Commission for Europe (UNECE) document TRANS/WP.29/78/Rev.1/Amend.4 (26 April 2005) extended the L category to four-wheeled vehicles as defined by L6 and L7.

3.4.1.1
category L1 and L2
mopeds

NOTE See ISO 9645 for further details.

3.4.1.2
category L3
two-wheeled motor vehicles with an engine cylinder capacity greater than 50 cm^3 or maximum speed greater than 50 km/h

3.4.1.3
category L4
three-wheeled motor vehicles with an engine cylinder capacity greater than 50 cm^3 or maximum speed greater than 50 km/h, the wheels being attached asymmetrically along the longitudinal vehicle axis

3.4.1.4
category L5
three-wheeled motor vehicles with an engine cylinder capacity greater than 50 cm^3 or maximum speed greater than 50 km/h, having a gross vehicle mass rating not exceeding 1 000 kg and wheels attached symmetrically along the longitudinal vehicle axis

3.4.1.5
category L6
four-wheeled vehicles whose unladen mass is not more than 350 kg, not including the mass of the batteries in the case of electric vehicles, whose maximum design speed is not more than 45 km/h, and whose engine cylinder capacity does not exceed 50 cm^3 for spark (positive) ignition engines, or whose maximum net power output does not exceed 4 kW in the case of other internal combustion engines, or whose maximum continuous rated power does not exceed 4 kW in the case of electric engines

3.4.1.6
category L7
four-wheeled vehicles, other than those classified as category L6, whose unladen mass is not more than 400 kg (550 kg for vehicles intended for carrying goods), not including the mass of the batteries in the case of electric vehicles, and whose maximum continuous rated power does not exceed 15 kW

3.4.2
category M
power-driven vehicles having at least four wheels and used for the carriage of passengers

3.4.2.1
category M1
vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat

3.4.2.2
category M2
vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat and having a maximum mass not exceeding 5 000 kg

NOTE In this definition, “maximum mass” is equivalent to “maximum authorized mass” used elsewhere in this part of ISO 362.

3.4.2.3
category M3
vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat and having a maximum mass exceeding 5 000 kg

NOTE In this definition, “maximum mass” is equivalent to “maximum authorized mass” used elsewhere in this part of ISO 362.

3.4.3
category N
power-driven vehicles having at least four wheels and used for the carriage of goods

3.4.3.1
category N1
vehicles used for the carriage of goods and having a maximum authorized mass not exceeding 3 500 kg

3.4.3.2
category N2
vehicles used for the carriage of goods and having a maximum authorized mass exceeding 3 500 kg but not exceeding 12 000 kg

3.4.3.3
category N3
vehicles used for the carriage of goods and having a maximum authorized mass exceeding 12 000 kg

3.5
reference point
point depending on the design and category of the vehicle

3.5.1
reference point for category M1 and N1 vehicles
point on the vehicle as follows:

— for front engine vehicles, it is the front end of the vehicle;

— for mid-engine vehicles, it is the centre of the vehicle;

— for rear engine vehicles, it is the rear end of the vehicle

3.5.2
reference point for category M2, M3, N2, and N3 vehicles
point on the vehicle as follows:

— for front engine vehicles, it is the front end of the vehicle;

— for all other vehicles, it is the border of the engine closest to the front of the vehicle

3.6
target acceleration
acceleration at a partial throttle condition in urban traffic, derived from statistical investigations

NOTE Refer to Annex A for more detailed explanations.

3.7
reference acceleration
required acceleration during the acceleration test on the test track

NOTE Refer to Annex A for more detailed explanations.

3.8
gear ratio weighting factor
k
dimensionless quantity used to combine the test results of two gear ratios for the acceleration test and the constant-speed test

3.9
partial power factor
k_P
dimensionless quantity used for the weighted combination of the test results of the acceleration test and the constant-speed test for vehicles of categories M1, N1 and M2 having a maximum authorized mass not exceeding 3 500 kg

NOTE Refer to Annex A for more detailed explanations.

3.10
pre-acceleration
application of acceleration control device prior to the position AA' for the purpose of achieving stable acceleration between AA' and BB'

NOTE See Figure 1 for additional details.

3.11
locked gear ratio
control of transmission such that the transmission gear cannot change during a test

3.12
engine
power source without detachable accessories

3.13
test track length
l_{10}
length of test track used in the calculation of acceleration from points PP' to BB'

3.14
test track length
l_{20}
length of test track used in the calculation of acceleration from points AA' to BB'

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'	—	3.10	line perpendicular to vehicle travel which indicates beginning of zone in which to record sound pressure level during test
a_i	m/s^2	A.2.6	partial throttle acceleration in gear i
a_{max}	m/s^2	A.2.2.3	maximum acceleration during an acceleration phase measured in in-use studies
$a_{max\ 90}$	m/s^2	A.2.3.1	90th percentile of maximum acceleration during an acceleration phase measured in in-use studies
a_{wot}	m/s^2	A.2.2.1	in-use acceleration measured in urban traffic for a specific vehicle
$a_{wot\ 50}$	m/s^2	A.2.8.1	acceleration at 90th percentile of noise emission and 50 km/h vehicle velocity for a specific vehicle
$a_{wot\ i}$	m/s^2	5.1	acceleration at wide-open-throttle in gear i
$a_{wot\ (i+1)}$	m/s^2	5.1	acceleration at wide-open-throttle in gear $(i+1)$
$a_{wot\ test}$	m/s^2	5.1	acceleration at wide-open throttle in single gear test cases
$a_{wot\ ref}$	m/s^2	5.4	reference acceleration for the wide-open-throttle test
a_{urban}	m/s^2	5.3	target acceleration representing urban traffic acceleration
BB'	—	3.10	line perpendicular to vehicle travel which indicates end of zone in which to record sound pressure level during test
CC'	—	8.1	line of vehicle travel through test surface defined in ISO 10844
$\delta_1 - \delta_7$	dB	B.2	input quantities to allow for any uncertainty
gear i	—	8.3.1.3.2	first of two gear ratios for use in the vehicle test
gear $(i+1)$	—	8.3.1.3.2	second of two gear ratios, with an engine speed lower than gear ratio i
j	—		index for single test run within overall acceleration or constant speed test series i or $(i+1)$
k_P	—	3.9	partial power factor
k	—	3.8	gear ratio weighting factor
k_n	—	A.2.8.1	interpolation factor between gears
l_{ref}	m	5.1	reference length
l_{veh}	m	5.1	length of vehicle
l_{10}	m	3.13	length of test section for calculation of acceleration from PP' to BB'
l_{20}	m	3.14	length of test section for calculation of acceleration from AA' to BB'
$L_{crs\ i}$	dB	8.4.3.2	vehicle sound pressure level at constant speed test for gear i
$L_{crs\ (i+1)}$	dB	8.4.3.2	vehicle sound pressure level at constant speed test for gear $(i+1)$
$L_{crs\ rep}$	dB	8.4.3.2	reported vehicle sound pressure level at constant speed test
$L_{wot\ i}$	dB	8.4.3.2	vehicle sound pressure level at wide-open-throttle test for gear i
$L_{wot\ (i+1)}$	dB	8.4.3.2	vehicle sound pressure level at wide-open-throttle test for gear $(i+1)$
$L_{wot\ rep}$	dB	8.4.3.2	reported vehicle sound pressure level at wide-open-throttle

Table 1 — (*continued*)

Symbol	Unit	Clause	Explanation
L_{urban}	dB	8.4.3.2	reported vehicle sound pressure level representing urban operation
$m_{fa\ load\ unladen}$	kg	8.2.2.1	unladen front axle load
$m_{ac\ ra\ max}$	kg	8.2.2.1	maximum rear axle capacity
$m_{ra\ load\ unladen}$	kg	8.2.2.1	unladen rear axle load
m_d	kg	8.2.2.1	mass of driver
m_{kerb}	kg	8.2.2.1	kerb mass of the vehicle
$m_{fa\ load\ laden}$	kg	8.2.2.2.2	laden front axle load
$m_{ra\ load\ laden}$	kg	8.2.2.2.2	laden rear axle load
m_{ref}	kg	8.2.2.1	kerb mass + 75 kg for the driver (75 kg ± 5 kg in the case of category L)
m_{ro}	kg	8.2.2.1	mass in running order
m_t	kg	3.2	test mass of the vehicle
m_{target}	kg	8.2.2.1	target mass of the vehicle
$m_{unladen}$	kg	8.2.2.1	unladen vehicle mass
m_{xload}	kg	8.2.2.1	extra loading
n	1/min	A.2.4	engine rotational speed of the vehicle
$n_{PP'}$	1/min	9	engine rotational speed of the vehicle when the reference point passes PP'
$n_{BB'}$	1/min	8.3.2.2.1	engine rotational speed of the vehicle, when the reference point passes BB'
$(n/S)_{a\ 90}$	—	A.2.8.1	dimensionless engine rotational speed ratio at 90th percentile acceleration
$(n/S)_{L\ 90}$	—	A.2.6	dimensionless engine rotational speed ratio at 90th percentile noise emission
$(n/S)_i$	—	A.2.8.1	dimensionless engine rotational speed ratio at maximum acceleration of i gear
$(n/S)_{(i+1)}$	—	A.2.8.1	dimensionless engine rotational speed ratio at maximum acceleration of $(i + 1)$ gear
PMR	—	3.2	power-to-mass ratio index to be used for calculations
P_n	kW	3.2	rated engine power (see ISO 1585)
PP'	—	3.13	line perpendicular to vehicle travel which indicates location of microphones
S	1/min	3.3	rated engine rotational speed in revs per minute, synonymous with the engine rotational speed at maximum power
$v_{AA'}$	km/h	5.2.1	vehicle velocity when reference point passes line AA' (see 5.1 for definition of reference point)
$v_{BB'}$	km/h	5.2.1	vehicle velocity when reference point or rear of vehicle passes line BB' (see 5.1 for definition of reference point)
$v_{PP'}$	km/h	5.2.2	vehicle velocity when reference point passes line PP' (see 5.1 for definition of reference point)
v_{test}	km/h	8.3.1.2	target vehicle test velocity
$v_{a\ max\ 50}$	km/h	A.2.3.1	50th percentile vehicle velocity at maximum acceleration during an acceleration phase measured in in-use studies
$v_{a\ max\ 90}$	km/h	A.2.3.1	90th percentile vehicle velocity at maximum acceleration during an acceleration phase measured in in-use studies

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

All accelerations are calculated using different speeds of the vehicle on the test track. The formulas given in 5.2 are used for the calculation of $a_{\text{wot }i}$, $a_{\text{wot }(i+1)}$ and $a_{\text{wot test}}$. The speed either at AA' ($v_{\text{AA'}}$) or PP' ($v_{\text{PP'}}$) is defined by the vehicle speed when the reference point passes AA' or PP'. The speed at BB' ($v_{\text{BB'}}$) is defined when the rear of the vehicle passes BB'. The method used for determination of the acceleration shall be indicated in the test report

Due to the definition of the reference point for the vehicle, the length of the vehicle is considered to be different in Equations (2) and (3). If the reference point is the front of the vehicle, $l_{\text{ref}} = l_{\text{veh}}$, i.e. the length of vehicle; if the reference point is the midpoint of the vehicle, $l_{\text{ref}} = 0{,}5\ l_{\text{veh}}$ (i.e. 0,5 times the length of vehicle); if the reference point is the rear of the vehicle, $l_{\text{ref}} = 0$.

The dimensions of the test track are used in the calculation of acceleration. These dimensions are defined as follows: l_{20} = 20 m, l_{10} = 10 m.

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.

5.2 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

The value of $a_{\text{wot test}}$ used in the determination of gear selection shall be the average of the four $a_{\text{wot test},j}$ values during each valid measurement run.

Calculate $a_{\text{wot test},j}$ using the equation:

$$a_{\text{wot test},j} = \frac{\left(v_{\text{BB'},j}/3{,}6\right)^2 - \left(v_{\text{AA'},j}/3{,}6\right)^2}{2\left(l_{20} + l_{\text{ref}}\right)} \tag{2}$$

where

$a_{\text{wot test},j}$ is the numerical value of the acceleration, expressed in metres per second squared;

$v_{\text{BB'},j}$, $v_{\text{AA'},j}$ are numerical values of the velocity, expressed in kilometres per hour;

l_{20}, l_{ref} are numerical values of the length, expressed in metres.

Pre-acceleration may be used.

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

The value of $a_{\text{wot test}}$ used in the determination of gear selection shall be the average of the four $a_{\text{wot test},j}$ values during each valid measurement run.

If the devices or measures described in 8.3.1.3.3 are used to control transmission operation for the purpose of achieving test requirements, calculate $a_{\text{wot test},j}$ using Equation (2).

Pre-acceleration may be used.