SLOVENSKI STANDARD
oSIST prEN ISO 11819-2:2015

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Akustika - Merjenje vpliva cestnih površin na prometni hrup - 2. del: Metoda merjenja v neposredni bližini (ISO/DIS 11819-2:2015)

Acoustics - Measurement of the influence of road surfaces on traffic noise - Part 2: The close-proximity method (ISO/DIS 11819-2:2015)

Akustik - Messung des Einflusses von Straßenoberflächen auf Verkehrsgeräusche - Teil 1: Nahfeldmessmethode

Acoustique - Méthode de mesurage de l'influence des revêtements de chaussées sur le bruit émis par la circulation - Partie 2: Méthode de proximité immédiate (ISO/DIS 11819-2:2015)

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17.140.30	Emisija hrupa transportnih sredstev	Noise emitted by means of transport

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Acoustics — Measurement of the influence of road surfaces on traffic noise —

Part 2:
The close-proximity method

Acoustique — Méthode de mesurage de l'influence des revêtements de chaussées sur le bruit émis par la circulation —

Partie 2: Méthode de proximité immédiate

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ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2, www.iso.org/directives.

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The committee responsible for this document is ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 11819 consists of the following parts, under the general title *Acoustics — Measurement of the influence of road surfaces on traffic noise*:

— *Part 1: Statistical Pass-By method*

— *Part 2: The close-proximity method*

— *Part 4: SPB method using backing board* [Publicly Available Specification]

The following part is under preparation:

— *Part 3: Reference tyres* [Technical Specification]

Introduction

The emission and propagation of road traffic noise greatly depends on road surface characteristics, notably on texture, flow resistivity, and acoustic absorption. All these characteristics influence the generation of tyre/road noise and, in addition, the acoustic absorption can influence the propagation of sound, particularly when the propagation takes place close to the surface. Power unit noise, which is usually generated at a greater height above the road surface than tyre/road noise, may also be affected during propagation by the porosity characteristics of the road surface. These effects lead to differences in sound pressure levels, associated with a given traffic flow and composition, from different road surfaces of up to 15 dB which can have a substantial impact on the environmental quality alongside a road.

It is therefore important to be able to measure the influence of surface characteristics on tyre/road noise by a standardized method. Within the constraints of this method, this International Standard offers an objective rating of the road characteristics to satisfy a need expressed by road planners, road administrators, contractors, manufacturers of so-called “low-noise surfaces”, and by other parties concerned with the control of road traffic noise.

A method satisfying the needs expressed in the foregoing, but having serious practical constraints, appears in ISO 11819-1. That method, called the statistical pass-by (SPB) method, is intended for use essentially for two main purposes. It can be used: first, to classify surfaces in typical and good condition as a type according to their influence on traffic noise (surface classification); and second, to evaluate the influence on traffic noise of different surfaces at particular sites irrespective of condition and age. However, due to severe requirements on the acoustical environment at the measurement site, the method cannot generally be used for approval of new or rebuilt surfaces at any arbitrary location. In addition, the SPB method has a number of other practical limitations, which are outlined in Annex D.

The method specified in this part of ISO 11819, together with the planned ISO/TS 11819-3 complement the SPB method in applications where the latter has limitations.

Acoustics — Measurement of the influence of road surfaces on traffic noise — Part 2: The close-proximity method

1 Scope

This part of ISO 11819 specifies a method of evaluating different road surfaces with respect to their influence on traffic noise, under conditions when tyre/road noise dominates. The interpretation of the results applies to free-flowing traffic travelling on essentially level roads at constant speeds of 40 km/h and upwards, in which cases tyre/road noise is assumed to dominate (although in some countries it is possible that tyre/road noise does not dominate at 40 km/h when the proportion of heavy vehicles is high). For other driving conditions where traffic is not free-flowing, such as at junctions or under heavy acceleration, and where the traffic is congested, the influence of the road surface on noise emission is more complex; as is also the case for roads with high longitudinal gradients and a high proportion of heavy vehicles.

A standard method for comparing noise characteristics of road surfaces gives road and environment authorities a tool for establishing common practices or limits as to the use of surfacings meeting certain noise criteria. However, it is not within the scope of this part of ISO 11819 to suggest such criteria.

Part 1 of ISO 11819 defines another method: The statistical pass-by (SPB) method. The close-proximity (CPX) method proposed in this part of ISO 11819 has the same main objectives as the SPB method, but is intended to be used specifically in applications that are complementary to it, such as:

— noise characterization of road surfaces at almost any arbitrary site, with the main purpose of checking compliance with a surface specification (an example for conformity of production is suggested in Reference [1]);

— checking the acoustic effect of maintenance and condition, e.g. wear of and damage to surfaces, as well as clogging and the effect of cleaning of porous surfaces;

— checking the longitudinal and lateral homogeneity of a road section;

— development of quieter road surfaces and research on tyre/road interaction.

NOTE 1 This standard does not describe the conditions of application for formal purposes of the measurement with the CPX method. Such conditions shall be defined in other standards or legal texts. However, suggestions for the applicability of Part 1 and Part 2 of ISO 11819 are provided in Annex D.

Measurements with the CPX method are faster and more practical than with the SPB method, but are more limited in the sense that it is relevant only in cases where tyre/road noise dominates and power unit noise can be neglected. Furthermore, it cannot take heavy vehicle tyre/road noise into account as fully as the SPB method can, since it does not make use of truck tyres for testing and does not take power unit noise into account.

NOTE 2 The CPX method specified in this part of ISO 11819 is intended to measure the properties of road surfaces, not the properties of tyres. If the method is used for testing tyres, the loads and inflations should normally be adjusted to other values than specified in this standard.

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 3911, *Wheels and rims for pneumatic tyres — Vocabulary, designation and marking*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 10844, *Acoustics — Specification of test tracks for measuring noise emitted by road vehicles and their tyres*

ISO 11819-1, *Acoustics — Measurement of the influence of road surfaces on traffic noise— Part 1: Statistical Pass-By method*

ISO/TS 11819-3, *Acoustics — Measurement of the influence of road surfaces on traffic noise — Part 3: Reference tyres*

ISO/TS 13471-1, *Acoustics — Temperature influence on tyre/road noise measurement — Part 1: Correction procedure when testing with the CPX method*

ISO 13473-1, *Characterization of pavement texture by use of surface profiles — Part 1: Determination of Mean Profile Depth*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1:2013, *Electroacoustics — Sound level meters — Part 1: Specifications*

ISO/IEC Guide 98-3, *Uncertainty of 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 11819-1 and the following apply.

3.1 Road and pavement related definitions

3.1.1
road section
the total stretch of the road lane subject to testing

3.1.2
road segment
part of a road section, being 20 m long and intended for normalization of sound pressure levels from the actual speed on that segment to a certain reference speed

3.2 Measurement methods and equipment

3.2.1
statistical pass-by method
SPB method
measurement procedure designed to evaluate vehicle and traffic noise generated on different sections of road surface under specific traffic conditions

Note 1 to entry: The measurements are taken from a great number of vehicles operating normally on the road. Results obtained using this procedure are normalized to standard speeds according to the category or type of road being considered. The method is specified in ISO 11819–1.

3.2.2
reference tyres
test tyres specified for the purpose of representing certain features in tyre/road sound emission, designed and constructed for use in this method with specified and reproducible standard properties

Note 1 to entry: The reference tyres are specified in ISO/TS 11819-3.

3.3 Acoustic quantities and symbols

3.3.1
CPX level
L_{CPX}
time-averaged A-weighted sound pressure level of the tyre/road noise as determined by the CPX method, either broadband or spectral bands, as required

Note 1 to entry: The CPX level is expressed in decibels. In order to provide more information, additional suffixes are used; see Table 1.

3.3.2
CPX level for passenger cars and other light vehicles
CPXP
sound level characterising the road surface under test, which is based on the tyre/road sound pressure levels of one or more tyres representative of passenger car tyres

Note 1 to entry: The *CPXP* is expressed in decibels. Passenger tyres are denoted P1, P2 …. .

3.3.3
CPX level for heavy vehicles
CPXH
sound level characterising the road surface under test, which is based on the tyre/road sound pressure levels of one or more tyres representative of heavy vehicle tyres

Note 1 to entry: The *CPXH* is expressed in decibels. Heavy vehicle tyres are denoted H1, H2 …. .

3.3.4
CPX index
CPXI
index composed of the weighted average of the CPX level for passenger cars and other light vehicles (*CPXP*) and CPX level for heavy vehicles (*CPXH*)

Note 1 to entry: The *CPXI* is expressed in decibels. The method is intended to describe performance of road surfaces for a certain traffic composition in a similar way to the SPB method in ISO 11819–1, although the numerical values for a given speed are higher.

3.3.5
acoustic variability due to road surface inhomogeneities
s_t
the standard deviation of the A-weighted SPL values for all segments, when using reference tyre t

Note 1 to entry: The acoustic variability is expressed in decibels. This variability is normally dominated by road surface variations, although random errors could add a little. Measurement speed and wheel tracks normally do not influence this value significantly. This measure is, therefore, considered to be an indication of road surface homogeneity as far as noise properties are concerned.

3.4 Symbols used for correction terms

3.4.1
speed coefficient
B
coefficient determining the speed dependence of the sound pressure levels, normally used for correction of the sound pressure level to a certain reference speed

Note 1 to entry: The speed coefficient is dimensionless.

3.4.2
reference speed
vr
preferred speed for measurement

Note 1 to entry: The reference speed is expressed in kilometres per hour. It can be 40 km/h, 50 km/h, 80 km/h or 100 km/h.

3.4.3
measured speed
v
actual speed during a measurement

Note 1 to entry: The measured speed is expressed in kilometres per hour.

3.4.4
temperature correction factor
$C_{T,\,t}$
quantity representing correction of CPX level for temperature for tyre t

Note 1 to entry: The temperature correction factor is expressed in dB per degree Celcius.

3.4.5
tyre tread hardness correction factor
$C_{SH,\,t}$
quantity representing correction of CPX level for rubber hardness of the tread of tyre t

Note 1 to entry: The tyre tread hardness correction factor is expressed in dB per Shore type A.

3.4.6
device dependent correction for sound reflections
$C_{d,\,f}$
correction for individual measuring devices in one-third-octave bands from 315 Hz to 5 000 Hz with the centre frequency f to account for deviations from acoustic hemi-free-field conditions

Note 1 to entry: The device correction for sound reflections is expressed in dB.

4 Symbols and abbreviated terms

Table 1 lists the symbols used in this part of ISO 11819.

Table 1 — Symbols and abbreviated terms used in this standard and their value or unit

Symbol	Value/unit	Explanation
$CPXP_v = L_{\mathrm{CPX:P},vr}$	dB	Measure of the acoustic properties of the tested road section, for tyre(s) representing light vehicles, at the reference speed, *vr*
$CPXH_{vr} = L_{\mathrm{CPX:H},vr}$	dB	Measure of the acoustic properties of the tested road section, for tyre(s) representing heavy vehicles, at the reference speed, *vr*
$CPXI_{vr} = 0{,}5 \cdot CPXP_{vr} + 0{,}5 \cdot CPXH_{vr}$	dB	"CPX index" representing the overall acoustic properties of the tested road section, for tyre(s) representing light and heavy vehicles combined (with equal weighting), at the ref. speed, *vr*
B	Dimensionless	Speed coefficient; i.e. increase in CPX level with 10-fold increase in speed, to be able to correct for deviations from the reference speed, *vr*
$C_{\mathrm{d},f}$	dB	Device dependent correction term to account for deviations from free field conditions
$C_{T,\mathrm{t}}$	dB/°C	Temperature correction for tyre t to account for deviations from reference temperature of 20 °C
$C_{SH,\mathrm{t}}$	dB/ShoreA	Tyre tread hardness correction for tyre t to account for deviations from a reference hardness of 66 Shore A
f	315 Hz, … 5 000 Hz	One-third-octave-band centre frequency
i	1, 2, 3 ….	Road segment number
$L_{\mathrm{CPX:t},w,r,i,f,m,vr}$	dB	Time-averaged tyre/road SPL ("CPX level") over the time it takes to run a road segment (20 m)
m	1 2	Front mandatory microphone position Rear mandatory microphone position
n	1, 2, 3 …	Total number of runs, n_r, wheel tracks, n_w, or road segments, n_i
r	1, 2, 3 ….	Run number
SPL	dB	Sound pressure level
s_{t}	dB	Acoustic variability in CPX levels; averaged for all segments, all used reference speeds and all lateral tracks, as applicable. This is considered to be an indication of road surface homogeneity
t	P H	Tyre type defined for testing Passenger car tyres Heavy vehicle tyres
T_i	°C	Air temperature at road segment *i* (index not needed if continuous temperature measurements are not made)
v	km/h	Actual measured speed
vr	40, 50, 80 or 100 km/h	Preferred nominal speed for measurement; thus a reference speed used when reporting results
w	1, 2, 3, ….	The tracks in a lane where tyres are rolling. Wheel track number 1 is closest to the road shoulder, 2 is the opposite wheel track, and 3, 4, and so on are additional tracks

5 Measurement principle

In the CPX method, the average A-weighted SPLs emitted by specified tyres are measured over an arbitrary or a specified road distance, together with the vehicle testing speed, by at least two microphones, located close to the tyres. For this purpose, a special test vehicle, which is either self-powered or towed behind another vehicle, is used. Reference tyres are mounted on the test vehicle, either one by one, or both at the same time. Two uniquely different reference tyres have been selected in order to represent the tyre/road characteristics which are to be studied.

Since the source of tyre/road noise is in close proximity to the tyre/road interface a substantial part of the propagation effect by acoustically absorptive surfaces is included in the microphone signal. This is supported by model calculations and the results of the CPX validation experiment (References [2][3]). See Annex N for further information.

The tests are performed with the intention of determining a tyre/road sound pressure level, here referred to as the CPX level, L_{CPX}, at one or more of the nominated reference speeds (40 km/h, 50 km/h, 80 km/h or 100 km/h). This can be achieved by testing at or close to one of the reference speeds or by testing over a wider speed range and normalizing for speed deviations.

For each reference tyre and each individual test run with that tyre, the average sound pressure levels over short measuring distances (segments of 20 m each), together with the corresponding vehicle speeds are recorded. The sound pressure level of each segment is normalized to a reference speed by a simple correction procedure. Averaging is then carried out according to the purpose of the measurement; i.e. measuring a particular segment or a number of consecutive segments (a section).

The CPX level, $L_{\mathrm{CPX:\,t},vr}$, is the resulting average sound pressure level for the two mandatory microphones at that reference speed, *vr*, for that reference tyre, t. This should be reported for each tyre/reference speed combination.

Where the reference tyres correspond to the reference tyre(s) P or H,[1] the CPX levels at the reference speed *vr* shall instead be reported as the close proximity sound index, $CPXP_{vr}$ or $CPXH_{vr}$ respectively. The close proximity sound index is a standard CPX-based index for single-value comparison of the acoustic performance of road surfaces.

Where both close proximity sound indices have been determined, $CPXI_{vr}$ is the average of $CPXP_{vr}$ and $CPXH_{vr}$ with equal weight given to the two indices.

6 Measuring instruments

6.1 Sound level instrumentation

Within the minimum frequency range of 315 Hz to 5 000 Hz, the sound level meter or the equivalent measuring system shall at least meet the requirements of IEC 61672-1, class 1. The microphones shall be of the “free-field” type.

An appropriate windscreen shall be used having a diameter of at least 90 mm. The sound properties of windscreens will deteriorate as the material is progressively exposed to dirt. It is therefore good practice to check the performance of the windscreens frequently and to replace them with new, fresh material when they show patterns of dirt coverage.

[1] As specified in ISO/TS 11819-3. See the foreword.

6.2 Frequency analysis instrumentation

Frequency analysis of the measured sound using one-third-octave-band resolution is mandatory. The range 315 Hz to 5 000 Hz (centre frequencies of one-third-octave bands) is the minimum range to be covered. The one-third-octave-band filters shall conform to IEC 61260.

6.3 Sound calibration instrumentation

At the beginning of the measurements, and following any warm-up time specified by the manufacturer, the overall sensitivity of the sound level meters or the equivalent measuring system (including the microphone) shall be checked. If necessary, adjust it according to the manufacturer's instructions. This may require use of a standard sound source, such as a calibrator or pistonphone. This check shall be repeated at the end of the measurements, and at least after every 4 h of operation. Any deviations shall be recorded in the test report. If the calibration readings differ by more than 0,5 dB between the checks, all intermediate measurements shall be considered invalid.

The sound calibration device shall at least meet the requirements of IEC 60942, class 1.

6.4 Verification of the sound measuring system

The compliance of the sound calibrator with the requirements of the appropriate class of IEC 60942 shall be verified annually. The compliance of the sound level meter or equivalent measuring system with the requirements of IEC 61672-1 shall be verified at least every two years. This shall be performed by a laboratory authorized to perform calibrations traceable to the appropriate standards.

6.5 Vehicle speed measuring instrumentation

The average speed of the vehicle over the measured segment shall be measured with a maximum permissible error of ±1 % of the indicated value.

For speed measurement, if a tyre is used it shall not be mounted on a drive axle.

6.6 Position monitoring instrumentation

GPS or other means of identifying the start positions of measurements are very useful in order to avoid problems in identifying a test section and to be able to return to the same place at a later occasion or for other types of measurements. The GPS system should be of a type specified with a maximum permissible error of ± 5 m.

It may also be a good idea to take a photo showing the start position in relation to surrounding objects.

6.7 Temperature measuring instrumentation

The air and (optional) road temperature measuring instrument(s) shall have a maximum permissible error of ±1 °C, as specified by the manufacturer. Meters utilizing the infrared technique shall not be used for air temperature measurements.

6.8 Tyre load measuring equipment

The weighing equipment used to determine the load of the test tyres shall have a maximum permissible error of ±5 %, as specified by the manufacturer.