FINAL
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AMENDMENT

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Tyres — Coast-by methods for measurement of tyre-to-road sound emission

AMENDMENT 1: Uncertainties

Pneumatiques — Méthodes en roue libre pour le mesurage de l'émission acoustique issue du contact pneumatique/chaussée

AMENDEMENT 1: Incertitudes

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Foreword

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This document was prepared by Technical Committee ISO/TC 31, *Tyres, rims and valves*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Tyres — Coast-by methods for measurement of tyre-to-road sound emission

AMENDMENT 1: Uncertainties

Clause 2

Add the following reference:

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

Between 10.2 and 10.3

Add the following text as a new 10.3:

10.3 Measurement uncertainty

The measurement procedure described in 10.2 is affected by several parameters (e.g. surface texture variation, vehicle design, environmental conditions, measurement system uncertainty) that lead to variation in the resulting sound level observed for the same set of tyres. The source and nature of these perturbations are not completely known and sometimes affect the end result in a non-predictable way. Since extensive inter- and intra-test data are not available, the procedure given in ISO/IEC Guide 98-3 is followed to estimate the uncertainty associated with the measurement procedure of this document. The uncertainties given in Table 1 are based on existing statistical data, an analysis of tolerances stated in this document and engineering judgement. The uncertainties so determined are grouped as follows:

a) variations expected on the same test facility and slight variations in ambient conditions found within a single test series, using same equipment and same vehicle on the day (run-to-run);

b) variations expected on the same test facility but with variations in ambient conditions and equipment properties (including different vehicle) that can normally be expected during the year (day-to-day);

c) variations between test facilities where, apart from ambient conditions, equipment, vehicle, staff and track surface conditions also are different (site-to-site) for all tyre classes covered in this document.

If reported, the expanded measurement uncertainty together with the corresponding coverage factor for the stated coverage probability of 95 % as defined in ISO/IEC Guide 98-3 shall be given. Information on the determination of the expanded uncertainty is given in Annex A.

NOTE Annex A gives a framework for analysis in accordance with ISO/IEC Guide 98-3, which can be used to conduct future research on measurement uncertainty for this document.

Uncertainty data are given in Table 1 for all tyre class of this document. The variability is given for a coverage probability of 95 %. The data express the variability of results for the same set of tested tyres and do not cover product variation.

Until more specific knowledge is available, the data for site-to-site variability may be used in test reports to state the expanded measurement uncertainty for a coverage probability of 95 %.

Table 1 — Variability of measurement results for a coverage probability of 95 %

Tyre category	Run-to-run dB(A)	Day-to-day [a] dB(A)	Site-to-site dB(A)
All tyres covered in this document	±0,4	±1,4	±3,1

10.3

Renumber 10.3 as 10.4.

Renumber Tables 1, 2 and 3 as Tables 2, 3 and 4.

After 10.3

Add the following text as Annex A.

Annex A
(informative)

Measurement uncertainty — Framework for analysis in accordance with ISO/IEC Guide 98-3

The measurement procedure is affected by several factors causing disturbance that lead to variations in the resulting level observed for the same tyre set under test. The source and nature of these perturbations are not completely known and sometimes affect the end result in a non-predictable way. The accepted format for expression of uncertainties generally associated with methods of measurement is that given in ISO/IEC Guide 98-3. This format incorporates an uncertainty budget, in which all the various sources of uncertainty are identified and quantified, and from which the combined standard uncertainty can be obtained. Uncertainties are due to the following factors:

— variations in measurement devices, such as sound level meters, calibrators and speed measuring devices;

— vehicle influence;

— variations in vehicle speed and in vehicle position during the pass-by runs;

— variations in local environmental conditions that affect sound propagation at the time of measurement of sound pressure levels;

— variations in local environmental conditions that affect the characteristics of the source;

— effects of environmental conditions (air pressure, air density, humidity, air temperature) that influence the mechanical characteristics of the source;

— effects of environmental conditions that influence the sound production and the rolling noise (tyre and road surface temperature, humid surfaces);

— test site properties (test surface texture and absorption, surface gradient).

The uncertainty determined according to 10.3 represents the uncertainty associated with this document. It does not cover the uncertainty associated with the variation in the production process of the tyres, the variations in the sound pressure level of identical tyres being out of the scope of this document.

The uncertainty effects for tyre testing can be grouped in three areas composed of the following sources (see 10.3):

a) run-to-run variations: variations expected on the same test facility and slight variations in ambient conditions found within a single test series, using same equipment and same vehicle on the day (run-to-run);

b) day-to-day variations: uncertainty due to changes in the test operation, changes in the measurement system performance over longer periods, changes in vehicle model, changes in the properties of the test facility over time, and changes in climatic conditions throughout the year;

c) site-to-site variations: uncertainty due to measurement systems, test site locations, vehicle model and road surface characteristics (tyre/road noise data from different test tracks).

The site-to-site variation comprises uncertainty sources from a), b) and c). The day-to-day variation comprises uncertainty sources from a) and b), which are cumulated in Table A.1.

Table A.1 — Uncertainty budget for determination of tyre sound pressure level uncertainty

Uncertainty category	Description	Peak to peak coast-by dB(A)	Probability distribution	Standard deviation dB(A)	Combined cumulated standard uncertainties dB(A)	Expanded uncertainties for a coverage of 95%
Run-to-run	Microclimate wind effect	0,5	Gaussian	0,1	±0,2	+/0,4
	Deviation from centred driving	0,5	rectangular	0,1		
	Varying background noise	0,1	Gaussian	0,0		
Day-to-day (include run-to-run)	Temperature influence (after temperature correction for C1/C2 tyres)	0,5[b]	rectangular	0,1	±0,7	+/- 1,4
	Varying background noise	0,5	rectangular	0,1		
	Residual humidity on test track surface	1	rectangular	0,3		
	Vehicle influence (possibility to use different vehicles. Uncertainty takes into consideration differences in: wheel adjustment, suspension, tyre load and inflation, body-road clearance, shadowing and reflecting properties, rims, transmission noise, bearings, brake noise (brakes not completely released), body shape (aerodynamic noise around the vehicle body and extra equipment).	2	rectangular	0,6		
Site-to-site	Test track surface	5,4[a]	Gaussian	1,4	±1,5	+/-3,1
	Microphone Class 1, see IEC 61672-1	0,6[a]	Gaussian	0,2		
	Sound calibrator, see IEC 60942	0,8[a]	Gaussian	0,2		
	Speed measuring equipment continuous at PP1 line. (The minimum requirement for sensor accuracy in this document is ±1 kph. Tire noise versus speed sensitivity = 0,2 dB/kph. Peak-to-peak = 0,2 dB(A) × 2 kph = 0,4 dB(A) (±0,13 dB(A) for 95 % coverage).	0,3	rectangular	0,1		
			Total		**±1,5**	**+/-3,1**
(1) PP' is a microphones line (transverse axis)						

[a] Values retrieved in literature.

[b] Estimation based on tyre-makers data.

NOTE The uncertainty evaluation described represents a framework that provides useful information to users of this document. This information represents the state of technical information at the time of publication. Further work is necessary to provide uncertainty information on all terms and all interactions between such terms.

The total uncertainty is calculated by combining standard uncertainty with a coverage factor of 95 % as described in ISO/IEC Guide 98-3.

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