Tyres – coast-by-method for measurement of tyre/road sound emission

1 Scope
This International Standard specifies a method to measure tyre/road sound emissions from tyres for passenger cars and commercial vehicles during coast-by using either a motor vehicle or a towed trailer.

This standard, includes two separate normative annexes, Annex A - Vehicle Method and Annex B - Trailer Method. The trailer method may be expected to give a good indication of the sound emissions produced from the tyres alone. The results of the vehicle method may be higher than for the tyres alone. This standard is not intended to be used either for determination of the sound contribution of tyres of vehicles running in powered condition, or for determination of traffic sound nuisance at a given location.

2 Normative references
The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards:

IEC Publication 651, Sound level meters.
IEC Publication 942, Sound calibrators.
ISO 3877 - Tyres, valves and tubes - list of equivalent items - Part 1: Tyres.
ISO 4209/1 - Truck and bus tyres and rims - Part 1: Tyres (metric series).
ISO 4223/1 - Definition of some terms used in the tyre industry - Part 1: Pneumatic tyres.
ISO 10844 - Acoustics - Test surface for road vehicle noise measurement.

3 Definitions
For the purpose of this standard the following classifications shall apply:

C1 Passenger Car tyres
C2 Commercial Vehicle tyres with load capacity index in single formation lower or equal to 121 and speed category symbol higher or equal to “N”.  
C3 Commercial Vehicle tyres with load capacity index in single formation lower or equal to 121 and speed category symbol “M” and below, or Commercial Vehicle tyres with load capacity index in single formation 122 and higher.

The load index (LI) is a numerical code associated with the maximum load a tyre can carry at the speed indicated by its speed symbol under the service conditions specified by the tyre manufacturer. In cases where the load index consists of two numbers, reference shall be made to the first number. For tyres where the load index is not available, reference shall be made to the maximum load marked on the tyre sidewall.
For definitions of other terms relating to tyres, see ISO 4223/1.

In this standard, the term “coast-by” refers to a motor vehicle or towed trailer in free-rolling, non-powered operation, with transmission in neutral position and the engine as well as all auxiliary systems which are not necessary for safe driving switched off.

4 General information

This International Standard is based on a test with a test motor vehicle or towed trailer in motion. Measurements shall relate to tyres in coast-by conditions.

The results obtained by this method give an objective measure of the sound emitted under the prescribed conditions of the test.

5 Test site

The test site shall consist of a substantially flat and level area. Conditions of a free acoustical field between the sound source and the microphone shall be attained to within 1 dB. These conditions shall be deemed to be met if there are no large sound reflecting objects, such as fences, barriers, bridges or building, within 50 m of the center of the test area.

The test surface, including voids, shall be dry and clean for all measurements. The test area and surface shall meet the requirements of ISO 10844. See Fig. 1.

6 Instrumentation

6.1 Instrumentation for acoustical measurements

The sound level meter or the equivalent measuring system shall at least meet the requirements of a type 1 instrument according to IEC Publication 651.

The measurements shall be made using the frequency weighting “A”, and the time weighting “F”.

The calibration of the sound level meter shall be checked and adjusted according to the manufacturer’s instructions or with a standard sound source (for example a pistonphone) at the beginning of the measurements and rechecked and recorded at the end of them. The calibration device must meet the requirements of Class 1 in IEC 942 (Sound Calibrators).

If the sound level meter indications obtained from these calibrations differ by more than 0.5 dB during a series of measurements, the test shall be considered invalid. Any deviation shall be recorded in the test report.

At intervals of not more than 1 year, the sound level meter and the calibration device shall be verified with the requirements of IEC Publications 651 and 942.

Windscreen shall be used in accordance with the microphone manufacturer’s recommendations.

The test area and surface shall meet the requirements of ISO 10844, as shown in Figure 1 below.
NOTE - There shall be no large acoustically reflective objects within this radius.

Figure 1 The test area and surface according to ISO 10844, with locations indicated for microphones (see filled circles) and travel of vehicle (see Annex A), and trailer (see Annex B) as appropriate. Dimensions in Fig. 1 are expressed in meters.

6.2 Microphone position

This test requires two microphones, one on each side of the vehicle, see Fig. 1.
In the vicinity of the microphone, there shall be no obstacle that could influence the acoustical field and no person shall remain between the microphone and the sound source. Any observer(s) shall be positioned so as not to influence the sound reading.
The distance from the microphone positions to the centerline of travel on the test track shall be 7,5 m (± 0,1 m).
Each microphone shall be located 1,2 m (± 0,05 m) above the test area surface. They shall be oriented as recommended by the manufacturer of the sound level meter for field conditions for a test vehicle passing along the centerline of travel in Fig. 1.

6.3 *Temperature measurement instrumentation

For air as well as test surface temperature, the measuring instrument shall have an overall accuracy of at least ± 1°C. Meters utilizing the infrared technique shall not be used for air temperature measurements.
The type of sensor shall be reported.
Continuous registration via an analog output may be employed. If such an option is not available, single values are to be measured.
6.4 *Temperature measurement method

6.4.1 General
Measurements of air as well as test surface temperature are mandatory.
The measurement must be made in accordance with the instrument manufacturer’s
instructions. The result is the reading rounded to the nearest integer °C.
Temperature measurements shall correspond reasonably in time with the sound
measurements. Alternatively, the average of the temperature at the beginning and the end of the
set of tests can be used as a substitute. This condition can be applied for both the vehicle and
trailer methods.

6.4.2 *Air temperature
The temperature sensor is to be positioned in an unobstructed location close to the microphone,
in such a way that it is exposed to the airflow and protected from direct solar radiation. The latter
may be achieved by any shading screen or similar device. The sensor should be positioned 1,0-
1,5 m above the test surface level, to minimize the influence of the test surface thermal radiation
at low airflows.

6.4.3 *Test surface temperature
The temperature sensor is to be positioned in a location where the temperature is representative
of the temperature in the wheel tracks, without interfering with the sound measurement.

If an instrument with a contact temperature sensor is used, heat-conductive paste shall be
applied between the surface and the sensor to ensure adequate thermal contact.
If a radiation thermometer (pyrometer) is used, the height should be chosen to ensure that a
measuring spot with a diameter of ≥ 0,1 m is covered.

6.5 Wind measurement
The device must be capable of measuring the wind speed to within ± 1 m/s. The wind shall be
measured at microphone height, between lines AA and BB and not more than 20 m from
centerline of travel in Fig. 1.

6.6 Speed measurement
The speed measuring device must be capable of measuring test motor vehicle or towed trailer
speed with a tolerance of ± 1 km/h.

7. Metrological conditions and background sound

7.1 Meteorological conditions
Measuring shall not be made in adverse weather conditions. It must be assured that the results
are not affected by gusts of wind. Testing shall not be performed if the wind speed at the

*Pending Results from TC 43, Subcommittee 1, Working Group 27
microphone height exceeds 5 m/s. Measurements shall not be made if either the air or test surface temperatures are below 5 °C or air temperature is above 40 °C.

7.2 Temperature correction

Temperature correction shall be applied only for category C1 and C2 tyres. Each measured sound level ($L_m$) shall be corrected using the following:

$$L = L_m + K\Delta T$$

where:
- $L$ = the corrected sound level;
- $L_m$ = the measured sound level;
- $K$ = for Class C1 tyres, the coefficient $K$ is −0.03 dB (A) / °C when the measured test surface temperature is greater than 20°C, and −0.06 dB (A) / °C when the measured test surface temperature is less than 20°C; and
- $K$ = for Class C2 tyres, the coefficient $K$ is −0.02 dB (A) / °C
- $\Delta T$ = the difference between the surface temperature ($t$) at the time of the sound recording and the reference surface temperature (20 °C).

$\Delta T = (t - 20)$.

**Note:** The $K$ factor listed is a result of a conservative preliminary estimation based on insufficient data, but represent the present state-of-the-art. ISO/TC43 SC1/WG 27 has the task to determine a temperature correction. When this standard is adopted, it shall make use of the latest findings of WG27.

7.3 Background sound level

The background sound level (including any wind noise) shall be at least 10 dB less than the measured tyre/road sound emission.

8. Preparation and adjustments with respect to tyres

Test tyres shall be mounted on any rim approved by the tyre manufacturer. The rim width shall be recorded. Tyres with special fitment requirements, such as asymmetric or directional design, shall be mounted in accordance with these requirements.

The tyre/rim assembly shall be balanced. Before testing, tyres shall be conditioned (broken-in). Tyre break-in shall be equivalent to about 100 km of normal operation on the road. Tyres with special fitment requirements shall be broken-in in accordance with these requirements.

Apart from the tread wear caused by the “break-in” procedure, the tyres shall have full tread depth.

Test tyres of categories C1 and C2 shall be warmed-up immediately prior to testing in conditions equivalent to 10 minutes at 100 km/h of normal driving.
Annex A  
(normative)

Vehicle method

A.1 General

A.1.1 Test vehicle

The test motor vehicle shall have two axles with two test tyres on each axle. It shall be loaded to obtain tyre loads in accordance with A1.4 below.

A.1.2 Wheel base

The wheel base between two axles fitted with test tyres shall be:

\[
\begin{align*}
\leq 3.5 \text{ m} & \quad \text{for tyre classes C1; and} \\
\leq 5.0 \text{ m} & \quad \text{for tyre classes C2 and C3.}
\end{align*}
\]

A.1.3 Other measures to minimize vehicle influence on sound level measurements

To ensure that tyre sound is not significantly affected by the test vehicle design, the following requirements and recommendations are given.

Requirements:

- Spray suppression flaps or other extra devices to suppress spray shall not be fitted.
- Addition or retention of elements in the immediate vicinity of the rims and tyres which may screen the emitted sound, is not permitted.
- Wheel alignment (toe in, camber, and caster) must be checked on the unladen vehicle and found to be in full accordance with the vehicle manufacturer’s recommendations.
- Additional sound absorbing material may not be mounted in the wheel housings or under the underbody.
- The windows of the vehicle shall be closed during testing.

Recommendations to avoid parasitic sound:

- Removal or modification of components on the vehicle that may contribute to the background sound of the vehicle is recommended. Any removals or modifications shall be recorded in the test report.
- During testing it should be ascertained that brakes are not poorly released, causing brake noise.
• 4-Wheel-drive vehicles and trucks with reduction gears in the axles, should not be used.

• Suspensions shall be in such a good condition that they do not result in an abnormal reduction in ground clearance when the vehicle is loaded in accordance with the testing requirement. If available, body level regulation systems shall be adjusted to give a ground clearance during testing which is normal for unladen condition.

• Before testing the vehicle should be washed clean of any mud/dirt or sound absorbing material inadvertently added during the break-in period.

A.1.4 Tyre load (vehicle method)

The load conditions shall meet all the following conditions:

1. The average load of all tyres shall be 75% ± 5% of the load index of the tyre.

2. No tyre shall be loaded to less than 70% or more than 90% of its load index.

A.1.5 Tyre inflation pressure

Each tyre shall be inflated to a cold inflation pressure \( P_t \) +10 % / −0 % where:

\[
P_t = P_r \left( \frac{Q_t}{Q_r} \right)^{1.25}
\]

where: \( P_t \) = Test inflation pressure;

\( P_r \) = Reference pressure;

\( = 250 \) kPa for standard tyres class C1;

\( = 300 \) kPa for reinforced tyres class C1;

\( = \) pressure corresponding to the pressure index marked on the sidewall for tyre classes C2 and C3

\( Q_r \) = Reference load;

\( = \) load corresponding to the maximum mass associated with the load index of the tyre; and

\( Q_t \) = Test load for that tyre.

A.1.6 Vehicle operating condition

The test vehicle shall approach line AA or BB with the engine off and transmission in neutral position with its center following as closely as possible the “centerline of travel” in Fig. 1.

A.1.7 Measuring speed range

The test vehicle speed at the time when it is at a position perpendicular to the microphones, shall be in the range:

• 70-90 km/h for tyre classes C1 and C2;
A.1.8 Sound pressure level readings to be taken

The maximum sound pressure level indicated for both microphones during each passage of the test vehicle between the two lines AA and BB shall be recorded.

The measurement shall be invalid if an abnormal discrepancy between the peak value and the general sound level is recorded, and provided such a peak is not repeatable if more measurements are made at the same speed.

Note: Some tyres may give peaks ("resonances") at certain speeds.

A.1.9 Number of measurements

For each microphone location (each side), there shall be at least four measurements at a test speed higher than reference speed (see A2.2), and at least four measurements at a test speed lower than the reference speed. The speeds shall be approximately equally spaced over the speed range specified in A1.7.

A.1.10 Frequency spectrum measurement (optional)

It is recommended, but not mandatory, to measure third-octave band frequency spectra. The averaging time should correspond to “F”. The spectrum should be captured when the A-weighted sound level during a vehicle pass-by is at its maximum.

A.2 Data processing

A.2.1 *Temperature correction

A.2.2 Reference speeds

For the purpose of normalization of sound with respect to speed, the following reference speeds shall be used:

- For tyres of class C1 and C2, the reference speed = \( V_{\text{ref}} \) shall be 80 km/h.
- For tyres of class C3, the reference speed = \( V_{\text{ref}} \) shall be 70 km/h.

*Pending Results from TC 43, Subcommittee 1, Working Group 27

A.2.3 Normalization with respect to speed

With each valid pair of measured values (test speed \( V_i \), temperature corrected sound level \( L_i \)), the determination of the test result for the reported tyre/road sound level \( L_R \) shall be obtained by a regression analysis according to the following:

\[
L_R = \bar{L} - a\bar{V}
\]

where \( \bar{L} \) is the arithmetic mean value of corrected sound levels in dB:
\[
\bar{L} = \frac{1}{n} \sum L_i
\]

\(n\) = number of corrected sound levels (\(n \geq 16\)), using the results for both microphones in the same regression analysis.

\(\bar{v}\) is the arithmetic mean value of logarithm of speeds: 
\[
\bar{v} = \frac{1}{n} \sum v_i
\]

where:
\[
v_i = \log \left( \frac{V_{ref}}{V_i} \right)
\]

\(a\) is the slope of the regression line in dB/speed decade:
\[
a = \frac{\sum_{i=1}^{n} (v_i - \bar{v})(L_i - \bar{L})}{\sum_{i=1}^{n} (v_i - \bar{v})^2}
\]

This gives the reported tyre/road sound level, \(L_R\). Then, optionally, the level \(L_v\) at any other speed \(V\) (within the speed range) can be determined as:
\[
L_v = L_R + a \log \left( \frac{V}{V_{ref}} \right)
\]

**A.3 Test report**

The test report shall include the following information:

1. Reference to this International Standard;

2. Meteorological conditions: This shall include the ambient air and surface temperature for each run;

3. When and how compliance of the test surface with ISO 10844 was checked;

4. Test rim width;

5. Tyre data: manufacturer, brand name, trade name, size, load index or load capacity, speed symbol, reference pressure, and serial number of the tyre;

6. Test vehicle type and make, vehicle year model and information about any modifications to the vehicle related to sound;

7. Tyre load in kg and in percentage of the load index for each test tyre;

8. Cold inflation pressure in kPa for each test tyre;

9. Test speeds when the vehicle passed the microphones;

10. Maximum “A”-weighted sound levels for each coast-by and each microphone;

11. Maximum “A”-weighted sound level in decibel, normalised to the reference speed and corrected for temperature shall be expressed to at least one decimal place.

Examples of a test report form and a background data form, designed for use with either the motor vehicle or trailer methods, are included in Annex A - Appendix on the following two pages. Also included is a test results form, Table 1A, specifically for motor vehicle results.
Appendix A

Example of test report:
Coast-by testing of tyres with respect to sound emission, in accordance with ISO WD 13325-EU

<table>
<thead>
<tr>
<th>Number of Test Report: __________________________</th>
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<tbody>
<tr>
<td>Tyre make (trade name, brand name, manufacturer):</td>
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<tr>
<td>Manufacturer tyre range trade description(s):</td>
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<tr>
<td>Address(es) of tire manufacturing plant(s):</td>
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<tr>
<td>Size of tyre: ________________________</td>
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<td>Tyre load index (LI) and Speed Symbol:</td>
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<tr>
<td>Class of tyre:</td>
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<tr>
<td>Passenger car (C1)</td>
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<td>Commercial vehicle, load index &gt; 121 (C3)</td>
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<tr>
<td>Category of use: __________________________________________</td>
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<td>Enclosures to this report: ____________________________________</td>
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<td>80 km/h</td>
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<tr>
<td>Reported A-weighted sound level: ______________dB at reference speed of: 70 km/h</td>
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<tr>
<td>Comments (if any): ________________________________________</td>
</tr>
<tr>
<td>Technical Service responsible for carrying out the tests: __________________________</td>
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<tr>
<td>Name and address of applicant: ________________________________________</td>
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<tr>
<td>Date of Test Report: __________________________ Signature: ____________________</td>
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</table>
Information regarding the tyre/road sound tests

Background data:

This form belongs to Test report No.: _______________ Date of sound testing: _______________

Test vehicle/trailer (type, make, year model, modifications, draw bar length): __________________________

____________________________________________________________________________________

Location of test track: ____________________ Date of track certification: _______________________

Test track certification available at: ________________________________________________________

____________________________________________________________________________________

Tyre test load in kg, front left: ___________ front right: ___________ rear left: ___________ rear right: ___________

Same, in % of LI, front left: ___________ front right: ___________ rear left: ___________ rear right: ___________

Tyre inflation in kPa, front left: ___________ front right: ___________ rear left: ___________ rear right: ___________

Test rim width: ____________________________

Temperature measuring sensor type: ________________________________________________________

Motor vehicle test results:

<table>
<thead>
<tr>
<th>Run Number</th>
<th>Speed [km/h]</th>
<th>Running direction</th>
<th>Sound Level left side [dB] (not temp corrected)</th>
<th>Sound level right side [dB] (not temp. corrected)</th>
<th>Air temperature [°C]</th>
<th>Road Temperature [°C]</th>
<th>Sound Level left side [dB] (corrected)</th>
<th>Sound level right side [dB] (corrected)</th>
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Note: Reported “A”-weighted sound level to be calculated at the reference speed utilizing regression analysis, after temperature corrections and rounded to the nearest tenth of a dB

Reported “A”-weighted sound level: dB

_______________
Annex B  
(informative)

Trailer method

B.1 Tow vehicle and trailer

The test apparatus shall consist of two parts.

B.1.1 Tow vehicle sound level

B.1.1.1 Tow vehicle sound level

The rolling sound of the tow vehicle can be minimized by appropriate measures (low-noise tyres, shielding, aerodynamic skirting, etc.). In the ideal case the tow vehicle alone sound level is 10 dB or more below the level for the combination of the tow vehicle and the trailer. For such cases, multiple measurements with tow vehicle alone are not necessary. Since subtraction of the towed vehicle is not required, improved measurement accuracy is possible. The required level differences and the derived tyre sound levels are described in Section B4 Determination of Tyre Sound Levels.

B.1.1.2 Tow vehicle loading

There shall be no load change on the tow vehicle tyres between the test pass of the tow vehicle trailer combination and the tow vehicle alone. To achieve consistent loading, it may be necessary to add ballast to the tow vehicle during tow vehicle alone tests.

B.1.2 Trailer

B.1.2.1 Single-axle frame trailer

The trailer shall be a single-axle frame trailer with drawbar and facility for varying wheel load. Superstructures or paneling are to be avoided in order to minimize vehicle-specific influences. Tyres shall be exposed with no tyre housing or covers.

B.1.2.2 Drawbar length

The draw bar length for the trailer shall be at least 5 meters in length when measured from the center of the tow vehicle axles to the trailer axle.

B.1.2.3 Track width

The horizontal distance perpendicular to the direction of travel shall be less than 2,5 m. This distance shall be measured between the centers of the contact patch of each trailer tyre.

B.1.2.4 Alignment

Alignment settings (camber and toe-in) of all test tyres shall be zero at test conditions. The tolerance for camber shall be ± 30’ and the tolerance for toe angle shall be ± 5’.
B.2 Tyre load and pressure

For tyres of all classes, the test load shall be 75% ± 2% of the reference load $Q_r$.

Each tyre shall be inflated to a cold inflation pressure $P + 10\% - 0\%$

Where:

\[ P_t = P_r \left( \frac{Q_t}{Q_r} \right)^{1.25} \]

$P_t$ = Test inflation pressure

$P_r$ = Reference pressure

- 250 kPa for standard tyres class C1
- 300 kPa for reinforced tyres class C1
- Pressure corresponding to the pressure index marked on the sidewall for tyre classes C2 and C3.

$Q_r$ = Reference load corresponding to the maximum mass associated with the load index of the tyre.

$Q_t$ = Test load for that tyre.

B.3 Measurement procedure

The towed trailer test procedure is described below. To perform this test, two sets of measurements must be made. The tow vehicle alone must be tested first and the measured sound levels recorded according to the procedures described below. Next, the tow vehicle-trailer combination must be tested and the resulting levels recorded. The derivation of the tyre sound levels is described in Section 4. Determination of Tyre Sound Levels.

B.3.1 Vehicle position

The tow vehicle or tow vehicle and trailer combination shall approach the line EE with the engine off, the transmission in neutral, and the clutch disengaged, with the path of the vehicle centerline following as closely as possible the centerline of travel as indicated on Figure 1.

B.3.2 Test speed

The tow vehicle shall be used to attain sufficient speed prior to entering the test zone (EE or FF, see Fig. 1), such that, when the tow vehicle engine is switched off and the vehicle and trailer are coasting into the test zone, the average vehicle speed, between AA and BB, shall be 80 km/h ± 1.0 km/h for class C1 and C2 tyres, and shall be 70 km/h ± 1.0 km/h for class C3 tyres.

B.3.3 Readings to be taken

B.3.3.1 Sound measurement

The maximum sound pressure level indicated by microphones during the entire period the test tyres are in the test zone, between lines AA and BB of Figure 2, shall be recorded. In addition, the sound level will be recorded for each microphone with an integration time equivalent to “F”...
time weighting at time intervals of no more than 0.01 seconds during the pass through the measurement section. This later data set will be known as the time history sound levels in the subsequent discussion.

The time history measurement begins with the definition of lines $A'A'$ and $B'B'$ as shown in Figure 2. These lines are defined as using the length $d_t$, the distance from the center of the test tire to the trigger point on the tow vehicle, see Figure 2. The trigger point is the point on the vehicle which will cause a mark on the time record when it passes lines $A'A'$ and $B'B'$. Sound recording begins and ends at these times, respectively. The same recording procedure is used for passes of the tow vehicle-trailer combination and for the tow vehicle alone.

![Figure 2 - Measurement Layout for Time History Calculation (dimensions are in meters).](image)

**B.3.3.2 Additional Measurements**

The following data shall also be recorded during each pass:

a) Ambient air temperature;
b) Road surface temperature;
c) Whether wind velocity was below 5 m/s, Yes/No?
d) Background sound level at least 10 dB below measured level, Yes/No?
e) Average speed of tow vehicle between $A'A'$ and $B'B'$.

**B.3.4 Sound pressure level averages**

The observer shall record the time history of the overall A-weighted sound pressure levels and the highest level attained during each pass for each microphone position. Measurement shall continue until five maximum sound levels are within $\pm 0.5$ dB of their arithmetic average without temperature correction and are recorded for each speed, and microphone position. Employing the procedure described in Section 7.2 of the main body of this standard, these average maximum levels and the average time history levels must be temperature corrected. The temperature corrected values obtained for all microphones will be averaged to determine a microphone averaged sound level and time history. Next, the arithmetic average of the two microphone averaged levels for the tow vehicle alone and the tire-vehicle trailer combination shall be calculated and denoted the pass average sound level. This same averaging procedure shall be conducted for the time history of sound level. This will yield an averaged sound level time history to be used in subsequent calculations described below. These will be designated as shown below:

*Changes will be made pending the results from ongoing work by ISO/TC 43/ SC 1/WG 27.*
\[ \bar{L}_T \] = average of the maximum sound levels of the tow vehicle without trailer;

\[ L_T(t) \] = average time history sound level of the tow vehicle without trailer;

\[ \bar{L}_{tp} \] = average of the maximum sound levels of the test pass (tow vehicle - trailer combination n);

\[ L_{tp}(t) \] = average time history sound level of the test pass (tow vehicle - trailer combination n).

**B.3.5 Alignment of the time history records**

When the tow vehicle crosses line O’O’ an indicator pulse must be recorded with the sound level time history records. This indicator pulse will be used to ensure proper alignment of signals in time for the necessary averaging and subtraction.

**B.3.6 Test conduct**

The step-by-step procedure for conducting the trailer test method is described below.

**B.3.6.1 Preparation**

a. Set the timing trigger point on the tow vehicle.

b. Measure the length \( d_t \), the horizontal distance from the center of the test tire to the trigger point on the tow vehicle, see Figure 2.

c. Determine the location of lines E’E’, A’A’, O’O’, B’B’, and F’F’ on the test section as shown in Figure 2. Set the trigger devices so that sound level recording shall begin at line E’E’ and stop at F’F’.

d. The average speed between AA and BB shall be 80 km/h ±1.0 km/h for tyre classifications C1 and C2. The average speed shall be 70 km/h ±1.0 km/h for tyre classification C3. Speed is measured in the section AA to BB for the test tyre which is equivalent to the section A’A’ to B’B’ for the timing indicator on the tow vehicle.

e. Set the data recorder so that the time history is always recorded from E’E’ to F’F’ for the solo and combination tests. Set the trigger alignment of time history records as described in section B3.5 to match the line O’O’.

f. Check the measuring devices for air temperature and wind.

**B.3.6.2 Solo test (tow vehicle alone) of at least five passes**

a. The observer shall record the maximum “A”-weighted sound pressure level and the sound level time history attained during each pass for each microphone position. This measurement procedure shall continue until five maximum sound levels are within ±0.5 dB of their arithmetic average and are recorded for each microphone position.
b. Apply the temperature correction to the 5 time histories with maximum levels within ±0,5 dB of the mean.

c. Determine the average sound pressure level time history for the five time histories obtained above.

d. This tow vehicle test, with 5 runs within ±0,5 dB of the mean, shall be run at the beginning and end of each series of tests. Tow vehicle test shall also be made when there is a 5° C change in air temperature during a test series.

B.3.6.3 Combination (tow vehicle and trailer) test of at least five runs

a. The observer shall record the maximum “A”-weighted sound pressure level and the sound level time history attained during each pass for each microphone position. This measurement procedure shall continue until five maximum sound levels are within ±0,5 dB of their arithmetic average and are recorded for each microphone position.

b. Apply the temperature correction to the 5 time histories with maximum levels within ±0,5 dB of the mean.

c. Determine the average sound pressure level time history for the five time histories obtained above.

d. Tables 1B and 2B in Annex B - Appendix summarize the calculations described in this section.

B.4 Determination of tyre sound levels

B.4.1 Consideration of tow vehicle influence

Before the coast-by tyre sound level can be calculated, tests must be done to ensure a valid computation is possible. There must be sufficient difference between the levels measured for the tow vehicle alone and the tow vehicle-trailer combination for an accurate computation of the tyre sound level. This difference can be checked in two ways.

B.4.1.1 Maximum sound level difference 10 dB

If the average of the maximum sound pressure levels for the tow vehicle alone is 10 dB or more below the average level for the tow vehicle and trailer combination for both microphones, then a valid measurement has been made. This assumes all other restrictions on environmental conditions, background sound, etc. have been met. In this special case, the tyre sound level is the averaged maximum level measured for the tow vehicle and trailer combination. This is shown in the equation below:

\[ L_{\text{tyre}} = \bar{L}_{\text{Tp}} \]

\( L_{\text{tyre}} \) = sound level of the subject tyre (this is the level reported).
B.4.1.2 Maximum sound level difference < 10 dB

If the average maximum sound pressure level for the tow vehicle alone is less than 10 dB below the level for the tow vehicle and trailer combination for either or both microphones, then a further calculation is required. This calculation uses the averaged time history sound levels corrected.

B.4.2 Time history sound level computation

The subject tyres' sound levels reported are the differences between the averaged sound pressure level of the tow vehicle-trailer combination and the averaged sound pressure level of the tow vehicle alone. To compute this difference, the temperature corrected averaged sound level time history for the tow vehicle must be subtracted from that for the tow vehicle and trailer combination. The averaged sound levels are calculated from the data obtained for the five runs in which the maximum sound levels are within ±0.5 dB of the mean of the maximum levels, as described above. An example of time history sound levels is shown in Figure 3.

Figure 3 - Time history data for trailer coast-by measurement

After the alignment of the time histories with respect to O'O', a key parameter in the analysis is the difference between the maximum average time history level for the combination (trailer and tow vehicle) and the tow vehicle alone average time history level at the same point. This difference is highlighted in Figure 3.

If this difference is equal to or greater than 10 dB, the levels measured for the tow vehicle and trailer combination are the correct values for the tyre under test. If this difference is less than 10 dB, then the tyre sound level is calculated by the logarithmic subtraction of the combined and the tow vehicle levels as shown below. This logarithmic subtraction is performed using the average time history levels noted above and shown in Figure 3.

* Changes will be made pending the results from ongoing work by ISO/TC 43/SC 1/WG 27.
The reported tyre sound level is the result from the above equation. Where:

\[ L_{\text{tyre}} = 10 \log_{10} \left[ 10^{\frac{L_{Tp}}{10}} - 10^{\frac{L_T}{10}} \right] \]

The reported tyre sound level is the result from the above equation. Where:

\[ L_{Tp} = \text{maximum sound level of the test pass (tow vehicle-trailer combination)}; \]
\[ L_T = \text{sound level of the tow vehicle without trailer obtained at the same tow vehicle location as } L_{Tp} \]

**B.4.3 Sound level determination procedure**

The step-by-step procedure for conducting the sound level determination is described below.

a. If the average of the maximum sound levels for the tow vehicle and trailer combination for the left and right microphones is greater than the equivalent level for the solo tow vehicle by more than 10 dB, the combination sound level is equal to the tyre sound level and steps “b” through “d” are not required. This calculation is illustrated in Table 3 of Appendix 1. If this difference is less than 10 dB, proceed with steps “b” through “d”.

b. Align the appropriate solo and combination averaged sound level time histories and determine the arithmetic difference in level for each increment in time. Record the sound level difference at the point of the maximum level for the combination. This procedure shall be repeated for each set of measurement passes.

c. If the difference recorded in step “b” is greater than 10 dB, the combination sound levels are equal to the tyre sound levels.

d. If the difference computed in step “b” is less than 10 dB and greater than 3 dB, determine the logarithmic difference between the maximum averaged time history sound level for the tow vehicle and trailer combination and the averaged time history sound level for the tow vehicle alone.

e. If the difference computed in step “b” is less than 3 dB the measurement is invalid. The tow vehicle sound level must be decreased until this level difference is greater than 3 dB for a valid tyre sound level to be computed.

f. Tables 3, 4, and 5 in the Annex B - Appendix summarize the calculations described in this section with a numerical example.

**B.5 Test report**

The test report shall include the following information:

a. Reference to this International Standard;

b. Meteorological conditions. This shall include the ambient and surface temperature for each run;
c. When and how compliance of the test surface with ISO 10844 was checked;

d. Test rim width;

e. Tyre data: manufacturer, brand name, trade name, size, load index or load capacity, speed symbol, reference pressure, and serial number of the tyre;

f. Description of test apparatus - specific items to be reported include the drawbar length and suspension alignment at test loads;

g. Tyre load in kg and in percentage of the load index for each test tyre;

h. Cold inflation pressure in kPa for each test tyre;

i. Test speeds when the vehicle passed the microphones;

j. Maximum sound levels for each coast-by and each microphone;

k. Maximum sound level in decibel, normalized to the reference speed and corrected for temperature shall be expressed to at least one decimal place.

Examples of a test report form and a background data form, designed for use with either motor vehicle or trailer methods, are included in Annex B - Appendix on the following pages. Also included is a series of Example Results Tables (Tables 1B, 2B, 3B, 4B, and 5B) designed specifically for reporting trailer results.
## Appendix B

### Example of test report:

<table>
<thead>
<tr>
<th>Coast-by testing of tyres with respect to sound emission in accordance with ISO WD 13325-EU</th>
</tr>
</thead>
</table>
| **Number of Test Report:** ___________________
| **Tyre make (trade name, brand name, manufacturer):** ________________________________
| **Manufacturer tyre range trade description(s):** ________________________________
| **Address(es) of tire manufacturing plant(s):** _______________________________________
| _______________________________________________________________________________
| **Size of tyre:** ________________________ **Tyre serial Number:** _______________________
| **Tyre load index (LI) and Speed Symbol:** ____________________ **Ref. Pressure:** __________
| **Class of tyre:**
| Passenger car (C1)
| Commercial vehicle, load index ≤ 121 (C2)
| Commercial vehicle, load index > 121 (C3)
| **Category of use:** _______________________________________________________________
| **Enclosures to this report:** _______________________________________________________
| _______________________________________________________________________________
| **Reported A-weighted sound level:** ____________dB at reference speed of: 80 km/h
| **Comments (if any):** _____________________________________________________________
| _______________________________________________________________________________
| **Technical Service responsible for carrying out the tests:** ____________________________
| **Name and address of applicant:** ________________________________________________
| _______________________________________________________________________________
| **Date of Test Report:** ________________________ **Signature:** _________________________
# Information regarding the tyre/road sound tests

## background data:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>This form belongs to Test report No.:</td>
<td>Date of sound testing:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test vehicle/trailer (type, make, year model, modifications, draw bar length):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of test track:</td>
<td>Date of track certification:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test track certification available at:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tyre test load in kg, front left:</td>
<td>front right:</td>
<td>rear left:</td>
<td>rear right:</td>
<td></td>
</tr>
<tr>
<td>Same, in % of LI, front left:</td>
<td>front right:</td>
<td>rear left:</td>
<td>rear right:</td>
<td></td>
</tr>
<tr>
<td>Tyre inflation in kPa, front left:</td>
<td>front right:</td>
<td>rear left:</td>
<td>rear right:</td>
<td></td>
</tr>
<tr>
<td>Test rim width:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature measuring sensor type:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example results tables

Table 1B - tow vehicle test record

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Speed (km/h)</th>
<th>Air temp. (°C)</th>
<th>Max. sound level left side (dB(A))</th>
<th>Max. sound level right side (dB(A))</th>
<th>Temp. Corrected*</th>
<th>Included in Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max. sound level left side (dB(A))</td>
<td>Max. sound level right side (dB(A))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>70.1</td>
<td>25</td>
<td>69.7</td>
<td>70.1</td>
<td>70.0</td>
<td>70.4</td>
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<tr>
<td>2</td>
<td>69.6</td>
<td>25</td>
<td>69.6</td>
<td>69.9</td>
<td>69.9</td>
<td>70.2</td>
</tr>
<tr>
<td>3</td>
<td>69.2</td>
<td>26</td>
<td>69.2</td>
<td>69.9</td>
<td>69.6</td>
<td>70.3</td>
</tr>
<tr>
<td>4</td>
<td>70.2</td>
<td>26</td>
<td>69.7</td>
<td>70.4</td>
<td>70.1</td>
<td>70.8</td>
</tr>
<tr>
<td>5</td>
<td>70.6</td>
<td>26</td>
<td>70.1</td>
<td>70.7</td>
<td>70.5</td>
<td>71.1</td>
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<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>26</td>
<td>69.7</td>
<td>70.2</td>
<td>70.0</td>
<td>70.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 2B - combination (tow vehicle and trailer) test record

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Speed (km/h)</th>
<th>Air temp. (°C)</th>
<th>Max. sound level left side (dB(A))</th>
<th>Max. sound level right side (dB(A))</th>
<th>Temp. Corrected*</th>
<th>Included in Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max. sound level left side (dB(A))</td>
<td>Max. sound level right side (dB(A))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>70.6</td>
<td>23</td>
<td>72.9</td>
<td>73.8</td>
<td>73.1</td>
<td>74.0</td>
</tr>
<tr>
<td>2</td>
<td>70.3</td>
<td>23</td>
<td>73.1</td>
<td>73.8</td>
<td>73.3</td>
<td>74.0</td>
</tr>
<tr>
<td>3</td>
<td>69.2</td>
<td>23</td>
<td>72.5</td>
<td>73.1</td>
<td>72.7</td>
<td>73.3</td>
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<tr>
<td>4</td>
<td>70.1</td>
<td>23</td>
<td>72.0</td>
<td>73.5</td>
<td>72.2</td>
<td>73.7</td>
</tr>
<tr>
<td>5</td>
<td>69.5</td>
<td>24</td>
<td>72.7</td>
<td>73.4</td>
<td>72.9</td>
<td>73.6</td>
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<td>6</td>
<td>70.1</td>
<td>24</td>
<td>73.0</td>
<td>73.6</td>
<td>73.2</td>
<td>73.8</td>
</tr>
<tr>
<td>7</td>
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<td>8</td>
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<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>72.8</td>
<td>73.5</td>
<td>73.0</td>
<td>73.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3B - Check for measurement validity

<table>
<thead>
<tr>
<th></th>
<th>Avg. of max. sound level for tow vehicle (dB(A))</th>
<th>Avg. of max. Sound level for combination (dB(A))</th>
<th>Arithmetic difference in level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Microphone</td>
<td>70.0</td>
<td>73.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Right Microphone</td>
<td>70.6</td>
<td>73.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Average</td>
<td>70.3</td>
<td>73.3</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* Changes will be made pending the results from ongoing work by ISO/TC 43/ SC 1/WG 27.
### Table 4B - check for time history calculation

<table>
<thead>
<tr>
<th></th>
<th>Max. averaged time history sound level for combination (dB(A))</th>
<th>Avg. time history sound level for tow vehicle at same point relative to O’O’ (dB(A))</th>
<th>Arithmetic Difference in level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left microphone</td>
<td>73.0</td>
<td>66.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Right microphone</td>
<td>73.7</td>
<td>66.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Average</td>
<td>73.3</td>
<td>66.2</td>
<td>7.2</td>
</tr>
</tbody>
</table>

### Table 5B - sound level difference and tyre level calculation

<table>
<thead>
<tr>
<th></th>
<th>Max. averaged time history sound level for combination (dB(A))</th>
<th>Avg. time history sound level for tow vehicle at same point relative to O’O’ (dB(A))</th>
<th>Logarithmic Difference in level (dB) (see Eq. 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left microphone</td>
<td>73.0</td>
<td>66.0</td>
<td>72.0</td>
</tr>
<tr>
<td>Right microphone</td>
<td>73.7</td>
<td>66.4</td>
<td>72.8</td>
</tr>
<tr>
<td>Average</td>
<td>73.3</td>
<td>66.2</td>
<td>72.4</td>
</tr>
<tr>
<td>Tyre sound level</td>
<td></td>
<td></td>
<td>72.8</td>
</tr>
</tbody>
</table>

.../...