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**Acoustics — Measurement of airborne  
sound emitted by vessels on inland  
waterways and harbours**

*Acoustique — Mesurage du bruit aérien émis par les bateaux de  
navigation intérieure et portuaire*

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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 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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

This third edition cancels and replaces the second edition (ISO 2922:2000), which has been technically revised. It also incorporates the amendment ISO 2922:2000/Amd 1:2013.

The main changes compared to the previous edition are as follows:

- clarification in the Scope that the document is applicable to vessels of all speeds and lengths;
- specification of: sound pressure level measurement response (slow), in [4.1](#); integration time for background noise (5 min), in [6.4](#); and the surf/weather limitation (sea state 1), in [6.3.2](#), during the survey period;
- addition of a formula to compute the sound pressure level at 25 m in [10.1.4](#).

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](http://www.iso.org/members.html).

# Acoustics — Measurement of airborne sound emitted by vessels on inland waterways and harbours

## 1 Scope

This document specifies the conditions for obtaining reproducible and comparable measurement results of the airborne sound emitted by vessels of all kinds, on inland waterways and in ports and harbours, except powered recreational craft as specified in the ISO 14509 series. This document is applicable to sea-going vessels, harbour vessels, dredgers, and all watercraft, including non-displacement craft, used or capable of being used as a means of transport on water. There are no limitations to the application of this document with regard to speed, length and height of vessels, as long as the ship is determined to act like a point source at the reference distance of 25 m.

All noise data obtained in accordance with this document are referred to a reference distance of 25 m.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1996-2:2017, *Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of sound pressure levels*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

IEC 60942:2017, *Electroacoustics — Sound calibrators*

IEC 61183, *Electroacoustics — Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260-1, *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications*

IEC 61260-3, *Electroacoustics — Octave-band and fractional-octave-band-filters — Part 3: Periodic tests*

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

IEC 61672-3, *Electroacoustics — Sound level meters — Part 3: Periodic tests*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### acceptance test for vessels

##### acceptance test

measurement performed to prove that the sound emitted by the vessel, stationary or in motion, as delivered by the manufacturer, complies with noise specifications or specified limits

**3.2  
monitoring test for vessels  
monitoring test**

measurement performed to check that the sound emitted by the vessel, stationary or in motion, is still within specified limits and that no noticeable changes have occurred since the acceptance on initial delivery or after modification, as applicable

**3.3  
maximum AS-weighted sound pressure level for vessels  
maximum AS-weighted sound pressure level**

$L_{pASmax}$   
maximum sound pressure level achieved from measurement during the passage of the vessel under specified operating conditions, measured with frequency weighting A and with time weighting slow (S)

Note 1 to entry: Sound pressure level is expressed in decibels (dB).

Note 2 to entry: Other weightings such as C or unweighted can be needed.

**3.4  
A-weighted sound exposure**

$E_{A,T}$   
integral of the square of the sound pressure,  $p$ , over a stated time interval or event of duration  $T$  (starting at  $t_1$  and ending at  $t_2$ ), measured with frequency weighting A

$$E_{A,T} = \int_{t_1}^{t_2} p_A^2(t) dt$$

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Note 1 to entry: Sound exposure is expressed in pascal-squared seconds (Pa<sup>2</sup>·s).

[SOURCE: ISO/TR 25417:2007, 2.6, modified – Former Notes 2 to 4 deleted.]

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**3.5  
A-weighted sound exposure level**

$L_{E,A,T}$   
ten times the logarithm to the base 10 of the ratio of the A-weighted sound exposure,  $E_{A,T}$ , to a reference value,  $E_0$ , which is given by the product of the square of the reference sound pressure of  $p_0 = 20 \mu\text{Pa}$  and the sound exposure reference duration of  $T_0 = 1 \text{ s}$ , ( $E_0 = p_0^2 \times T_0 = 4 \times 10^{-10} \text{ Pa}^2 \text{ s}$ )

Note 1 to entry: Sound exposure level is expressed in decibels (dB).

Note 2 to entry: In symbols, the A-weighted sound exposure level,  $L_{E,A,T}$ , of a specified event (e.g. the passage of a vessel) with the duration  $T = t_2 - t_1$ , is related to a corresponding measurement of the time-averaged A-weighted sound pressure level,  $L_{pAeq,T}$ , by

$$L_{E,A,T} = 10 \lg \left\{ \frac{\int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2 T_0} \right\} \text{dB} = 10 \lg \left( \frac{E_{A,T}}{E_0} \right) \text{dB} = L_{pAeq,T} + 10 \lg \left( \frac{T}{T_0} \right) \text{dB}$$

where  $p_A^2(t)$  is the squared, instantaneous, A-weighted sound pressure as a function of running time  $t$ .

Note 3 to entry: The A-weighted sound exposure level  $L_{E,A,T}$  is arithmetically identical to the A-weighted single-event sound pressure level  $L_{pA,1s}$  (reference duration  $T_0 = 1 \text{ s}$ ) as, for example, defined in ISO 3744.

Note 4 to entry: The abbreviation "SEL" is sometimes used for the single-event sound pressure level,  $L_{p,1s}$ .

Note 5 to entry: In this document, the sound exposure level characterizes the emission of the source and not the noise impact on people exposed to the sound.

### 3.6

#### background noise for vessels background noise

noise from all sources other than the craft under test

EXAMPLE Noise from waves splashing on the measuring craft or the shore, other craft or equipment, and wind effects.

### 3.7

#### time-averaged sound pressure level

$L_{p,T}$   
equivalent continuous sound pressure level

$L_{p,eqT}$   
ten times the logarithm to the base 10 of the ratio of the time average of the square of the sound pressure,  $p$ , during a stated time interval of duration,  $T$  (starting at  $t_1$  and ending at  $t_2$ ), to the square of a reference value,  $p_0$ , expressed in decibels

$$L_{p,T} = L_{p,eqT} = 10 \lg \left\{ \frac{\frac{1}{T} \int_{t_1}^{t_2} p^2(t) dt}{p_0^2} \right\} \text{ dB}$$

where the reference value,  $p_0$ , is 20  $\mu\text{Pa}$

Note 1 to entry: Because of practical limitations of the measuring instruments,  $p^2$  is always understood to denote the square of a frequency-weighted and frequency-band-limited sound pressure. If a specific frequency weighting as specified in IEC 61672-1 and/or specific frequency bands are applied, this should be indicated by appropriate subscripts; e.g.  $L_{p,A,10s}$  denotes the A-weighted time averaged sound pressure level over 10 s.

[SOURCE: ISO/TR 25417:2007, 2.3]

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## 4 Measurement quantities

4.1 Frequency weighting A shall be used for all measurements. The time weighting shall be set to slow (S) for all measurements.

4.2 Care should be taken to avoid any influence on the result from unwanted sound signals, for example noise from the wind on the microphone of the measuring equipment, electrical interferences, or noise from extraneous sound sources not under consideration.

4.3 The quantities that shall be determined at all microphone positions in acceptance and monitoring tests are the A-weighted sound exposure level,  $L_{E,A,T}$ , received from the operation of the vessel, and the maximum AS-weighted sound pressure level,  $L_{pASmax}$ .

4.4 If, in addition to the sound exposure level, spectral analysis in acceptance tests or determination of some special acoustical characteristics of vessels is needed, the quantities that shall be measured are the unweighted or C-frequency weighted, octave-band or one-third-octave-band S-time weighted sound pressure levels, in decibels, at the time of maximum sound pressure, or the unweighted or C-frequency weighted, octave-band or one-third-octave-band sound exposure levels, in decibels (dB).

4.5 When measurements are made at some distance from the source, the levels observed can be considerably affected by the weather conditions. For example, the attenuation of sound due to air absorption is affected by the temperature and humidity of the air. In addition, the refraction of sound waves due to wind and temperature gradients affect the levels received at a particular position. It is recommended that measurements taken in extreme or atypical conditions be avoided. If possible, a value obtained under typical climatic conditions, and an indication of the range of values obtained under other climatic conditions, should be included in the test report.

4.6 For steady-state noise, as that from a stationary ship's engine, the quantity that shall be measured is the time-averaged A-weighted sound pressure level,  $L_{pAeq}$ .

## 5 Measuring equipment

### 5.1 Equipment specifications

The instruments for measuring sound pressure levels, including microphone(s) as well as cable(s), recording devices and other accessories, if used, shall meet the requirements for a class 1 instrument according to IEC 61672-1 for free field or random incidence application, as appropriate. Filters shall meet the requirements for a class 1 instrument according to IEC 61260-1.

A wind speed anemometer with a maximum permissible error of  $\pm 10\%$  shall be used.

An engine speed tachometer with a maximum permissible error of  $\pm 50$  r/min shall be used.

### 5.2 Windscreen

A suitable windscreen shall be used to reduce the influence of the wind on the reading. When it can be expected that the wind-induced signal will be within 10 dB of the average sound level induced by the vessel under investigation, windscreens shall be used which, together with the sound level meter, meet the requirements of a class 1 instrument according to IEC 61672-1.

### 5.3 Operational check/Calibration

At the beginning and at the end of every measurement session, the entire sound pressure level measuring system shall be checked at one or more frequencies by means of a sound calibrator meeting the requirements for a class 1 instrument according to IEC 60942. Without any further adjustment, the difference between the readings of two consecutive checks shall be less than or equal to 0,5 dB. If this value is exceeded, the results of measurements obtained after the previous satisfactory check shall be discarded.

In connection with each measurement session and at least at the beginning and the end of each measurement day, where possible, the impact of residual sound levels on measured results shall be checked to determine their potential impact on the measurement results.

### 5.4 Verification

Conformance of the sound pressure level measuring instrument, including the microphone, the filters and the sound calibrator, with the relevant requirements of IEC 61672-1, IEC 61260-1 and IEC 60942, respectively, shall be verified by the existence of a valid certificate of conformance from the manufacturer. Conformance testing in accordance with IEC 61672-3, IEC 61260-3 and ISO 60942:2017, Annex B, respectively, is required for verification. If applicable, random incidence response of the microphone shall be verified by a procedure from IEC 61183.

All conformance testing shall be conducted by a laboratory operating in accordance with ISO/IEC 17025 and meeting the maximum-permitted uncertainty defined in IEC 61672-1, IEC 61260-1 and IEC 60942 respectively.

It is recommended that the sound calibrator be calibrated at intervals not exceeding 1 year, that the conformance of the instrumentation system with the requirements of IEC 61672-1 be verified at intervals not exceeding 2 years, and that the conformance of analog filters with the requirements of IEC 61260-1 be verified at intervals not exceeding 2 years. National regulations can require otherwise.

NOTE Testing in accordance with IEC 61672-3 does not fully verify conformance with the requirements of IEC 61672-1, unless it has been pattern approved in accordance with IEC 61672-2.



## 6 Test site specifications and environmental conditions

### 6.1 Test conditions

Two classes of test conditions are considered, namely:

- moving vessels - when the vessel is under way, the requirements of [6.2.1](#), [6.3](#) and [6.4](#) shall apply;
- stationary vessels - when the vessel is alongside a wharf or at anchor, the requirements of [6.2.2](#), [6.3](#), [6.4](#) and [6.5](#) shall apply.

### 6.2 Test site specifications

#### 6.2.1 Moving vessels

Within 30 m around the vessel under test and the microphone, there shall be no large surfaces (e.g. retaining walls, building façades, rocks, bridges) from which sound can be reflected back to the microphone.

In the vicinity of the microphone, there shall be no obstacles which can disturb the sound field. Therefore, no person shall be between the microphone and the sound source, and any observers shall be in such a position that any influence on the meter reading is avoided.

The area between the vessel under test and the measurement microphone shall be open water, free from any sound absorbing or sound reflecting objects.

#### 6.2.2 Stationary vessels (standards.iteh.ai)

The surroundings of the microphone up to 30 m shall be free of large, sound-reflecting objects like barriers, hills, rocks, bridges or buildings.

### 6.3 Environmental conditions

**6.3.1** At wind velocities above 7 m/s, the sound propagation can be disturbed and measurements shall not be performed unless the user has a method for adjusting the measurements for high wind.

**6.3.2** Tests shall be avoided in conditions of rain or other precipitation, and/or when the wave heights are greater than 0,1 m (World Meteorological Organization (WMO) Sea State 1).

### 6.4 Background noise

#### 6.4.1 Acceptance tests

The maximum AS-weighted sound pressure level, the A-weighted sound exposure level and/or the time-averaged sound pressure level due to other noise sources (e.g. waves splashing on the measuring boat or ashore, other vessels, local industry or other machinery) and due to wind shall be at least 10 dB below the maximum AS-weighted sound pressure level, the A-weighted sound exposure level and/or the time-averaged sound pressure level of the sound of the vessel. The background noise shall be measured for a period of 5 min.

If the background noise is frequency-analysed, the difference shall be at least 10 dB in the required octave or one-third-octave bands.