INTERNATIONAL STANDARD

ISO 14509

First edition
2000-11-01

Small craft — Measurement of airborne sound emitted by powered recreational craft

Petits navires — Mesurage du bruit aérien émis par les navires de plaisance motorisés

Reference number
ISO 14509:2000(E)

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

Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14509 was prepared by Technical Committee ISO/TC 188, *Small craft*.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Small craft — Measurement of airborne sound emitted by powered recreational craft

1 Scope

This International Standard specifies the conditions for obtaining reproducible and comparable measurement results of the maximum sound pressure level of airborne sound generated during the passage of powered recreational craft of up to 24 m length of hull, including inboards, stern drives, personal watercraft (PWC) and outboard motors used in conjunction with a standard craft.

Annex A specifies the procedure to be followed if, in addition to the maximum sound pressure level, the determination of the sound exposure level is desired.

NOTE For craft other than those specified above, ISO 2922 is applicable for sound emission measurements.

The accuracy grade of the acoustical test procedures specified in this International Standard is engineering grade (grade 2) as defined in ISO 12001. See also clause 6.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8665, *Small craft — Marine propulsion engines and systems — Power measurements and declarations.*

ISO 10087, *Small craft — Hull identification — Coding system.*

ISO 12001, *Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code.*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*.[1)]

IEC 60942, *Electroacoustics — Sound calibrators.*

1) To be published. (Revision of IEC 60651 and IEC 60804)

3 Terms and definitions

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

3.1
type test for recreational craft
measurement performed to prove that the sound of the craft in motion, or of the outboard motor when using a standard craft, as delivered by the manufacturer, complies with sound specifications or prescribed limits

NOTE See also definition of "acceptance test" in ISO 2922.

3.2
monitoring test for reacreational craft
measurement performed in order to check that the sound of the craft in motion, or of the outboard motor when using any craft, is still within prescribed limits and that no noticeable changes have occurred since the acceptance on initial delivery or after modification, as applicable

NOTE 1 Subsequent type testing may also be required in the case of a significant change.

NOTE 2 See also definition of "monitoring test" in ISO 2922.

3.3
maximum AS-weighted sound pressure level for recreational craft
maximum AS-weighted sound pressure level
$L_{p\mathrm{ASmax}}$
maximum sound pressure level achieved from measurement of the passage of the craft under specified operating conditions measured with frequency weighting A and with time weighting S (slow) according to IEC 61672-1

NOTE It is expressed in decibels (dB).

3.4
A-weighted sound exposure
E_{A}
time integral of squared, instantaneous, A-weighted sound pressure over a stated time interval or event

NOTE 1 It is expressed in pascal squared seconds ($\mathrm{Pa}^2\cdot\mathrm{s}$).

NOTE 2 In symbols, the A-weighted sound exposure, E_{A}, of a specified event (e.g. the passage of a craft), is represented by

$$E_{\mathrm{A}} = \int_{t_1}^{t_2} p_{\mathrm{A}}^2(t)\,\mathrm{d}t \qquad (1)$$

where $p_{\mathrm{A}}^2(t)$ is the squared, instantaneous, A-weighted sound pressure as a function of running time t for an integration time starting at t_1 and ending at t_2 (see A.7.2).

NOTE 3 This definition applies only for the optional measurement of sound exposure level according to annex A.

3.5
A-weighted sound exposure level
$L_{\mathrm{A}E}$
ten times the logarithm to the base 10 of the ratio of an A-weighted sound exposure, E_{A}, to the reference sound exposure, E_0, given by the product of the square of the reference sound pressure of $p_0 = 20$ μPa and the sound exposure reference duration of $T_0 = 1$ s ($E_0 = p_0^2\,T_0 = 4 \times 10^{-10}$ $\mathrm{Pa}^2\cdot\mathrm{s}$)

NOTE 1 It is expressed in decibels (dB).

NOTE 2 In symbols, the A-weighted sound exposure level, L_{AE}, of a specified event [e.g. the passage of a vessel (see A.7.2)] with the duration $T = t_2 - t_1$, is related to a corresponding measurement of time-averaged A-weighted sound pressure level, $L_{pAeq,T}$ by

$$L_{AE} = 10 \lg \left\{ \frac{\left[\int_{t_1}^{t_2} p_A^2(t)\,\mathrm{d}t \right]}{p_0^2 T_0} \right\} \mathrm{dB} = 10 \lg \left(\frac{E_A}{E_0} \right) \mathrm{dB} = L_{pAeq,T} + 10 \lg \left(\frac{T}{T_0} \right) \mathrm{dB} \quad (2)$$

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

NOTE 3 The A-weighted sound exposure level L_{AE} is arithmetically identical to the single-event sound pressure level $L_{p,1s}$ (reference duration T_0 = 1 s) as, for example, defined in ISO 3744.

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

NOTE 5 In this International Standard, the sound exposure level is to characterize the emission of the source and not the noise impact on people exposed to the sound.

NOTE 6 This definition applies only for the optional measurement of sound exposure level according to annex A.

3.6
background noise for recreational craft
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.

4 Symbols

The following symbols are used in this International Standard:

L'_{pASmax}	the maximum AS-weighted sound pressure level during the passage, expressed in decibels (dB);
L''_{pAS}	the AS-weighted background sound pressure level, expressed in decibels (dB);
L_{pASmax}	L'_{pASmax} after applying background noise correction according to 8.3 and distance correction according to 9.2, expressed in decibels (dB);
L'_{AE}	the A-weighted sound exposure level during the passage, expressed in decibels (dB);
L''_{AE}	the A-weighted background sound exposure level, expressed in decibels (dB);
L_{AE}	L'_{AE} after applying background noise correction according to A.5 and distance correction according to A.6, expressed in decibels (dB).

5 Measurement quantity

The quantity to be measured during the passage of the craft is the maximum AS-weighted sound pressure level, L'_{pASmax}.

From this quantity, the maximum AS-weighted sound pressure level L_{pASmax} is determined by applying the background noise correction and distance correction, if applicable.

6 Measurement uncertainty

Table 1 lists the likely sources of uncertainty and estimates of the standard devation associated with each, based on experience. These sources of uncertainty are considered to be independent for each measurement type. Therefore, the estimated total standard uncertainty is given by the square root of the sum of the squares of the individual standard deviations contained in Table 1.

Table 1 — Standard deviation of reproducibility

Individual sources of uncertainty	Individual standard deviations of the maximum AS-weighted sound pressure level, L_{ASmax} dB
Distance effects	0,25
Measuring equipment	1,0
Sound propagation conditions	1,5
Waves, currents and tides	1,5
Operator(s) effects	0,2
Test site variations	1,0
Operating conditions	0,5
Estimated total standard uncertainty	2,6

7 Measuring equipment

7.1 Equipment specifications

The instrumentation system, including microphones and cables (which shall be used according to the manufacturer's specifications), and including the windscreen recommended by the manufacturer and the overall electroacoustic performance of any additional measuring equipment, including for example a tape recorder and/or level recorder, shall meet the requirements for a type 1 instrument specified in IEC 61672-1.

NOTE Sound level meters with "maximum hold" capabilities are preferred.

When a tape recorder is used for the measurements, the dynamic range of the instrumentation shall be consistent with the measured signal.

A wind speed anemometer which is accurate to within ± 10 % shall be used.

An engine speed tachometer which is accurate to within ± 50 r/min shall be used.

7.2 Equipment calibration

A sound calibrator which meets the requirements of IEC 60942 shall be used.

The overall acoustic performance of the measurement equipment shall be checked with the sound calibrator according to the instructions of its manufacturer at the beginning and at the end of each series of measurements, and at least at the beginning and end of each measurement day.

At intervals of no longer than 2 years, the sound level meter shall undergo laboratory verification for compliance with IEC 60651. The date of the last verification of the compliance with IEC 61672-1 shall be recorded.

The sound calibrator used for calibration of the sound level meter shall undergo laboratory verification every year with traceability to a primary standards laboratory.

8 Test site specifications and environmental conditions

8.1 Test site specifications

Within 30 m around the craft 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 could 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 craft under test and the measurement microphone shall be open water, free from any sound absorbing or sound reflecting objects.

8.2 Environmental conditions

8.2.1 Planing craft

The measurements shall be performed under the following conditions:

— absence of precipitation;

— wind speed less than 5 m/s measured at the microphone height;

— calm water; i.e. wave height less than 100 mm.

8.2.2 Non-planing craft

The measurements shall be performed under the following conditions:

— absence of precipitation;

— wind speed less than 7 m/s measured at the microphone height;

— calm water; i.e. wave height less than 200 mm.

8.3 Background noise

8.3.1 General

A measurement shall be invalid if changes in the background noise affect the applicable reading.

8.3.2 Type tests

For type tests, the AS-weighted background sound pressure level, L''_{pAS}, shall be at least 10 dB below the maximum AS-weighted sound pressure level, L'_{pASmax}, obtained during the passage of the craft.

8.3.3 Monitoring tests

For monitoring tests, the AS-weighted background sound pressure level, L''_{pAS}, shall be at least 6 dB below the maximum AS-weighted sound pressure level, L'_{pASmax}, obtained during the passage of the craft. The reading shall then be corrected as shown in Table 2.

Table 2 — Correction for background sound pressure level, L''_{pAS}, for monitoring tests

Values in decibels

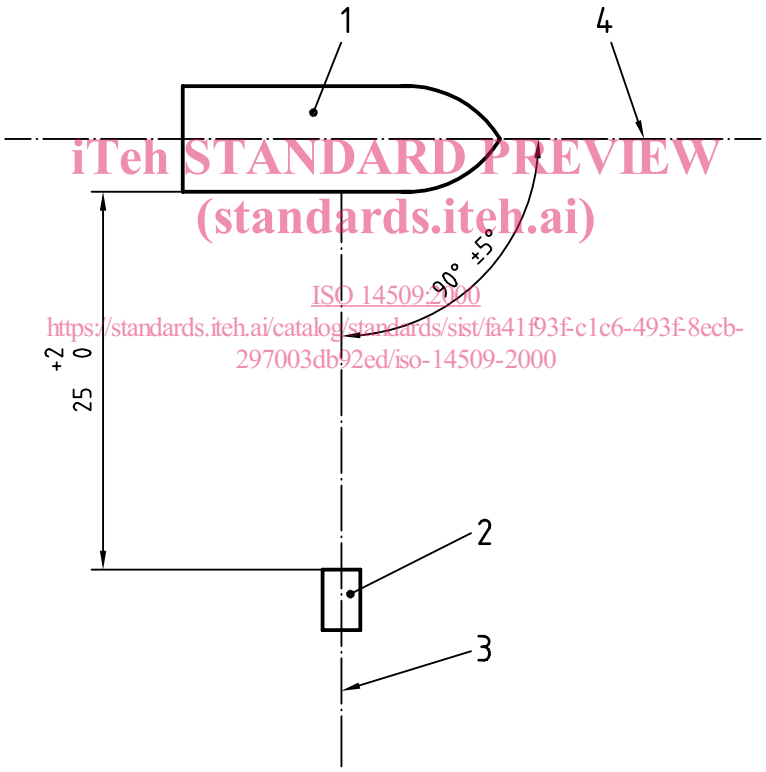
Increase in the indication of the AS-weighted sound pressure level obtained during the passage of the craft $\left(L'_{pASmax} - L''_{pAS}\right)$	Correction to be applied to the reading of the AS-weighted sound pressure level, L'_{pASmax}, obtained during the passage of the craft
$\geqslant$ 10	0
6 to 9	– 1

9 Test course, microphone positions and measurement distance

9.1 General

9.1.1 The test course to be followed shall be a straight line which is perpendicular within ± 5° to a line through the microphone axis (see Figure 1).

Dimensions in metres



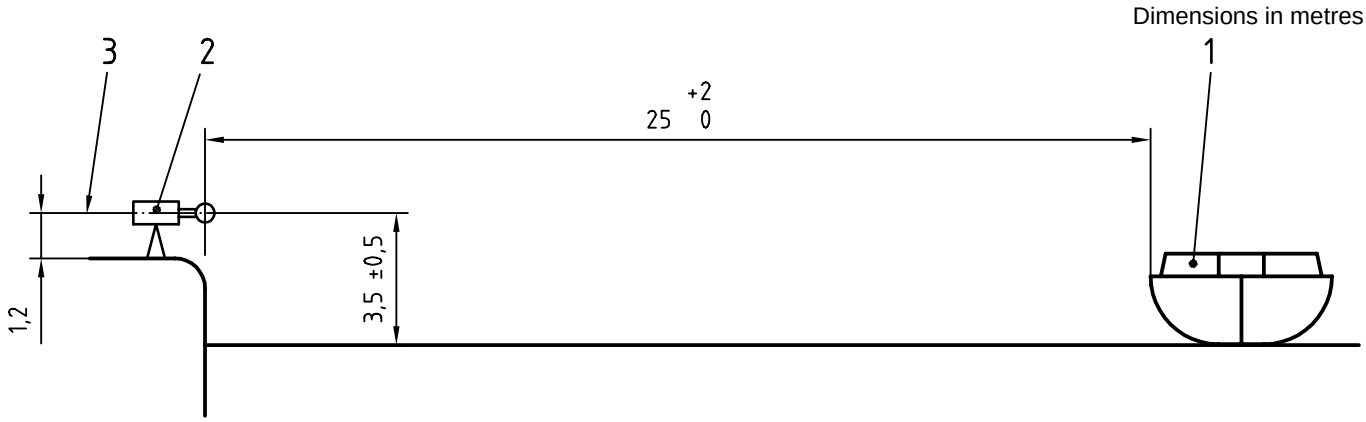
Key

1 Craft
2 Microphone
3 Microphone axis
4 Craft course line

Figure 1 — Position of the microphone and test course

9.1.2 The microphone shall be positioned at 3,5 m ± 0,5 m above the water surface and, if mounted on a solid surface, shall be positioned at least 1,2 m above that surface. The microphone shall be positioned within ± 0,5 m of the edge of the surface above which it is mounted.

Figure 2 shows the heights of the microphone position.



Key

1 Craft
2 Microphone
3 Microphone axis

Figure 2 — Microphone position and heights

9.1.3 The distance between the microphone and the side of the craft nearest to the microphone when passing it shall be 25^{+2}_{0} m.

The intended course line should be indicated with markers, if possible.

9.1.4 For craft less than 6 m in length, the microphone may be placed at a distance of $12{,}5^{+1}_{0}$ m from the test source when the background noise requirements according to 8.3 cannot be met when measuring at the distance of 25 m.

NOTE The reason is that it may be necessary to compensate for the low sound pressure levels by moving the microphone to a position which is closer to the craft without venturing into the acoustic near field.

9.2 Distance correction

If the distance between the microphone and the course line is set at 12,5 m, the measured maximum AS-weighted sound pressure level for each passage, $L'_{p\mathrm{ASmax}}$, shall be normalized to 25 m by subtracting 5 dB to obtain the 25 m value for $L_{p\mathrm{ASmax}}$.

NOTE The value of 5 dB has been found appropriate from the results of many tests under similar conditions (e.g. IMEC 17 F/01 and IMEC 17 F/02; see bibliography).

10 Operating conditions

Craft shall be operated with an equivalent two-person load and a minimum fuel load of 10 litres, except for craft intended for one person as well as all PWC which shall have an equivalent one-person load. An equivalent one-person load is defined as 75 kg ± 20 kg.

The engine of the craft shall be raised to operating temperature before the measurement starts. All the other operating conditions (fuel used, run-up time, etc.) shall comply with the manufacturer's instructions.

For type tests, craft with the power units installed inboard (e.g. inboards, stern drives, PWC and sailboats) shall be tested as sold.

For type tests, outboard motors shall be tested on standard craft as specified in clause 13.