INTERNATIONAL STANDARD

ISO 14509-2

First edition
2006-11-01

Small craft — Airborne sound emitted by powered recreational craft —

Part 2: Sound assessment using reference craft

Petits navires — Bruit aérien émis par les bateaux de plaisance motorisés —

Partie 2: Évaluation du bruit à l'aide de bateaux de référence

Reference number
ISO 14509-2:2006(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14509-2 was prepared by Technical Committee ISO/TC 188, *Small craft*.

ISO 14509 consists of the following parts, under the general title *Small craft — Airborne sound emitted by powered recreational craft*:

— *Part 1: Pass-by measurement procedures*

— *Part 2: Sound assessment using reference craft*

The following part is under preparation:

— *Part 3: Sound assessment using calculation and measurement procedures*

Introduction

The development of this part of ISO 14509 became necessary in order to provide an assessment procedure which would satisfy the needs of the European Union Directive 2003/44/EC (Amendment to Directive 94/25/EC). The reason for the inclusion of this type of assessment procedure in the Directive is to try to minimize the economic impact of the Directive on the boating industry, in particular small European boat builders, while still providing an environmental benefit to the community through lower sound levels.

Small craft — Airborne sound emitted by powered recreational craft —

Part 2:
Sound assessment using reference craft

1 Scope

This part of ISO 14509 specifies the procedures to assess the maximum sound emission of powered mono-hull recreational craft of up to 24 m length according to one of the two alternative methods defined in Annex A and Annex B.

This part of ISO 14509 is not applicable for the type testing of outboard motors and of stern drives with integral exhaust systems.

2 Normative references

The following referenced documents are indispensable for the application 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 8665, *Small craft — Marine propulsion reciprocating internal combustion engines — Power measurements and declarations*

ISO 8666:2002, *Small craft — Principal data*

ISO 14509-1:—[1)], *Small craft — Airborne sound emitted by powered recreational craft — Part 1: Pass-by measurement procedures*

IEC 60942, *Electroacoustics — Sound calibrators*

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

3 Terms and definitions

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

3.1
recreational craft
any craft, regardless of the means of propulsion, intended to be used for sports and leisure purposes

1) To be published.

3.2
stern drive with integral exhaust
any stern drive powered boat where the exhaust gases are expelled through the transmission or drive

3.3
bottom type configuration
construction type of the bottom of a craft

3.3.1
hard-chine bottom
bottom of a boat with an abrupt intersection between the hull side and the hull bottom

3.3.2
flat bottom
hard-chine bottom with a deadrise angle $\beta \leqslant 5°$ at the transom

3.3.3
round bottom
bottom of a boat with a round bilge hull form

3.3.4
multi-chine bottom
hard-chine bottom with more than one chine

3.4
performance test mass
m_P
mass of the craft that includes all permanently attached standard items of equipment and all items of loose equipment needed for the safe operation of the boat, and additionally the mass of the number of persons needed for the safe operation of the boat and the mass of the fuel (i.e. at least at 25 % but no more than 50 % of the tank capacity of permanently installed fuel tanks, or one portable tank per engine at least 50 % full at the beginning of each test trial), but excludes the mass of fresh water, waste water, provisions and other loose equipment

NOTE 1 This definition is in conformity with ISO 8666:2002, 6.4.

NOTE 2 Loose equipment needed for the safe operation of the boat includes warps, anchors/chain/ropes, working sails, engine(s) and batteries; other loose equipment includes cutlery, crockery, kitchen utensils and spare parts.

3.5
insertion loss
reduction of the exhaust-outlet sound power level due to the insertion of the vessel's silencing system in place of a substitution duct

NOTE Insertion loss is expressed spectrally in decibels and is dependent upon the source impedance of the engine.

3.6
substitution duct
duct with the same length as the vessel's silencing system and with as constant a cross-sectional area as possible, that is designed to be fitted in place of the vessel's silencing system

4 Symbols

The following symbols are used in this part of ISO 14509:

B_{WL} beam at the waterline, as defined in ISO 8666:2002, 5.3.4, expressed in metres (m);

F freeboard, as defined in ISO 8666:2002, 5.4.3, expressed in metres (m);

L_{WL} length of the waterline, as defined in ISO 8666:2002, 5.2.3, expressed in metres (m);

$L_{pAS,\ max}$ maximum AS-weighted sound pressure level of the reference boat, as measured according to ISO 14509-1, expressed in decibels (dB);

m_P performance test mass, as defined in ISO 8666:2002, 6.4, expressed in kilograms (kg).

5 Reference boat

Any boat which has been tested in accordance with ISO 14509-1 may be used as a reference boat provided that the key parameters required for the relevant assessment method (according to Annex A or Annex B) have been recorded for the boat as tested.

6 Sound assessment method

The key parameters of any boat/engine/propulsion system combination to be assessed shall be compared with those of an appropriate reference boat, according to the assessment method selected, which is either the "insertion loss measurement method" defined in Annex A or the "sound pressure level over stern measurement method" defined in Annex B.

If the key parameters are within the stated tolerances for each and every item listed in the relevant annex (indicating "yes" in every line of Table A.1 or Table B.1), the maximum AS-weighted sound pressure level of the boat is assessed to be not more than 2 dB higher than that of the reference boat.

7 Assessment report

The assessment report shall include the following:

a) reference to this part of ISO 14509;

b) a declaration that all of its requirements are met;

c) the assessor, the date of the assessment, the signature of the responsible person;

d) the maximum AS-weighted sound pressure level, $L_{pAS,\ max}$, of the reference boat used;

e) data for the assessed boat:

   1) manufacturer, boat model, boat model year,

   2) engine manufacturer, engine type;

f) the declaration that, according to the result of the sound assessment method, $L_{pAS,\ max}$ is assessed to be not more than 2 dB higher than that of the reference boat;

g) the completed key-parameter data table, either Table A.1 or Table B.1 depending on the chosen assessment method.

Annex A
(normative)

Insertion loss measurement method

This annex may be used alternatively to Annex B.

Table A.1 — Key parameters

	Key parameter	Unit	Reference boat	Boat to be assessed	Tolerance level with respect to reference boat	Compatibility established? yes/no
1 Boat						
1.1	Primary material (e.g. wood, steel, fibre-reinforced plastic)				same	
1.2	Length of the waterline, L_{WL}, as defined in ISO 8666:2002	m			± 10 %	
1.3	Beam at the waterline, B_{WL}, as defined in ISO 8666:2002	m			± 10 %	
1.4	Bottom type configuration (hard-chine, multi-chine, flat, round)				same	
1.5	Propeller tunnel geometry				same	
1.6	Performance test mass, m_P, as defined in ISO 8666:2002	kg			± 25 %	
1.7	Stern shape (plan view): square, round or specify				same	
1.8	Stern shape (elevation): vertical, raked or specify				same	
1.9	Beam at primary exhaust outlet station measured at centre of outlet	m			± 10 %	
1.10	Freeboard, F, as defined in ISO 8666:2002, measured at exhaust outlet station	m			± 10 %	
1.11	Stern swim platform (yes or no)				same	
1.12	Stern swim platform construction (solid or open)				same	
1.13	Breadth of stern swim platform	m			± 10 %	
1.14	Minimum height from underside of stern swim platform to design static waterline according to ISO 8666:2002	m			± 10 %	

Table A.1 (*continued*)

	Key parameter	Unit	Reference boat	Boat to be assessed	Tolerance level with respect to reference boat	Compatibility established? yes/no
2 Engine/propulsion						
2.1	Number of engines				same	
2.2	Engine make, build type and type number				same	
2.3	Declared power according to ISO 8665	kW			same	
2.4	Declared engine speed according to ISO 8665	min^{-1}			same	
2.5	Propulsion type (conventional, surface drive, jet drive)				same	
3 Exhaust system						
3.1	Insertion loss of silencer and/or baffle system and/or water injection into the exhaust stream to the primary exhaust outlet. This may be calculated or measured	dB			same or higher	
3.2	Insertion loss of silencer and/or baffle system and/or water injection into the exhaust stream to the secondary exhaust outlet[a]. This may be calculated or measured	dB			same or higher	
3.3	Primary exhaust outlet location (stern, side or quarter)				same	
3.4	Primary exhaust outlet location related to water line in running condition or in condition as specified by the boat builder (above, at, below)				same or below waterline	
3.5	Secondary exhaust outlet[a] location (stern, side or quarter)				same	
3.6	Secondary exhaust outlet[a] location related to water line (above, at, below)				same	

[a] Secondary exhaust outlet is typically an idle relief to minimize exhaust tube pressure.

Annex B
(normative)

Sound pressure level over stern measurement method

This annex may be used alternatively to Annex A.

B.1 General

B.1.1 Equipment specification

The sound measurement equipment including the windshield recommended by its manufacturer shall meet the requirements for a Class 2 instrument according to IEC 61672-1.

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, where a series is the seven accepted on-board measurements. The sound calibrator used for calibration of the sound level meter shall undergo laboratory verification every year with traceability to a primary standards laboratory.

B.1.2 Test specification

Measurements shall be made at the seven microphone positions given in Figure B.1.

Microphones shall be located as close to 1,2 m from the hull as practically possible. Similarly they shall be located as close to 1,2 m from the water surface as practically possible.

Microphones shall have omnidirectional directivity characteristics and shall be oriented horizontally away from the craft.

B.1.3 Operating conditions

NOTE The following operating conditions are in conformity with ISO 14509-1.

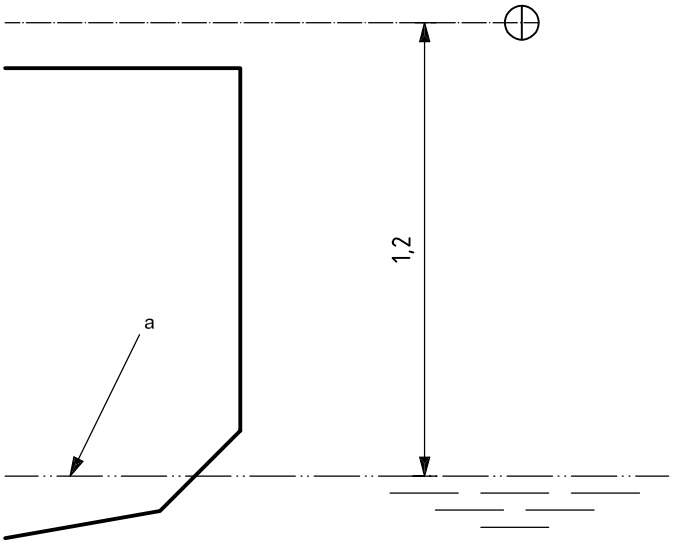
B.1.3.1 Craft shall be operated with an equivalent two-person load, except for craft intended for one person and all personal watercraft (PWC) which shall have an equivalent one-person load. An equivalent one-person load is defined as 75 kg $\pm$ 20 kg.

B.1.3.2 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.

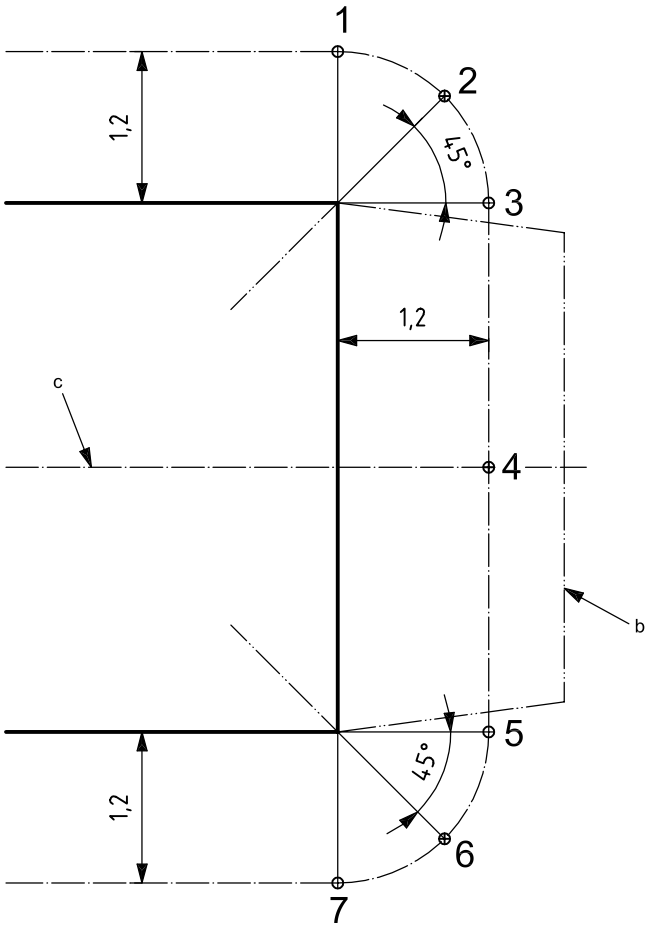
B.1.3.3 The engine shall be operated at full throttle for all tests.

B.1.3.4 If the craft speed exceeds 70 km/h, the engine throttle shall be adjusted to maintain a maximum speed of 70 km/h $\pm$ 2 km/h.

Dimensions in metres



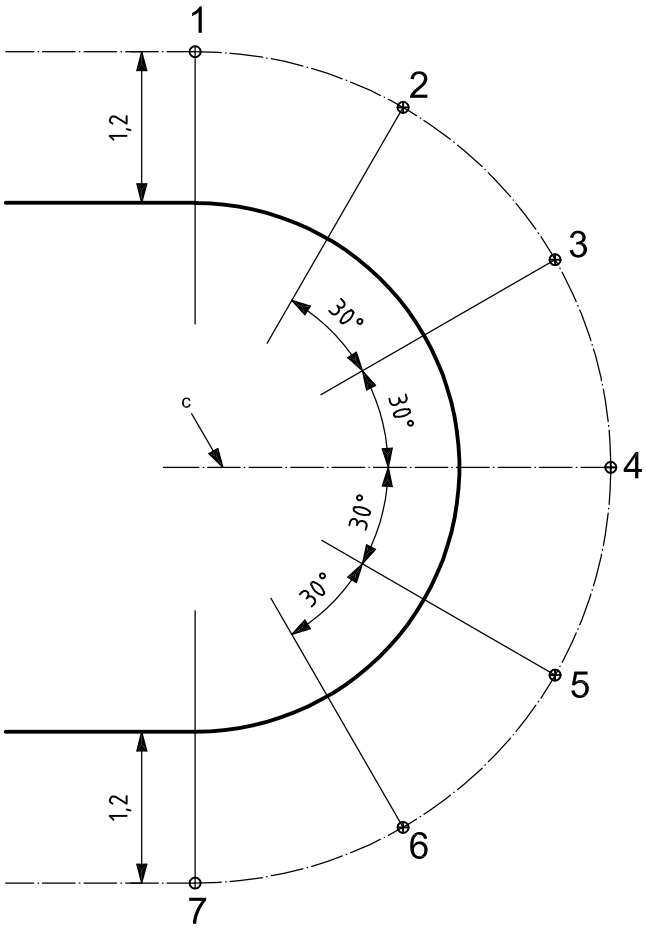
a) Microphone over side deck or transom (profile view)



b) Square transom

Figure B.1 (*continued*)

Dimensions in metres



c) Round transom

Key

1 to 7 microphone positions
a waterline
b swim platform
c centre line of craft

Figure B.1 — Microphone positions

B.1.3.5 For propulsion systems which are equipped with adjustable trim, the trim angle shall be adjusted so that the propeller or impeller thrust is parallel to the bottom- or keel-line of the craft to within ± 2°, hereafter referred to as “level trim” for all test conditions.

B.1.3.6 The craft shall be trimmed for zero heel for all tests.

B.1.3.7 The propeller or impeller shall be selected such that at full throttle the engine speed falls within ± 4 % of the declared engine speed at level trim, in accordance with ISO 8665. In the case of spark-ignition engines without speed governor, the declared engine speed shall be the mid-point of the full throttle speed range recommended by the manufacturer for propeller selection. In the case of engines with speed governors, the declared engine speed shall be the governed speed specified by the manufacturer. For controllable-pitch propellers, the pitch shall be fixed in a position required to obtain the declared engine speed at full throttle.

B.2 Measurement of exhaust outlet sound

The A-weighted equivalent continuous sound pressure level, $L'_{p\mathrm{Aeq}}$, shall be measured over a 10 s period. Measurements shall be made at the seven microphone positions given in Figure B.1.

Throughout the series of measurements, the microphone windshield shall remain dry.

The average of these seven sound pressure level measurements shall be recorded. The average sound pressure level shall be the arithmetic average of the seven values measured at each microphone position.

This average sound pressure level will be deemed to be the exhaust outlet sound (key parameter in Table B.1).

Table B.1 — Key parameters

	Key parameter	Unit	Reference Boat	Boat to be assessed	Tolerance level with respect to reference boat	Compatibility established? yes/no
1	Length of the waterline, L_{WL}, as defined in ISO 8666:2002	m			± 10 %	
2	Beam at the waterline, B_{WL}, as defined in ISO 8666:2002	m			± 10 %	
3	Number of engines				same	
4	Craft speed during test	km/h			± 15 %	
5	Primary exhaust outlet location related to waterline in running condition or in condition as specified by the boat builder (above, at, below)				same	
6	Bottom type configuration (hard-chine, multi-chine, flat, round)				same	
7	Performance test mass, m_P, as defined in ISO 8666:2002	kg			± 25 %	
8	Stern shape (plan view): square, round or specify				same	
9	Stern shape (elevation): vertical, raked or specify				same	
10	Stern swim platform (yes or no)				same	
11	Stern swim platform construction (solid or open)				same	
12	Exhaust outlet sound as defined in B.2	dB			same or less	

Annex C
(informative)

Background information on the reference boat concept

The concept of using reference boats was developed by industry to reduce the potential costs for demonstrating compliance of sound emissions regulations; in particular, to avoid a situation where boat-builders might have to test each and every boat/engine model configuration.

First, a list of reference boats will be established by running any normal production boat/engine combination through a pass-by sound test in accordance with ISO 14509-1. Providing the boat/engine combination passes the relevant sound level requirements for its engine size, the boat may then be added to the list of reference boats. A master list of reference boats will be held centrally. Full details of this reference boat master list will be available for consultation to all boat-builders and/or engine manufacturers.

Subsequently, boat-builders wishing to self-certify their production boat/engine combinations may choose from the master list a reference boat most similar to their production boat/engine combination. They would then carry out a detailed comparison of the two boat/engine combinations.

At the time that the concept was developed, there was little practical experience of sound testing or knowledge of boat-related sound. The authors believed that it would be possible to compare a reference boat and the boat to be assessed without any sound testing, by just comparing certain hull and engine parameters to within specified tolerances. Since that time industry's knowledge has increased significantly in both these areas, thanks in large part to marine industry sound-assessment research. It is evident that relying solely on a comparison of parameters is extremely challenging and, with the exception of determining insertion loss for the exhaust system, this remains unproven. Alternatively, this document offers a combination of hull parameters and a measurement of onboard sound which the industry has demonstrated provides the desired level of certainty.

When selecting a reference boat for use with this part of ISO 14509, the testing body should consider whether the reference boat used is suitable, by ensuring that the reference boat used has a maximum sound pressure level such that when the 2 dB positive tolerance allowed in this part of ISO 14509 is added to the reference boat maximum sound pressure level, the sound pressure level of the boat under assessment will not exceed the limit in the relevant legislation.

Bibliography

[1] ISO 2922, *Acoustics — Measurement of airborne sound emitted by vessels on inland waterways and harbours*

[2] ISO 8178-4, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 4: Test cycles for different engine applications*

[3] IMEC 17 F/06:2001[2)], *Identification of recreational craft with different sound characteristics, using the P/D ratio and Froude number calculation method*

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ICS 17.140.30; 47.080

Price based on 12 pages