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Acoustics — Quantities and procedures for description and measurement of underwater sound from ships —

Part 1: General requirements for measurements in deep water

Acoustique — Grandeurs et modes de description et de mesurage de l'acoustique sous-marine des navires —

Partie 1: Exigences générales pour les mesurages en eau profonde

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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.org
Web www.iso.org

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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/PAS 17208-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*. However, by the time of its publication, responsibility for this document, as well as for future underwater acoustics work, had been transferred to Subcommittee SC 3, *Underwater acoustics*.

ISO/PAS 17208 consists of the following parts, under the general title *Acoustics — Quantities and procedures for description and measurement of underwater sound from ships*:

— *Part 1: General requirements for measurements in deep water* [Publicly Available Specification]

Measurements in shallow water is to form the subject of a future part of ISO 17208.

Introduction

This part of ISO 17208 was developed to provide a standardized measurement method for the quantification and qualification of a ship's underwater (radiated) noise, and is aimed at promoting consistency of reported sound measurements from shipping sources. Reduction of all types of vessel emissions — most notably, ballast water and engine emissions — became an issue in the decade prior to its publication. More recently, those concerns came to include underwater noise and its the impact on marine animals.

Excessive underwater noise has the potential to interfere with a marine animal's ability to perform a variety of critical life functions, including navigation, communication and finding food. Because of this, the environmental impact statements of underwater projects such as pile-driving, pipe-laying and oil exploration now include assessments of the impact of underwater noise.

Acoustics — Quantities and procedures for description and measurement of underwater sound from ships —

Part 1:
General requirements for measurements in deep water

1 Scope

This part of ISO 17208 describes the general measurement systems, procedures and methodologies to be used to measure underwater sound pressure levels from ships at a prescribed operating condition. It presents a methodology for the reporting of one-third-octave band sound pressure levels. The resulting quantities are the sound pressure levels normalized to a distance of 1 m. Since the underwater sound pressure levels are affected by the presence of the free surface (and sometimes the bottom), such quantities are sometimes called “affected source levels” (see ANSI/ASA S12.64-2009). This part of ISO 17208 refers to the result of these measurements as “radiated noise levels”.

The underwater sound pressure level measurements are performed in the geometric far field and then adjusted to the 1 m normalized distance for use in comparison with appropriate underwater noise criteria. However, this part of ISO 17208 does not specify or provide guidance on underwater noise criteria or address the potential effects of noise on marine organisms.

This part of ISO 17208 is applicable to any and all underway surface vessels, either manned or unmanned. Its methods have no inherent limitation on minimum or maximum vessel size. It is not applicable to submerged vessels or to aircraft, and is limited to vessels transiting at speeds no greater than 50 knots (25,70 m/s). The measurement methods mitigate the variability caused by Lloyd's mirror surface image coherence effects, but do not exclude a possible influence of propagation effects such as bottom reflections, refraction and absorption. No specific computational adjustments for these effects are given. A specific ocean location is not required for the application of this part of ISO 17208, but requirements for an ocean test site are provided.

Among the applications of this part of ISO 17208 are the showing of compliance with contract requirements, the enabling of periodic signature assessments and in research and development. Intended users include government agencies, research vessel operators and commercial vessel owners operating in acoustically sensitive waters.

This part of ISO 17208 offers three grades of measurement — A, B and C — each with a stated applicability, test methodology, uncertainty, system repeatability and complexity. A summary of the attributes of each grade is given in Table 1. Application of the three grades of measurement to the same ship under the same conditions does not necessarily result in the same radiated noise level.

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.

IEC 60565, *Underwater acoustics — Hydrophones — Calibration in the frequency range 0,01 Hz to 1 MHz*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

ANSI S1.1, *American National Standard Acoustical Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ANSI S1.1 and the following apply:

3.1
acoustic centre
position at which it is assumed that all of the noise sources are co-located as a single point source

NOTE For the purposes of this document, the position is on a ship.

3.2
background noise
noise from all sources (biotic and abiotic) other than the source under test

NOTE 1 For the purposes of this document, the source under test is a ship.

NOTE 2 See 6.2 for background noise adjustments.

[SOURCE: ISO 11202:2010, 3.17, modified]

3.3
beam aspect
direction to either side of the ship under test

NOTE Beam aspect is in reference to the location of the hydrophones. Another approach for hydrophone measurement (not applied here) is *bottom aspect*, where the hydrophone(s) are mounted at or near the sea floor.

3.4
frequency response
frequency range a system is able to measure, for a given uncertainty and repeatability, from the lowest frequency to the highest stated frequency

3.5
closest point of approach
CPA
point at which the horizontal distance (during a test run) from the acoustic centre of ship under test is the closest to the hydrophone(s)

NOTE The distance at the closest point of approach is defined by the symbol d_{CPA} as used in Equation (1).

3.6
commence exercise
COMEX
start test range location
position of the vessel under test when twice (2×) the “start data” distance ahead of the CPA

NOTE See Figure 4.

3.7
data window angle
angle subtended at the hydrophone, between the start data location and the end data location

NOTE The data window angle is expressed as a value in degrees, as shown in Figure 4. For all grades of measurement, the data window angle is ±30°.

3.8
data window length
DWL
distance between the start data location and end data location

NOTE The DWL is defined by the distance at CPA and the data window angle of ±30°, as given in Equation (1) and shown in Figure 4.

3.9
data window period
DWP
time taken by the vessel under test to travel the data window length at a certain speed

NOTE See Equation (2) and Figure 4.

3.10
end data location
position of the acoustic centre of the vessel under test where data recording is ended

NOTE End data location is one data window length after the start data location. See Figure 4.

3.11
finish exercise
FINEX
end test range location
position of the vessel under test when twice (2×) the "start data" distance past the CPA

NOTE See Figure 4.

3.12
field calibration
method of using known inputs, possibly using physical stimuli (such as a known and calibrated/traceable acoustic or vibration source) or electrical input (charge or voltage signal injection) at the input (or other stage) of a measurement system in order to ascertain that the system is responding properly (i.e. within its stated uncertainty) to the known stimulus

3.13
geometric far field
horizontal distance from the ship under test at which the assumption of source co-location causes less than 1 dB of error when adjusting to the reference distance

3.14
hydrophone cable drift angle
angle between the vertical axis and the line created between the fixed support of the hydrophone cable and the hydrophone

3.15
insert voltage calibration
known, calibrated and traceable input stimulus in the form of an electrical input injected at the input (or other stage) of a measurement system in order to ascertain that the system is, in fact, responding properly (i.e. within the system's stated uncertainty and repeatability) to a known stimulus

3.16
Lloyd's mirror surface image coherence effects
alteration of radiated-noise levels caused by the presence of a free (pressure release) surface

NOTE Radiation from the "surface image" constructively and destructively influences the source's direct radiation. For the purposes of this document, these effects are considered as part of the source's radiation, causing it to exhibit a vertical directivity, necessitating the acquisition angle(s) be defined for each grade.

3.17
measurement uncertainty
maximum difference between the measured resulting signature radiated noise level and the true signature radiated noise level stated in decibels for a given measurement system, for one-third-octave bands using a given measurement method (averaging time, bandwidth-time product, etc.)

NOTE This concept is extensively treated in ISO/IEC Guide 98-3:2008 (GUM).

3.18
measurement repeatability
expected difference between signature-radiated noise levels resulting from successive measurements on the same vessel at the same operating condition, carried out under the same conditions of measurement with the same equipment at the same location, stated in decibels and in one-third-octave bands

NOTE This concept is extensively treated in ISO 3534-1.

3.19
measurement system
data acquisition system consisting of, but not limited to, one or more transducer(s), conditioning amplifier(s), analogue-to-digital converter(s), digital signal processing computer and ancillary peripherals

3.20
omni-directional hydrophone
underwater sound pressure transducer that responds equally to sound from all directions

3.21
slant range
distance from the acoustic centre of the vessel under test to each hydrophone

3.22
overall ship length
longitudinal distance between the forward-most and aft-most perpendicular of a ship

3.23
resulting signature-radiated noise level
measure of the underwater noise radiated by a surface vessel, obtained by averaging the far-field sound pressure level and scaling this quantity according to spherical spreading to a standard reference distance of 1 m from the acoustic centre of the source

NOTE 1 The signature-radiated noise level is defined as the outcome of the procedure in Clause 6. Specifically, it is the variable, L_S, on the left hand side of Equation (9).

NOTE 2 The signature-radiated noise level is also sometimes referred to as an “affected source level” or “signature.”

3.24
sound speed profile
measure of the speed of sound in seawater as a function of depth, measured vertically through the water column

3.25
start data location
position of the acoustic centre of vessel under test where data recording is started

NOTE See Figure 4.

3.26
test site
location at which the underwater noise measurements are performed

3.27
underwater sound pressure level
SPL
L_p
ten times the logarithm to the base 10 of the ratio of the time-mean-square pressure of an underwater sound, in a stated frequency band, to the square of a reference value, p_0, expressed in decibels

$$L_p = 10\lg\frac{p^2}{p_0^2}\,\text{dB}$$

where the reference value, p_0, is 1 µPa

NOTE 1 The reference value for underwater is different from that for airborne sound, which is 20 µPa.

NOTE 2 In this part of ISO 17208, the averaging time for the sound pressure level is the DWP (3.9).

[SOURCE: ISO/TR 25417:2007, 2.2, modified]

4 Instrumentation

4.1 General

In order to quantify the underwater sound from a marine vessel, three main instrumentation components are required: hydrophone(s) and signal conditioning; data acquisition, recording, processing and display system; and distance measurement system. The requirements for each of the three components will depend on which of the three grades of measurement is desired. Detailed specifications for each of the measurement systems are given below. A summary of the attributes of each grade is given in Table 1.

4.2 Hydrophone and signal conditioning

The terms “hydrophone”, “underwater electro-acoustic transducer” and “underwater microphone” may be used synonymously, but for the purposes of this part of ISO 17208, *hydrophone* is used, and includes any signal conditioning electronics either within or exterior to the hydrophone. The hydrophone(s) should have the sensitivity, bandwidth and dynamic range necessary to measure the ship under test and meet the performance for each intended grade in accordance with Table 1.

For all grades of measurement, the hydrophone(s) should be omni-directional across the required frequency range for the grade. However, directional hydrophones may be used, as long as the directional characteristics are accounted for in the final data processing (see 6.3). The number of hydrophones used to perform the measurement depends on the grade. The hydrophones may or may not have integral cable. However, the required performance shall be obtained with the full cable length to be used during the test.

When portable hydrophones are used, they shall be laboratory-calibrated every 12 months in accordance with IEC 60565 for all required one-third-octave bands. When fixed (i.e. permanently installed underwater) hydrophones are used, they shall be laboratory-calibrated before installation in accordance with IEC 60565 for all required one-third-octave bands. The fixed hydrophone calibration shall be confirmed by a comparative measurement utilizing a calibrated underwater sound source every 12 months.

For Grades A and B, the full measurement system shall be field-calibrated prior to, and daily throughout, the measurement series, using insert voltage methods (3.15) for all required one-third-octave bands. For Grade C, the full measurement system shall be field-calibrated prior to, and daily throughout, the measurement series, using either insert voltage methods for all one-third-octave bands or a single-frequency device (such as a pistonphone).