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Acoustics — Measurement of noise on board vessels

Acoustique — Mesurage du bruit à bord des bateaux

Reference number
ISO 2923:1996(E)

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.

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.

International Standard ISO 2923 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 2923:1975), which has been technically revised.

Annex A of this International Standard is for information only.

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Acoustics — Measurement of noise on board vessels

1 Scope

This International Standard specifies techniques and conditions for the measurement of noise on board vessels, both inland and seagoing, in order to obtain reproducible and comparable measurements. The results may be used, for example, for the following:

— to compare various vessels;

— in delivery and acceptance tests for comparison with national or international legislation and owner's specifications;

— in monitoring tests;

— as a basis for further investigations and noise-abatement measures;

— as a basis to assess the noise exposure and the effects of the noise to which seafarers are exposed;

— to assess speech intelligibility;

— to assess the audibility of acoustical alarms.

The uncertainty of measurements on board vessels depends on several factors, for example, measurement techniques and environmental conditions. Measurements made in conformity with this International Standard with few exceptions result in standard deviations of reproducibility of the equivalent continuous A-weighted sound pressure level equal to or less than 1,5 dB.

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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 editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 651:1979, *Sound level meters*, and Amendment 1:1993.

IEC 804:1985, *Integrating-averaging sound level meters,* and Amendment 1:1989, and Amendment 2:1993.

IEC 942: 1988, *Sound calibrators.*

IEC 1260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

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

3.1 accommodation spaces: Cabins, offices (for carrying out ship's business), hospitals, mess rooms and recreation rooms.

3.2 duty stations: Those spaces in which the main navigating equipment, the ship's radio or the emergency source of power are located, or where the fire-recording or fire-control equipment is centralized, and also those spaces used for galleys, main pantries, laundries, stores (except isolated pantries and lockers), mail and specie rooms, machinery and equipment control rooms, workshops other than those forming part of the machinery spaces, and similar such spaces.

3.3 machinery spaces: All spaces containing propulsion machinery, boilers, oil fuel units, motors and engines, generators and major electrical machinery, cargo machinery spaces, fuel filling, purifying and pumping stations, refrigerating, stabilizing, ventilation and air-conditioning machinery and similar spaces, and trunking leading to such spaces.

3.4 delivery and acceptance tests: Tests performed to verify that the vessel after completion or after substantial repair complies with noise specifications.

3.5 monitoring tests: Tests performed in order to assess impact of changes made since the acceptance on initial delivery or after modification, as applicable.

3.6 sound pressure level, L_p: The level, expressed in decibels, of a sound or noise given by the following equation:

$$L_p = 10 \lg \left(\frac{p}{p_0} \right)^2 \text{ dB}$$

where

p is the sound pressure, in pascals;

p_0 is the reference sound pressure (= 20 μPa).

The A-weighted sound pressure level L_{pA}, in decibels, is obtained by using the frequency weighting A defined in IEC 651 in the measurement of the sound pressure level.

3.7 equivalent continuous sound pressure level, $L_{peq,T}$: Sound pressure level of a continuous steady sound that, within a measurement time interval, T, has the same mean square sound pressure as a sound under consideration which varies with time. It is expressed in decibels and is given by the following equation:

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

where $(t_2 - t_1)$ is the period T over which the average is taken, starting at t_1 and ending at t_2.

NOTE — The subscript "T" may be omitted.

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3.8 impulsive noise: Noise of less than one second duration which occurs as an isolated event or as one of a series of events with a repetition rate of less than 15 times per second. The presence of impulsive noise shall be determined by obtaining the difference between the equivalent continuous sound pressure level measured with time weighting I and F. If the difference is more than 2 dB, the presence of impulsive noise may be assumed.

3.9 tonal sound: Sound which contains easily audible tones.

4 Instrumentation

The instrumentation system, including the microphone, cable and recording devices shall meet the requirements for a type 1 instrument specified in IEC 651 or, in the case of integrating-averaging sound level meters, the requirements of IEC 804.

NOTE — If the noise fluctuates less than 5 dB maximum to minimum, a non-integrating-averaging sound level meter with the time-weighting S can be used and the level estimated by averaging the level indication visually during at least 10 s.

The microphone shall be calibrated to have an essentially flat frequency response in a diffuse sound field.

Octave- or one-third-octave-band filters shall comply with the requirements of IEC 1260.

The wind screen, if used, shall not affect the measured A-weighted sound pressure level by more than 0,5 dB when there is no wind.

Before and after each series of measurements, a sound calibrator with an accuracy of ± 0,3 dB (class 1 according to IEC 942) shall be applied to the microphone for verifying the calibration of the entire measuring system at one or more frequencies over the range of interest.

The compliance of the calibrator with the requirements of IEC 942 shall be verified at least once a year. The compliance of the instrumentation system with the requirements of IEC 651 or, in the case of integrating-averaging systems, with the requirements of IEC 804 shall be verified at least every 2 years.

The date of the last verification and confirmation of the compliance with the relevant IEC standards shall be recorded.

5 Test environment

5.1 General

The depth of water under the vessel, if less than five times draught, and the presence of large reflecting areas in its vicinity shall be mentioned in the test report.

NOTE 1 On inland waterways, the condition of five times draught often cannot be fulfilled.

The meteorological conditions such as wind and rain, as well as sea state, shall be such that they do not influence the measurements. The weather conditions shall be reported.

NOTE 2 If practicable, measurements should not be taken when wind force 4 wave height 1 m are exceeded.

5.2 Criterion for noise from extraneous sound sources

Noise from extraneous sound sources (such as people, construction work, wind, waves, rain, etc.) shall not influence the sound pressure level at the position of measurement.

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6 Quantities to be measured

The basic quantities to be measured are:

— the equivalent continuous A-weighted sound pressure level;

— the C-weighted peak sound pressure level when there is a risk that it may exceed 130 dB;

— the equivalent continuous sound pressure levels in octave bands from 31,5 Hz to 8 000 Hz, if required;

— the presence of impulsive noise (to be determined from the definition);

— the presence of tonal sound (to be determined subjectively).

7 Operating conditions for the vessel

7.1 Operating conditions at sea

The vessel shall be loaded or in ballast condition. The condition shall be reported.

The course of the vessel shall be as straight as possible. Vessels being tested on inland waterways shall be run either against the stress or tide or in slack water.

The propulsion machinery shall be run at normal service speed and at no less than 80 % of the maximum continuous rating (MCR). The main engines of inland vessels shall be run at least 95 % of MCR. Controllable pitch and Voith-Schneider propellers shall be in position for nominal speed and nominal power.

All auxiliary machinery, navigation instruments and radar sets, etc., normally or likely to be in use at any one time, shall operate throughout the measurement period. The communication radio shall be turned on but not operating.

Measurements in spaces containing emergency diesel engine driven generators, fire pumps or other emergency equipment that would normally be run only in emergency, or for test purposes, shall be taken with the equipment operating. Adjoining spaces need not to be measured with such equipment operating, unless it is likely that the equipment will be operated for periods other than those mentioned above.

Mechanical ventilation and air-conditioning equipment shall be in normal operation, taking into account that the capacity shall be in accordance with the design conditions.

Doors and windows shall be shut, unless they are kept open in normal use, as for example the door on the lee side of the navigating bridge.

Spaces shall be furnished with all necessary equipment. No corrections are allowed if measurements are made with no soft furnishing.

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7.2 Operating conditions in port

The vessel's cargo-handling equipment shall be in operation during measurements in areas and accommodation spaces affected by its operation. Where the vessel is a vehicle carrier or a Ro/Ro ship and noise during loading and discharging originates from vehicles, the noise level in cargo spaces and the duration of the exposure shall be measured.

8 Test procedure

8.1 General

Measure with the microphone at a height between 1,2 m (seated persons) and 1,6 m (standing persons) from the deck. No microphone position shall be closer than 0,5 m from the boundary surface of a space. During the measurement, only seafarers necessary for the operation of the vessel and persons measuring shall be present in the space concerned. The measurement time shall be long enough to enable the measurement of the equivalent continuous A-weighted sound pressure level for any specified time interval within stated limits of overall measurement uncertainty. The measurement time shall be at least 10 s.

In large cargo holds, use at least three microphone positions. In other spaces not containing machinery, measure at distances not smaller than 2 m and not greater that 7 m throughout the space, including positions of maximum noise level and in the proximity of other types of noise sources (e.g. inlets and outlets of air-circulation systems).

Measure at the positions where the personnel work, including communication stations.

Bow thrusters, stabilizers, cargo hold ventilation, etc. may produce high levels of noise when in operation. Measure at positions around such machinery when in operation and in adjacent accommodation spaces and duty stations.

Measure, if required, the noise exposure of seafarers, or the exposure time in order to make it possible to calculate the noise exposure.

Use a microphone wind screen when measuring outside (e.g. on navigating bridge wings or on an open deck) and below deck where there is any substantial air movement.

Assess and record

— the presence of impulsive noise (to be determined from the definition), and

— the presence of tonal sound (to be determined subjectively).

8.2 Accommodation spaces

Measure in all accommodation spaces. Carry out octave-band measurements in at least one cabin with the highest noise level on each deck.

In cabins and hospitals, measure in the middle of the cabin. Additional measurements shall be performed at other positions if appreciable differences in the level of the noise inside the room occur, especially near the position of the head of sitting or lying persons.

8.3 Machinery spaces

Measure at the principal workplaces and at locations which would be visited during routine inspections, adjustment and maintenance and at positions on all normally used access routes. Pay special attention to telephone locations and to positions where voice communication and audible signals are important. Measure, in addition, at a distance of approximately 1 m from propulsion machinery and any particularly noisy machines or equipment. If practicable, do not measure closer than 1 m from operating machinery, air inlets, or from decks, bulkheads or other large surfaces. Where this is not possible, measure at a position midway between the machinery and an adjacent reflecting surface.

Make octave-band measurements at a minimum of two of the positions with the highest measured A-weighted sound pressure levels.

In order to avoid an unnecessarily large and impractical number of measurements and recordings in the case of large engines and of machinery spaces where the measured A-weighted sound pressure levels at the intervals given above do not vary significantly, it is not necessary to record each position. Full measurements at

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representative positions and at the positions of maximum sound pressure level shall, however, be made and recorded. At least four measurements shall be recorded at each deck.

8.4 Duty stations

Measure in places where speech communication and signal audibility is of importance and on both navigating bridge wings but only when that navigating bridge wing is on the lee side of the vessel.

If, inside these spaces, appreciable differences in the noise levels occur, make additional measurements at the points of interest where the differences exist. Make additional measurements at all points where work normally is performed (e.g. cargo holds and open deck areas).

Measure in all locations where people can be exposed to high levels of noise.

Measure in octave bands in locations where speech intelligibility is essential for navigation or safety.

8.5 Open recreation areas

Measure in any areas provided for the purpose of recreation and, additionally, where a preliminary survey shows high levels of noise.

9 Test report

Report all results of the measurements and include a reference to this International Standard and all relevant details concerning the following:

a) the nature of the tests;

b) the vessel, its main engines, the engine and shaft speeds during test, and the setting of controllable pitch or Voith-Schneider propellers;

c) the auxiliary engines and equipment and their operating conditions;

d) the loading of the vessel;

e) the test site, depth of water under the vessel and meteorological conditions, wind and sea state;

f) the measuring equipment;

g) names and addresses of those carrying out the measurements;

h) the microphone positions;

i) the equivalent continuous A-weighted sound pressure level;

j) the peak C-weighted sound pressure level, if appropriate;

k) the noise spectrum;

l) measurement results and calculations of the noise exposure, e.g. the 24 h equivalent continuous sound pressure level, if requested;

m) the presence of tonal sound or noise of an impulsive character;

n) indications of those windows and doors that are open;

o) indications concerning the probable noise sources in the vessel;

p) the main noise-abatement measures applied on board the vessel.

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Annex A
(informative)

Bibliography

[1] IMO Resolution 468 (XII), *Code on Noise Levels On Board Ships*.

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