INTERNATIONAL STANDARD

ISO 9875

Third edition
2000-11-01

Ships and marine technology — Marine echo-sounding equipment

Navires et technologie maritime — Appareils de sondage par écho

Reference number
ISO 9875:2000(E)

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Printed 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 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 9875 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

This third edition cancels and replaces the second edition (ISO 9875:1996), which has been technically revised.

Annex A forms a normative part of ISO 9875. Annex B is for information only.

Ships and marine technology — Marine echo-sounding equipment

1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and test results of marine echo-sounding equipment required to comply with the performance standards adopted by the IMO Resolution A.224(VII). In addition, it takes account of IMO Resolution A.694(17) and is associated with IEC 60945.

When a requirement in this International Standard is different from IEC 60945, the requirement in this International Standard takes precedence.

The purpose of echo-sounding equipment is to provide reliable information on the depth of water under a ship to aid navigation in particular in shallow water.

This International Standard is *applicable for ship speeds from 0 kn to 30 kn.*

Any text in this International Standard with wording identical to that in the IMO Resolution A.224(VII) and IMO Res. A.694(17) is printed in italics.

NOTE Resolution A.224(VII) represents Resolution A.224(VII) as amended by Resolution MSC.74(69), annex 4.

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.

IEC 60945:1996, *Maritime navigation and radiocommunication equipment and systems — General requirements, methods of testing and required test results.*

IEC 61162, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces.*

IMO Resolution A.224(VII), *Performance standards for echo-sounding equipment.*

IMO Resolution A.694(17), *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids.*

International Convention of Safety of Life at Sea (SOLAS) Chapter V, Regulation 12, Shipborne navigational equipment.

3 Terms and definitions

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

3.1
source level
S
maximum root mean square (r.m.s) sound pressure level at a point on the principal axis of the transducer, as measured in the far field but referred to the distance of 1 m

NOTE This value is expressed in decibels.

3.2
receiving directivity index
D
ratio of the acoustic power density at a distant point on the principal axis of the transducer, when used as a transmitter, to that of an omnidirectional transducer, with the same total radiated acoustic power

NOTE This value is expressed in decibels.

3.3
receiving bandwidth
B
bandwidth at which the response of the overall system, measured through water, is 3 dB below the maximum response of the system

$B = 10 \lg(f_1 - f_2)$

where f_1 and f_2 are respectively the upper and lower frequencies expressed in hertz

NOTE This value is expressed in decibels.

3.4
minimum detectable signal-to-noise ratio
E
ratio of the signal level, expressed in decibels, to the background noise level, expressed in decibels, in the bandwidth of the receiver required to give a minimum detectable signal on the display

3.5
speed of sound in water
1 500 m/s in the context of this International Standard

3.6
transducer
substance or device, such as a piezoelectric element, that converts an input electrical energy into an acoustic energy and vice versa, installed on the ship's hull and exposed to the sea water

3.7
performance test
test to confirm full compliance with the requirements of the equipment standard

3.8
performance check
short test to confirm compliance with the essential requirements specified in the equipment standards

NOTE In this International Standard, a performance check means non-quantitative visual check that the system is still operative for the purpose of IEC 60945.

3.9
inspection
visual check of the equipment or documentation

3.10
pre-conditioning
treatment of a specimen with the objective of removing or partly counteracting the effects of its previous history

4 Abbreviated terms

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

DPT depth

ECDIS electronic chart display and information system

EMC electromagnetic compatibility

EUT equipment under test

VDR voyage data recorder

5 Performance requirements

5.1 General

Echo-sounding equipment shall comply with the following performance requirements and with the general requirements of IEC 60945, where applicable.

5.2 Functionality

5.2.1 Range performance

Under normal propagation and sea bed reflectibility conditions, the equipment shall *be capable of measuring any clearance under the transducer between 2 m and 200 m.*

5.2.2 Range scales

5.2.2.1 *The equipment* shall *provide a minimum of two range scales one of which, the shallow range,* shall *cover a range of 20 m, and the other, the deep range, shall cover a range of 200 m.*

5.2.2.2 Where an automatic range is provided, a device to select these ranges manually shall be available to override the automatic range.

5.2.2.3 Where phased ranges, not starting from zero, are available, an indication shall be provided to show that such a range is in use.

5.2.2.4 Positive indication of the range in use shall be provided in all cases.

5.2.2.5 Where depth measurement relative to the sea surface is provided, in addition to measurement of the depth of water under the ship, there shall be a positive indication of an offset (draught) value.

5.2.3 Main display

5.2.3.1 *The primary presentation* shall *be a suitable graphical display which provides the immediate depth and a visible record of soundings.*

5.2.3.2 *The displayed record* shall *show at least 15 minutes of soundings* on the deep range scale.

5.2.3.3 Multi-colour display may be used. In this case, the colour assignment shall be clearly explained in the manual.

5.2.4 Other displays

Other forms of display may be added, but these shall *not affect the normal operation of the main display.*

5.2.5 Pulse repetition rate

The pulse repetition rate shall *not be slower than 12 pulses per minute on the deep range and 36 pulses per minute on the shallow range.*

5.2.6 Roll and pitch

The performance of the equipment shall *be such that it will meet the requirements of* this International Standard *when the ship is rolling ± 10° and/or pitching ± 5°.*

5.3 Multiple installation

5.3.1 *More than one transducer and associated transmitter-receiver may be fitted.*

5.3.2 If more than one transducer is used:

— *means* shall *be available to display the depths from the different transducers separately; and*

— *a clear indication of the transducer(s) in use* shall *be provided.*

5.4 Data storage

It shall *be possible to record on paper recording or other means the information about:*

— *the depth(s), and*

— *the associated time for 12 hours.*

There shall *be means to retrieve the recorded information.* The information may be recorded and retrieved in the form of graphics or digital readouts at intervals of 1 min.

5.5 Accuracy

5.5.1 Accuracy of measurement

Based on a sound speed in water of 1 500 m/s, the tolerance of the indicated depth shall *be either:*

— *± 0,5 m on the* shallow *range scale, respectively ± 5 m on the* deep range *scale; or*

— *± 2,5 % of the indicated depth,*

whichever is the greater.

NOTE These tolerances take no account of the ship's roll and pitch.

5.5.2 Discrimination

The scale of display shall *not be smaller than 5,0 mm per metre depth on the shallow range scale and 0,5 mm per metre depth on the deep range scale.*

5.6 Malfunctions, alarms and indications

5.6.1 Depth alarm

An alarm signal — both visual and audible with mute function — shall *be provided when the water depth is below a pre-set value.* If the pre-set alarm depth is not referenced to the transducer position, there shall be an indication of the reference position.

5.6.2 Failure or reduction in power supply

Alarm signals, both visual and audible (with mute function) to the navigator on the watch, shall *be provided to indicate failure or a reduction in the power supply to the echo sounder which would affect the safe operation of the equipment.* This facility may be integrated into a switchboard or elsewhere; it need not necessarily be an integral part of the equipment.

5.7 Ergonomic criteria

5.7.1 Operational controls

The function of range scale selection shall *be directly accessible.* Other functions shall be directly accessible and immediately effected by dedicated controls or primary access in an associated menu.

The settings for the following functions shall *be recognizable in all light conditions:*

— *range scale; and*

— *preset depth alarm.*

5.7.2 Presentation of information

5.7.2.1 Marks

The graphical display shall *be capable of showing:*

— *depth marks at intervals not larger than one-tenth of the range/scale in use; and*

— *time marks at intervals not exceeding 5 min.*

5.7.2.2 Paper recording

If paper is used for recording either by marks on the recording paper or by other means, there shall *be a clear indication when the paper remaining is less than 1 m.*

5.8 Design and installation

The equipment shall *comply with IMO resolution A.694(17).*

5.9 Interfacing

Output(s) shall *be available from which depth information may be supplied to other equipment such as remote digital displays, voyage data recorder and a track control system.*

These outputs shall include depth under keel, the depth scale currently being displayed, the transducer in use in multiple installations and other status information where available.

These outputs shall *be digital, serial communication, facilities which* shall *comply with the relevant International Standards* (IEC 61162).

5.10 Safety precautions

In the case of equipment using a high voltage electrosensitive recording medium and/or a moving writing mechanism, and where access to the record is possible while the echo-sounding equipment is operating, the equipment shall provide for operator safety.

5.11 Marking

The equipment shall be provided with an indication of the manufacturer, type and serial number.

Each unit of equipment normally to be installed in the vicinity of a standard compass or a magnetic steering compass shall *be clearly marked with the safe distance at which it may be mounted from such compasses.*

5.12 Information

Information shall be provided to enable competent members of a ship's crew to operate and maintain the equipment efficiently.

6 Methods of testing and required test results

6.1 General

Any requirement in clause 5 for which no test is specified in this clause or in IEC 60945, shall be checked by inspection of the equipment, the manufacturer's drawing or the relevant documents. The results of the inspection shall be stated in the test report.

6.2 General conditions of measurement

All the general requirements of IEC 60945 shall be carried out before tests to verify whether the Equipment Under Test (EUT) meets these technical requirements. The equipment shall comply with those requirements of IEC 60945 appropriate to its category, that is "protected" (from the weather), "exposed" (to the weather), or "submerged" (in continuous contact with sea water).

The manufacturer shall declare which equipment or units are "protected", "exposed" or "submerged". The manufacturer shall declare the "pre-conditioning" required before environmental checks.

Where pre-conditioning is called for, it is the first process in the test procedure. It may be effected by subjecting the specimen to climatic, electrical, or any other conditions required by the relevant specification in order that the properties of the specimen may be stabilized before measurements and test.

6.3 General underwater test conditions

The equipment transducer in its housing, complete with acoustic window if provided, shall be attached underwater to a clamp calibrated in degrees to enable the transducer to be rotated to any required angle about the major axis of the face of its element (that is about the longer axis, which will run parallel to the ship fore-and-aft line) and about the minor axis (the athwartships axis) where the element is rectangular or elliptical, or about any facial axis where the element is circular.

A calibrated hydrophone, which can be replaced by a calibrated projector (or, alternatively, a single instrument capable of being used in either role as required) shall be mounted under the water at a suitable known distance, d, from the transducer and directed towards it. Initially, the transducer shall be directed towards the calibrated hydrophone.

NOTE See [5], [6] and [7] in the bibliography for details.

In order to minimize near-field effects, distance d, in metres, shall not be less than

$$1{,}25a^2 f/c$$

where

a is the largest active dimension of the transducer element, in metres, appropriate to the mode of use, that is transmission or reception (usually the same figure for either);

f is the highest operation frequency of the echo-sounding equipment, in hertz;

c is the speed of sound in water, equal to 1 500 m/s (see 3.5).

Precautions shall be taken to minimize the effects of reverberation in the water. These precautions shall include the use of gated pulse measurement techniques. These techniques are essential in the case of some echo-sounding equipment receivers that operate in a non-linear mode.

6.4 Functionality

6.4.1 Range performance

6.4.1.1 Minimum depth test method

The transducer in its housing, complete with an acoustic window if provided, shall be immersed in water with its axis of maximum response directed towards a test target such as the bottom or side of the tank holding the water. It shall be possible to adjust the physical distance between the transducer and the target.

The test shall be conducted such that no other object or discontinuity shall be capable of affecting the result significantly.

The equipment shall be set to the shallow scale with the longest pulse length available on that scale, and the physical distance between the transducer and the test target shall be adjusted until the echo from the target is displayed separately and distinctly. This physical distance shall be measured and noted as the minimum depth indication.

6.4.1.2 Result required

The minimum depth shall not be greater than 2 m.

6.4.1.3 Maximum required measurable depth detection using the figure of merit system

The equipment shall be tested by the assessment, under laboratory conditions, of the system figure of merit for a water depth of 200 m.

The figure of merit, L', expressed in decibels, is defined as

$$L' = S - 2r + D - B - E \quad (1)$$

and shall exceed L_0 as indicated by the following relationship:

$$L_0 = L + 2\alpha R + K + N + x + y + z \quad (2)$$

where

S is the source level, in decibels relative to 1 µPa at 1 m;

r is the one-way loss figure due to roll and pitch, in decibels;

D is the receiving directivity index, in decibels;

B is the receiving bandwidth, in decibels relative to 1 Hz;

E is the minimum detectable signal-to-noise ratio, in decibels;

L is the spreading loss due to divergence, equal to 20 lg(2 000R);

R is the depth, in kilometres;

α is the sound absorption coefficient of sea water in decibels per kilometre (see annex A): combining R and α gives $2\alpha R$, as the total water attenuation loss, in decibels;

K is the bottom reflection loss at normal incidence and is taken to be 25 dB;

N is the background noise level, in decibels relative to 1 µPa in a 1 Hz bandwidth, equal to 82,5 – (50/3) lg$f$, f in kHz ;

x is the transmission loss in the case when the transducer is mounted inside the hull, in decibels;

y is a signal excess of 10 dB above the minimum detectable signal-to-noise ratio to provide a practical working level under all conditions;

z is a manufacturing tolerance of 3 dB.

The value of $L' = S - 2r + D - B - E$ shall be calculated and shall exceed the value of L_0 calculated for the appropriate operating frequency, a depth R of 200 m and the value of x declared by the manufacturer.

6.4.1.4 Test methods

6.4.1.4.1 Source level, S

Immerse the transducer in water with its principal axis directed towards a calibrated hydrophone and lead (also immersed in the water) and situated at a known distance, d, in metres, in the far sound field from the transducer. Switch on the equipment.

The source level, S, is given by

$$S = (V + 120) - M + 20 \lg d$$

where

M is the known response of the hydrophone and lead, in decibels relative to 1 µV/µPa;

V is the rms output voltage of the hydrophone and lead, in decibels relative to 1 V, measured during the pulse and averaged over its duration.

6.4.1.4.2 Roll and pitch, r

This test may be waived where suitable transducer beam direction stabilization is provided and can be demonstrated. Otherwise the one-way loss figure described below shall be determined to allow for the roll and pitch criteria specified in 5.2.6. The one-way loss figure, r, shall be the greatest reduction in response obtained when the

source level measurement in 6.4.1.4.1 is repeated with the transducer element rotated by up to ± 10° about its roll axis and at the same time by up to ± 5° about its pitch axis.

6.4.1.4.3 Receiving directivity index, D

This test may be carried out, at the discretion of the type test authority, with the transducer used in the transmitting mode as in 6.4.1.1 and 6.4.1.4.1 but, whenever practicable, the receiving mode described as follows shall be used.

The transmitter shall be disabled, but the trigger shall be available for external use. With the transducer and a test projector directed towards each other and the projector energized from a suitable pulsed signal source, the output voltage of the receiver of the echo-sounding equipment shall be monitored.

The pulse from the pulsed signal source shall be triggered by the echo-sounding equipment and delayed suitably to correspond with a definite depth within the scale. This pulse shall simulate the pulse normally transmitted by the equipment in regard to duration. The carrier frequency shall be adjusted to give maximum response on the echo-sounding equipment.

Using the method of maintaining constant receiver output voltage by varying the signal source voltage suitably, a pattern shall be plotted of transducer response against positive and negative angles of rotation of the transducer about each of its appropriate axes, in order to find the angular beam width θ in degrees, between the two points giving a level 3 dB below maximum response.

The receiving directivity index D shall be calculated as follows:

a) for circular transducers

$$D = 45{,}5 - 20 \lg\theta$$

b) for rectangular or elliptical transducers

$$D = 45{,}5 - 10 \lg(\theta_1) - 10 \lg(\theta_2)$$

where θ_1 and θ_2 are the 3 dB beamwidths about the major and minor axes measured as specified above.

The type test authority shall take due note of the suitability of this method of calculating D from the measured beam patterns in the light of the patterns found. As a guide, the above method of calculating D is suitable provided that no narrow side lobe exceeds a level of 8 dB below the maximum of the main lobe. Extended side lobes, even at a much lower level, may render this method unsuitable.

6.4.1.4.4 Receiving bandwidth, B

The equipment shall be set up on the deep range with the transducer in water and with its principal axis directed towards a calibrated projector fed by a continuous wave (cw) signal source. The transmitter of the equipment shall be disabled, but not the transmitting trigger pulse where this is required to initiate the display trace.

The carrier frequency of the signal source shall be varied, and the level suitably adjusted and noted, and weighted by reference to the frequency calibration of the projector, in order to plot the frequency response of the equipment receiving system by the method of maintaining constant receiver output level. From the results, the upper and lower frequencies f_1 and f_2 respectively, in hertz, shall be found where the receiver response is 3 dB below maximum. Then

$$B = 10 \lg(f_1 - f_2)$$

6.4.1.4.5 Minimum detectable signal-to-noise ratio, E

The transmitter shall be disabled while the trigger shall be available for external use. However, the test projector will not be required and the transducer need not be immersed in water.

A continuous random noise voltage of bandwidth equal to the bandwidth of the equipment receiving system and at a level well below saturation shall be added to a simulated echo pulse of variable amplitude which shall be triggered from the equipment delayed suitably to correspond with a definite depth within the shallow range scale. The combined signal shall be applied from a low-impedance source in series with the transducer. The level of the echo shall be adjusted to give a minimum detectable signal on the display of the equipment. E is then the ratio of the rms voltage of the echo pulse to the rms noise voltage.

6.4.2 Receiver sensitivity

6.4.2.1 Test method

Apply a simulated transmission pulse through the water at the transmission frequency while the equipment is set to receive only, giving a pressure level at the face of the transducer of the equipment of 10 dB less than the value of $(S - 2r - 2\alpha R - L - K - x)$. Observe the effect at the display, and measure and record the pulse amplitude at the input terminals of the equipment for use in the test of 6.4.3.3.

6.4.2.2 Result required

An indication shall appear on the display at the appropriate depth.

6.4.3 Performance checks

6.4.3.1 General

The following performance checks shall be carried out under normal conditions at room temperature. The results shall be recorded and retained for comparison with the results obtained from similar checks carried out when the equipment is being subjected to tests required by the relevant clauses in IEC 60945.

6.4.3.2 Transmitter

6.4.3.2.1 Test method

Measure the value of each of the following parameters for the deep range scale:

a) transmission frequency;

b) transmission rms voltage during the pulse.

Feed the output of the transmitter through the normal cable to the transducer, either in air or immersed in water, at the discretion of the type test authority in consultation with the manufacturer.

6.4.3.2.2 Result required

The transmitter frequency shall fall within the receiver pass band by a margin sufficient to accommodate the pulse spectrum defined by the reciprocal of the pulse duration.

During the tests specified in IEC 60945, any decrease in the transmission rms voltage below that recorded in 6.4.3.2.1 under normal conditions shall not cause the figure of merit to fall below its required value.

6.4.3.3 Receiver

6.4.3.3.1 Test method

The transmitter (but not the internal trigger) shall be disabled. A simulated signal pulse of amplitude equal to that recorded at 6.4.2.1 delayed to correspond to a depth of approximately 200 m, shall be injected in series with the transducer. This test shall be repeated during each relevant test in IEC 60945.

6.4.3.3.2 Result required

An indication shall appear on the display at the appropriate depth.

6.4.3.4 Transducer

6.4.3.4.1 Test method

The output of the transmitter shall be fed through the normal cable to the transducer. The transducer shall be either in air or immersed in water, as agreed by the type test authority and manufacturer. The arrangement agreed shall be used for all transducer performance checks. With the equipment operating, the transducer shall be directed at a suitable target. This test shall be repeated immediately after each relevant test in IEC 60945.

6.4.3.4.2 Result required

An indication shall appear on the display related to the distance separating the transducer and the target.

6.4.4 Range scales

The range scale requirements laid down in 5.2.2 shall be checked by inspection.

6.4.5 Main display

The main display requirements laid down in 5.2.3 shall be checked by inspection.

6.4.6 Other display

The other display requirements laid down in 5.2.4 shall be checked by inspection.

6.4.7 Pulse repetition rate

6.4.7.1 Test method

The transmitter pulse repetition rate shall be averaged over not less than 1 min on the deep range. The same process shall be repeated on the shallow range.

6.4.7.2 Result required

The pulse repetition rate shall not be less than 12 pulses per minute on the deep range and not less than 36 pulses on the shallow range.

6.4.8 Roll and pitch

This shall be determined by measurement of the transducer beam widths in the ship's fore-aft line and athwartships. Alternatively, the compliance with the requirements of 5.2.6 may be demonstrated by tilting the transducer first in the fore-aft axis and then in the port-starboard axis at sea or in the tank, wherever is considered appropriate.

6.5 Multiple installation

The multiple installation requirements laid down in 5.3 shall be checked by inspection.

6.6 Data storage

6.6.1 Method of test

The data storage requirements laid down in 5.4 shall be checked by inspection for the recording means. The means to retrieve recorded information shall be checked by inspection. If the equipment is provided with a built-in storage media, the performance shall be tested as an entity. If the EUT uses external means, such as ECDIS, radar or other displays, the applicant shall supply entity, in such case the instrument to demonstrate compliance to the requirements of 5.4 and 5.7.2.

6.6.2 Required result

Water depths shall be recorded on the paper with depth and time marks as specified in 5.7.2.1 for the duration of 12 hours. Where other means are used this information shall be recorded at intervals of 1 min or less for the duration of 12 hours and shall be retrievable.

6.7 Accuracy

6.7.1 Method of test

With the equipment set up normally, a signal pulse, whose delay from the trigger pulse of the equipment can be controlled to an accuracy of ± 100 µs or better, shall be fed into the receiver and be adjusted to represent echoes at intervals of 1 m on the shallow range scale and 10 m on the deep range scale, by progressing in increments of 4/3 ms and 40/3 ms respectively. Suitable intervals of not less than 1 m (4/3 ms) shall be used on other scales.

The apparent depth of the leading edge of each pulse shall be read off the scale.

6.7.2 Required result

The difference between the simulated depth being fed into the receiver and the reading of the display shall not exceed

± 0,5 m on the shallow range scale, and ± 5 m on the deep range scale;

or

± 2,5 % of the indicated depth,

whichever is the greater.

6.7.3 Discrimination

The discrimination requirements laid down in 5.5.2 shall be checked by inspection.

6.8 Malfunctions, alarm and indications

6.8.1 Depth alarm

The requirements laid down in 5.6.1 shall be checked by inspection.

6.8.2 Failure or reduction in power supply

The requirements laid down in 5.6.2 shall be checked by inspection.

6.9 Ergonomic criteria

6.9.1 Operational controls

The requirements laid down in 5.7.1 shall be checked by inspection.

6.9.2 Presentation of information

6.9.2.1 Marks

The requirements laid down in 5.7.2.1 shall be checked by inspection.

6.9.2.2 Paper end mark

The requirements laid down in 5.7.2.2 shall be checked by inspection.

6.10 Other tests

6.10.1 Durability and resistance to environmental conditions

The equipment shall be tested in accordance with IEC 60945 for durability under specified environmental conditions. For the equipment using paper for recording depth on the graphical display, the dry heat test (IEC 60945:8.2), the damp heat test (IEC 60945:8.3) and the low temperature test (IEC 60945:8.4) shall be carried out without recording paper.

6.10.2 Interference — Electromagnetic compatibility

EMC tests may be performed by replacing the transducer with a dummy having a short cable.

6.11 Interfacing

Check that depth data is available under a formatter of DPT in IEC 61162. If other data is provided in another format, the manufacturer shall clarify it.

6.12 Safety precautions

The requirements laid down in 5.10 shall be checked by inspection.

6.13 Marking

The requirements laid down in 5.11 shall be checked by inspection.

6.14 Information

The requirements laid down in 5.12 shall be checked by inspection.

Annex A
(normative)

Sound absorption coefficient

A.1 The value of the sound absorption coefficient, α, in decibels per kilometre, for sea water is given by the equation

$$\alpha = \frac{A_1 P_1 f_1 f^2}{f^2 + f_1^2} + \frac{A_2 P_2 f_2 f^2}{f^2 + f_2^2} + A_3 P_3 f^2$$

for frequency f in kilohertz, and where coefficients A_1, A_2, A_3, P_1, P_2, P_3, f_1, and f_2 are each functions of a sub-set of the parameters, water temperature, salinity, pH value and depth. The three expressions in the equation give, respectively, the contributions due to boric acid, magnesium sulfate and pure water. These were widely accepted as being the only three contributions to absorption which need to be considered, as the only other contribution identified by researchers is insignificant by comparison.

A.2 Two articles, [8] and [9] in the bibliography, are the basis for the determination of expressions for the coefficients A_1, A_2, A_3, P_1, P_2, P_3, f_1, and f_2. They are quoted below and were used to calculate the values of α given in Table A.2 and Table A.3.

$$A_1 = \frac{8{,}86}{c} \times 10^{(0{,}78\,\mathrm{pH} - 5)} \qquad (\mathrm{dB \cdot km^{-1} \cdot kHz^{-1}})$$

$$A_2 = 21{,}44 \times \frac{s}{c} \times (1 + 0{,}025T) \qquad (\mathrm{dB \cdot km^{-1} \cdot kHz^{-1}})$$

For $T \leqslant 20°C$:

$$A_3 = 4{,}937 \times 10^{-4} - 2{,}59 \times 10^{-5} T + 9{,}11 \times 10^{-7} T^2 - 1{,}5 \times 10^{-8} T^3 \qquad (\mathrm{dB \cdot km^{-1} \cdot kHz^{-2}})$$

For $T > 20°C$:

$$A_3 = 3{,}964 \times 10^{-4} - 1{,}146 \times 10^{-5} T + 1{,}45 \times 10^{-7} T^2 - 6{,}5 \times 10^{-10} T^3 \qquad (\mathrm{dB \cdot km^{-1} \cdot kHz^{-2}})$$

$$P_1 = 1$$

$$P_2 = 1 - 1{,}37 \times 10^{-4} D + 6{,}2 \times 10^{-9} D^2$$

$$P_3 = 1 - 3{,}83 \times 10^{-5} D + 4{,}9 \times 10^{-10} D^2$$

$$f_1 = 2{,}8 \times \left(\frac{s}{35}\right)^{0{,}5} \times 10^{(4 - 1\,245/\theta)} \qquad (\mathrm{kHz})$$

$$f_2 = \frac{8{,}17 \times 10^{(8 - 1\,990/\theta)}}{1 + 0{,}0018 \times (s - 35)} \qquad (\mathrm{kHz})$$

where

$c = 1\,412 + 3{,}21T + 1{,}19s + 0{,}0167D$, equal to the speed of sound in metres per second;

T is the temperature, in degrees Celsius;

$\theta = 273 + T$, in kelvins;

s is the salinity, in milligrams per gram;

D is the depth, in metres.

A.3 Consideration was given to the need for echo-sounding equipment, which is intended to meet the IMO requirement, to operate satisfactorily worldwide. Accordingly, for each frequency, values of α were calculated for several sea areas used by a significant number of merchant ships and in which water depths of at least 400 m exist. Specifically, these areas were:

a) Pacific Ocean near Japan (south of Tokyo);

b) Pacific Ocean near the northwest coast of the USA;

c) Atlantic Ocean near the east coast of the USA;

d) Atlantic Ocean south of Newfoundland;

e) Indian Ocean south of India;

f) Western approaches to the English Channel;

g) Gulf of Mexico;

h) Red Sea.

A.4 The data on the relevant parameters (water temperature, salinity and pH value) were obtained from the library of the Marine Information and Advisory Service (MIAS) of the Institute of Oceanographic Sciences. MIAS is the British Oceanographic Data Centre of the Inter-governmental Oceanographic Commission of UNESCO and obtains the data from participating nations which have made measurements of the parameters.

A.5 For areas where the values of any of the parameters were found to vary significantly throughout the year (this applied particularly to water temperature), more than one calculation of the value of α was made in order to allow for such seasonal changes. During initial investigations, it was found that variation of the value of pH had an insignificant effect on the value of α. It was therefore treated as a constant with a value of 8.

A.6 Investigation of the salinity of the sea worldwide indicated that area h) in A.3 is an isolated case. Here the salinity tends to be in excess of 40 mg/g while in coastal areas of the rest of the world, it is generally between 30 mg/g and 36,5 mg/g. It was considered that this, coupled with the high water temperature in area h) in A.3, placed a requirement more stringent than is strictly necessary on echo-sounding equipment operating at frequencies higher than 100 kHz. Accordingly, the values of α calculated for area h) in A.3 were excluded from further consideration.

A.7 For the other seven areas listed in A.3, a total of 22 calculations was made at each of the 24 frequencies (10 kHz to 240 kHz in steps of 10 kHz). In these calculations, account was taken of the variation of water temperature and salinity with depth.

A.8 Recognizing that the seven areas considered may well not have produced the maximum value of α which would otherwise result from a fully comprehensive worldwide study, the maximum value of α calculated for each operating frequency was used for calculation of the corresponding figure of merit.

A.9 Table A.1 gives the seven sets of data on temperature and salinity values, versus depth, which provided the values of α quoted in Table A.2. The maximum value so calculated (for each operating frequency) is underlined in Table A.2. These values are listed in Table A.3. The other 15 sets of data used in the calculations produced, for all operating frequencies, values of α less than those listed in Table A.3.

Table A.1

Depth	Column 1		Column 2		Column 3		Column 4		Column 5		Column 6		Column 7	
	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity	Temperature	Salinity
m	°C	mg/g	°C	mg/g	°C	mg/g	°C	mg/g	°C	mg/g	°C	mg/g	°C	mg/g
0	– 1,4	32,86	5,7	35,5	14,2	35,9	20,1	35,9	25,64	36,4	29,9	36,35	30,57	36,74
10	– 1,37	32,87	5,95		13,8		19,4		25,62	36,41	29,67	36,32	30,27	36,68
15			6			35,75		35,75						
20	– 1,36	32,9							25,53	36,41	29,67	36,31	30,3	36,58
30	– 1,37	32,9	6			35,7		35,7	25,55	36,42	29,31	36,33	29,47	36,36
50	– 1,35	32,95	6,8		11,4	35,95		35,95	25,31	36,46	28,69	36,36	28,42	36,33
70							15,4							
75	– 1,47	33,09							25,03	36,51	27,94	36,46	27,28	36,44
80					10,6	36		36						
100	– 1,54	33,52	6,8		10,2	36		36	24,85	36,6	26,82	36,62	26,5	36,52
125	– 1,27	33,67							24,27	36,69	25,51	36,79	25,74	36,6
150	– 1,26	34,28	7,8						23,68	36,77	23,99	36,86	25,17	36,76
180						35,9		35,9						
200	1,38	34,63							21,91	36,81	21,21	36,78	22,56	36,8
250	3,5	34,56							20,08	36,7	19,62	36,69	20,47	36,63
300	3,69	34,43			9,9	35,9		35,9	18,45	36,53	18,74	36,57	17,99	36,46
320							12,5							
325			7,8											
400	3,69	34,43	8,6		9,4	35,7	11,9	35,7	16,58	36,26	16,58	36,26	15,27	36,01
600				35,45										

Table A.2

Frequency	Values of sound absorption coefficient calculated from data contained in Table A.1 [a] db/km						
KHz	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
10	1,3	1,02	0,95	0,85	0,72	0,71	0,71
20	4,14	3,55	3,3	2,93	2,37	2,31	2,31
30	7,48	7,14	6,77	6,12	4,99	4,87	4,85
40	10,7	11,2	10,9	10,1	8,46	8,26	8,22
50	13,6	15,2	15,3	14,5	12,6	12,3	12,3
60	16,1	19	19,5	19,2	17,3	16,9	16,8
70	18,3	22,5	23,6	23,8	22,3	21,8	21,7
80	20,2	25,5	27,3	28,2	27,4	26,9	26,8
90	21,9	28,3	30,7	32,4	32,7	32,1	31,9
100	23,5	30,7	33,7	36,3	37,9	37,4	37,2
110	25,1	32,9	36,5	40	43	42,5	42,3
120	26,7	35	39,1	43,3	48	47,6	47,3
130	28,2	36,9	41,4	46,5	52,8	52,5	52,2
140	29,8	38,7	43,6	49,3	57,4	57,2	57
150	31,4	40,5	45,7	52,1	61,8	61,8	61,6
160	33,1	42,2	47,6	54,6	66	66,1	65,9
170	34,8	43,9	49,5	57	70	70,3	70,2
180	36,6	45,5	51,4	59,3	73,8	74,3	74,2
190	38,5	47,2	53,2	61,5	77,4	78,2	78,1
200	40,4	48,9	55	63,6	80,9	81,9	81,8
210	42,5	50,6	56,7	65,7	84,2	85,4	85,3
220	44,6	52,4	58,5	67,7	87,3	88,8	88,8
230	46,7	54,2	60,3	69,7	90,4	92	92,1
240	49	56	62,1	71,6	93,3	95,2	95,3

[a] The values underlined are calculated maximum values (see A. 9).

A.10 When used in conjunction with the expressions for L and N and the values given for R, K, y and z in 6.4.1.3, the values of α given in Table A.3 produce the values for L_0, i.e. the figure of merit, given in Table A.4.

A.11 The values in Table A.4 are plotted in Figure A.1. It is recommended that type test authorities use Figure A.1 for determination of the required figure of merit for the echo-sounding equipment under test.

Table A.3

Operating Frequencies kHz	Maximum sound absorption coefficient dB/km
10	1,3
20	4,14
30	7,48
40	11,2
50	15,3
60	19,5
70	23,8
80	28,2
90	32,7
100	37,9
110	43
120	48
130	52,8
140	57,4
150	61,8
160	66,1
170	70,3
180	74,3
190	78,2
200	81,9
210	85,4
220	88,8
230	92,1
240	95,3

Table A.4

Operating Frequencies kHz	Minimum figure of merit dB
10	156,39
20	152,51
30	150,91
40	150,32
50	150,35
60	150,71
70	151,31
80	152,10
90	153,05
100	154,37
110	155,72
120	157,09
130	158,43
140	159,73
150	160,99
160	162,25
170	163,49
180	164,67
190	165,84
200	166,95
210	168,00
220	169,02
230	170,02
240	170,99

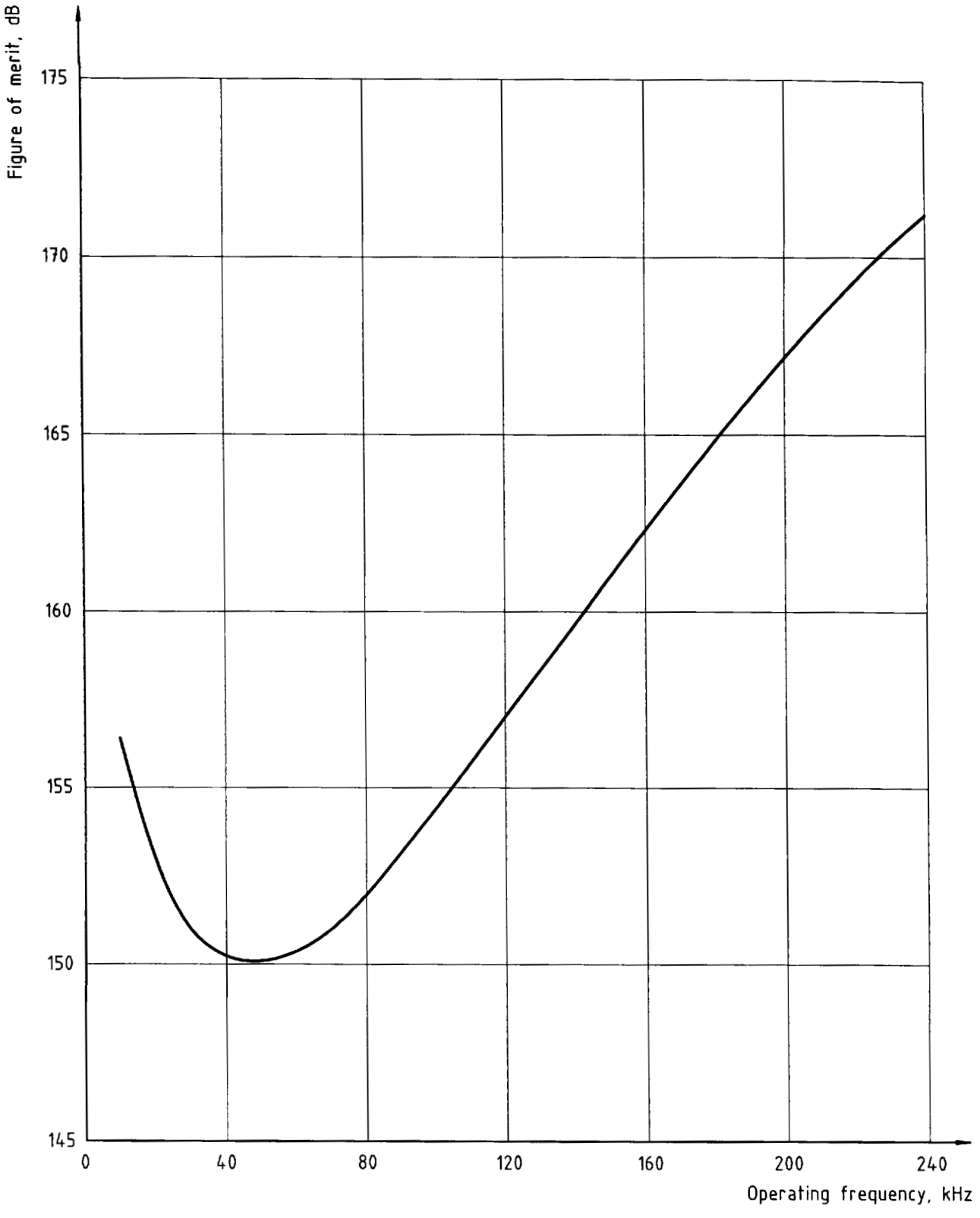

Figure A.1

Annex B
(informative)

Equivalent requirements in ISO 9875 and IMO Resolutions

Clause or subclause in **ISO 9875**	Clause or subclause in Draft amendments to Resolution A.224(VII) as amended by Resolution MSC.74(69), Annex 4 and IMO Res. A. 694(17)
1	Res. MSC.74(69), Annex 4, 1 and 2
2	Res. MSC.74(69), Annex 4, 3
3.5	Res. MSC.74(69), Annex 4, 4
5.2.1	Res. MSC.74(69), Annex 4, 5.1.1
5.2.2.1	Res. MSC.74(69), Annex 4, 5.1.2
5.2.3.1 and **5.2.3.2**	Res. MSC.74(69), Annex 4, 5.1.3
5.2.4	Res. MSC.74(69), Annex 4, 5.1.4
5.2.5	Res. MSC.74(69), Annex 4, 5.1.5
5.2.6	Res. MSC.74(69), Annex 4, 5.1.6
5.3	Res. MSC.74(69), Annex 4, 5.1.7
5.4	Res. MSC.74(69), Annex 4, 5.1.8
5.5	Res. MSC.74(69), Annex 4, 5.2
5.6	Res. MSC.74(69), Annex 4, 5.3
5.7	Res. MSC.74(69), Annex 4, 6
5.8	Res. MSC.74(69), Annex 4, 7
5.9	Res. MSC.74(69), Annex 4, 8
5.11	Res. A.694(17), 6.3

Bibliography

[1] IMO Resolution A.817:1995, *Performance standards for electronic chart display and information systems.*

[2] IMO Resolution A.861(20), *Performance standards for shipborne voyage data recorder.*

[3] ISO 9000 family 1987, *Quality management and quality assurance standards.*

[4] ISO/IEC 9126, *Software quality characteristics and guidelines.*

[5] IEC 60500:1974, *IEC standard hydrophone.*

[6] IEC 60565:1977, *Calibration of hydrophones.*

[7] IEC 60565A:1980, *First supplement.*

[8] Sound absorption based on ocean measurements, *Journal of the Acoustical Society of America*, September 1982, vol 72, No. 3.

[9] Sound absorption based on ocean measurements, *Journal of the Acoustical Society of America*, December 1982, vol 72, No. 6.

ICS 47.020.70

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