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Ships and marine technology — Sound reception systems

Navires et technologie maritime — Systèmes de réception sonore

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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 14859 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

Introduction

Sound reception systems are acoustical-electronic navigational aids to enable the officer of the watch to hear outside sound signals inside a totally enclosed bridge in order to perform the lookout function as required in the International Regulations for Preventing Collisions at Sea, 1972. Optionally, they can also be installed on vessels without fully enclosed bridges.

The requirements in this International Standard take into account human factors, ergonomic principles, and advances in technology.

Ships and marine technology — Sound reception systems

1 Scope

This International Standard specifies the functional requirements and recommended installation and performance tests for sound reception systems. Guidelines have been drawn up for the methods and solutions to meet the functional requirements.

The requirements apply to fully enclosed bridges, and other bridges where such equipment is voluntarily installed.

This International Standard specifies bridge requirements that will secure a safe and efficient lookout on those seagoing ships having a fully enclosed bridge.

This International Standard will be for the design of ship bridges. It will also be useful for

a) specifiers and procurers of ships and bridge equipment, and

b) operators and owners for ensuring that changes made through the life of a ship still conform to its requirements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3745, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic rooms and hemi-anechoic rooms*

ISO 9613-1, *Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere*

IEC 60945:2002, *Maritime navigation and radiocommunication equipment and systems — General requirements — Methods of testing and required test results*

IEC 61162-1, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 1: Single talker and multiple listeners*

IEC 61162-450, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 450: Multiple talkers and multiple listeners — Ethernet interconnection*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems — Presentation of navigation-related information on shipborne navigational displays — General requirements, methods of testing and required test results*

IMO, International Regulations for Preventing Collisions at Sea, COLREG 72, *Sound Signal Appliances*

IMO Resolution A.468(XII), *Code on Noise Levels on Board Ships*

IMO Resolution A.694(17), *General Requirements for Shipborne Radio Equipment Forming Part of the GMDSS and for Electronic Navigational Aids*

MSC.86(70), Annex 1, *Recommendation on performance standards for sound reception systems*

3 Terms and definitions

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

3.1
dB(A)
sound pressure measurement in decibels using A-weighting scale

NOTE The A-weighting scale is used for industrial and environmental applications.

3.2
SPL
Sound Pressure Level
calculation in dB as a ratio of the measured sound pressure to a reference sound pressure, which, for SPL, is 20 uPa

4 Functional requirements

4.1 General

Users of this International Standard shall note that while attempting to implement its requirements, they shall ensure compliance with such statutory requirements, rules and regulations as may be applicable to the individual ship concerned.

NOTE All requirements that are extracted from the recommendations of IMO Resolution MSC.86(70), annex 1, Performance standards for sound reception systems, are printed in italics and the resolution and paragraph numbers are indicated in brackets.

Sound reception systems shall comply with the following minimum requirements in addition to the general requirements contained in resolution MSC.86(70), Annex 1, and A.694(17).

4.1.1 Environmental

The sound reception system shall conform to the environmental requirements of IEC 60945. Those elements of the system exposed to the weather shall use the exposed category and those inside the bridge shall use the protected category.

The sound reception system shall be resistant to icing and frost conditions.

4.1.2 Audio functions

[IMO MSC.86(70) Annex 1, 2.1.2, 2.1.4 and 3.1] The system shall *reproduce incoming sound signals acoustically inside the bridge. Incoming sound signals shall be reproduced inside the bridge by means of at least one loudspeaker*. The system shall *suppress unwanted background noise* while *allowing reception of meaningful sounds*. The operator must set an appropriate output level to ensure the signal is heard on the bridge.

[IMO MSC.86(70) Annex 1, 3.2] *The volume* at the speaker(s) shall *be adjustable by means of one volume control only. The volume control* shall *be capable of being set so that the sound pressure level* reproduced on the bridge for *an incoming signal is at least 10 dB(A) above the* maximum ambient *bridge noise level* of 65 dB(A) measured at a distance of 1 m.

4.1.3 Frequency range

[IMO MSC.86(70) Annex 1, 2.1.1] The system shall *receive sound signals from all directions in the audio band 70 Hz-2 100 Hz*. This frequency range exceeds the limits stated in IMO Resolution MSC.86 (70), Annex 1. The audibility of a signal of the sound signal appliance is influenced by its fundamental frequency and may include higher frequency content on smaller vessels.

4.1.4 Visual indicator

[IMO MSC.86(70) Annex 1, 2.1.3] There shall be a display which gives a visual indication of the incoming signals and their approximate direction. The system shall *indicate the approximate direction of incoming sound signals to determine at least whether the sound signal being detected is forward of or abaft the beam and from which side of the ship it is being detected.* The visual indication shall persist for a minimum of 3 s. The

visual indication can be a dedicated display unit or part of a combined, multifunction display as long as the performance criteria in this specification are met.

The visual display must indicate the sound being reproduced on the speaker.

4.1.5 Disable function

The system shall provide an input that disables its amplifier when the ship's horn or whistle is sounded.

4.1.6 Self-test

The system shall provide either a built-in self-test function or an alternate test process to verify the operational status of the microphones and system on a periodic basis. The alternate test process shall be described in the user documentation along with a suggested schedule of testing.

4.1.7 Marking and identification

The sound reception systems shall conform to the marking requirements of IEC 60945.

4.1.8 Information

Manufacturer documentation for the sound reception systems shall meet the requirements of IEC 60945.

4.2 Installation recommendations

4.2.1 Microphone placement

The microphones shall be installed in such a way that they are as far from noise sources in the ship as is reasonably practicable where wind induced noise and mechanical vibrations are reasonably reduced.

4.2.2 Display placement

The display shall be installed so that it is visible from the conning position. Optionally, the information may be displayed (as on overlay) on other systems such as a radar or ECDIS display. Serial interfaces and sound reception system information display on other systems shall comply with IEC 61162-1 and IEC 62288 respectively.

4.2.3 Speaker placement

[IMO MSC.86(70) Annex 1, 4.3] *The loudspeaker(s) should be installed so that incoming sound signals are audible at all positions inside the bridge*.

5 Type tests

5.1 General

Type testing of the equipment shall validate that the equipment meets the performance requirements stated in Clause 4.

Type testing of operational performance characteristics can be carried out on a ship, in a test facility, or a combination of both locations. Guidance for testing is provided in 5.2 and 5.3.

5.1.1 Sensitivity and frequency response

Type testing shall confirm the sensitivity and frequency response of the audio processing functions. When type testing of sensitivity and frequency response is performed at a test facility using a test signal, the test signal shall simulate the spectrum and SPL of sources in COLREG 72, Sound Signal Appliances at the distance

employed for the test. IALA Recommendation E-109 provides guidance on the calculation of the range of a sound signal.

5.1.2 Directionality of microphones and visual indicators

Type testing shall confirm the directionality of the microphones and the visual indicators incorporated into the sound reception system.

5.1.3 Audio output and controls

Confirm the presence of at least one loudspeaker.

Confirm that there is only a single volume control affecting signals reproduced from the microphones equally.

Adjust the volume control and confirm that the sound pressure level of an incoming signal can be set at least 10 dB(A) above the ambient bridge noise level indicated in IMO Resolution A.468(XII) which itself is a maximum of 65 dB(A).

5.2 Shipboard type testing

The sound reception system shall be tested under voyage speed conditions for the ship.

The sound signal intensity and the range of audibility for all possible length of vessels (according to COLREG, Annex III point 1.a-c) shall be covered by the test.

The shipboard type testing shall be carried out with at least two sound signals and up to the relevant audibility range of the sound signal (listed in Table 1).

One signal shall meet the fundamental frequency range of 70 Hz to 200 Hz and has to be recognized up to 2 nautical miles and the other signal shall meet the fundamental frequency range of 250 Hz to 700 Hz and has to be recognized as specified in Table 1.

Table 1 — Sound signal intensity and range of audibility

Length of vessel	Limits of fundamental frequencies	1/3rd-octave band level at 1 m [dB referred to 2 x 10 −5 N/m^2]	Audibility range in nautical miles
m	Hz	dB	
> 200	70 to 200	143 dB	2
75 up to 200	130 to 350	138 dB	1,5
20 up to 75	250 to 700	130 dB	1
< 20	250 to 700	120 dB	0,5
		115 dB	0,5
		111 dB	0,5

Confirm that the sound reception system reproduces the incoming sound signals in accordance with 4.1.2 and indicates the approximate direction of incoming sound signals in accordance with 4.1.4. The results displayed from the sound reception systems shall be as good as at least two human observers at a lookout position outside the enclosed bridge. Annex A provides the methodology to perform type testing on a representative test vessel.

5.3 Test facility type testing

This section provides the methodology to perform type testing using test signals and all microphones in an anechoic chamber or semi-anechoic chamber. The chamber shall be qualified according to ISO 3745, app. 1, to ensure reproducibility of the test. Annex B is informative and provides a representative arrangement of the equipment layout for type testing.

The test signal shall be a 3 second test tone. The SPL and frequency characteristics of the test signal/source received at the microphones shall be equivalent to the intensity and range of audibility of the sources stated in Table 86.05 of COLREG 72, Annex III, Technical Details of Sound Signal Appliances. Frequency-dependent damping of the signal (according to its range of audibility) shall be taken into account as described in ISO 9613-1 (air temperature 10°, 90 % humidity). This can be achieved by pre-processed signals or appropriate filtering technology. The test signals representing the different ship classes may be synthesized using digitized waveform or a set of discrete frequencies.

A noise ($1/f^2$) with 57 dB (SPL) octave band level at 1 kHz, measured at the centre of the sound reception system (Note: sound reception system removed during calibration measurement), shall be used for all lab testing. Reproduction of a test signal should be introduced by the noise signal of minimum 10 s length to allow the detection algorithm to adapt to the noise signal. Noise shall be reproduced from at least three different directions. The minimum distance of the loudspeaker which reproduces the test signal to the microphones shall be at least four times larger than the largest dimension of the sound reception system (Dmax in Figure B.1). Non-linear distortion of the loudspeaker used for reproducing the test signal must be below −40 dB in the frequency range from 70 Hz to 2 100 Hz.

5.3.1 General

Conduct an omni-directional test to ensure that sounds are received from all directions (360° at either 22,5° or 30° intervals) over the frequency band of 70 Hz to 2 100 Hz within −3 dB. The system and visual indicator shall be tested using an acoustic source at 22,5° or 30° intervals starting at 0°.

5.3.2 Directionality and audio persistence

[IMO MSC.86(70) Annex 1, 3.3] Move test signal source or the unit under test throughout 360° and confirm that the display correctly identifies at minimum port/starboard and fore/aft directionality. Cause the test signal to appear at 3 s intervals throughout 360° at 22,5° or 30° intervals and confirm that the *display gives a visual indication of the incoming signals for at least 3 s* with the appropriate port/starboard and fore/aft directionality.

6 Installation performance tests

6.1 Microphone installation

The microphones shall be externally installed in such a way that they are as far from noise and mechanical vibrations sources in the ship as is reasonably practicable. Microphones shall be installed to minimize wind-induced noise. Confirm microphone location by inspection.

6.2 Bridge equipment installation

[IMO MSC.86(70), Annex 1, 4.2] *The display should be installed so that it is visible at least from the conning position*.

Confirm display location by inspection.

[IMO MSC.86(70), Annex 1, 4.3] *The loudspeaker(s) should be installed so that incoming sound signals are audible at all positions inside the bridge*.

Confirm loudspeaker location by inspection.

6.3 Operational performance

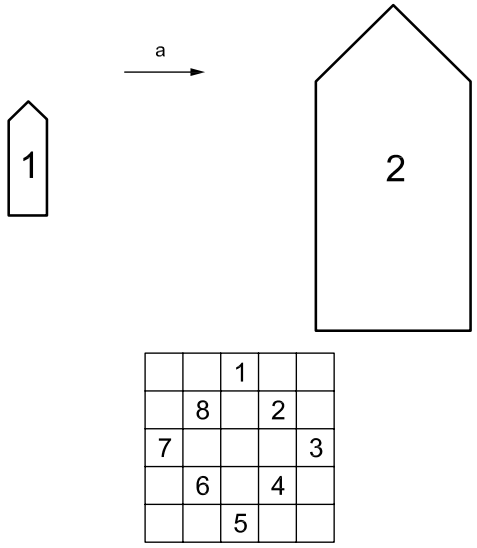
To include the effect of wind-induced noise, installation performance tests shall be performed under-way at 25 % to 50 % of the ship's service speed. At-sea installation tests shall be performed using a 3-second test burst. The methodology in Annex A or equivalent is recommended for shipboard operation performance testing. The source of the burst, such as a whistle, shall be equivalent to the intensity and range of audibility of the sources stated in Table 86.05 of COLREG 72, Annex III, Technical Details of Sound Signal Appliances. The test source shall have a predominant frequency content within the bandwidth of the sound reception system. Test a minimum of four orthogonal directions.

Annex A
(informative)

Shipboard type test methodology

A.1 Test set-up

The following test set-up was chosen for the measurements:



Reference direction (1 = Ahead)

Key

1 dinghy
2 test ship
a Wind direction.

Measurement a: — Comparison with the lookout
Date:
Type:
Wind:
Air:
Signal Source: *air pressure — Whistle, ca. 135 dB(A) — declaration of the manufacturer.*
Sound Reception Systems comparison to a lookout.

Figure A.1 — Suggested test set-up for measurements

A.2 Procedure of test set-up

The procedure of test set-up is carried out as follows:

a) Install whistle on a dinghy or a suitable test platform.

b) Install a microphone sensor unit in suitable high location on the test vessel.

c) Position the lookout at the microphone sensor (at peak) or closest to the dinghy. Ensure the lookout cannot observe the signal source.

d) Position the dinghy and the test vessel where the wind blows from the dinghy towards the test vessel.

e) From the dinghy, generate two signals with a duration of 3 s and a minimum separation of 10 s. The signal source shall be equivalent to sound sources defined in COLREG 72, Sound Signal Appliances.

f) Document the reaction on the sound reception system and the heard sounds from the lookout. Change the distances between the dinghy and the test vessel and repeat signal test.

Table A.1 — Comparison of the audibility and the identification of the direction

Comparison of the audibility and the identification of the direction							
Distance [NM]	**Time**	**Signal can be heard from the lookout**		**Signal can be heard with the Sound Reception System**		**Direction of the Sound Reception System**	
		Signal 1	Signal 2	Signal 1	Signal 2	Signal 1	Signal 2
0,5							
0,6							
0,7							
0,8							
0,9							
1,0							
1,1							
1,2							
1,3							
1,4							
1,5							
1,6							
1,7							
1,8							
1,9							
2,0							
2,1							
2,2							
2,3							
2,4							
2,5							
Signal recognized							

Annex B
(informative)

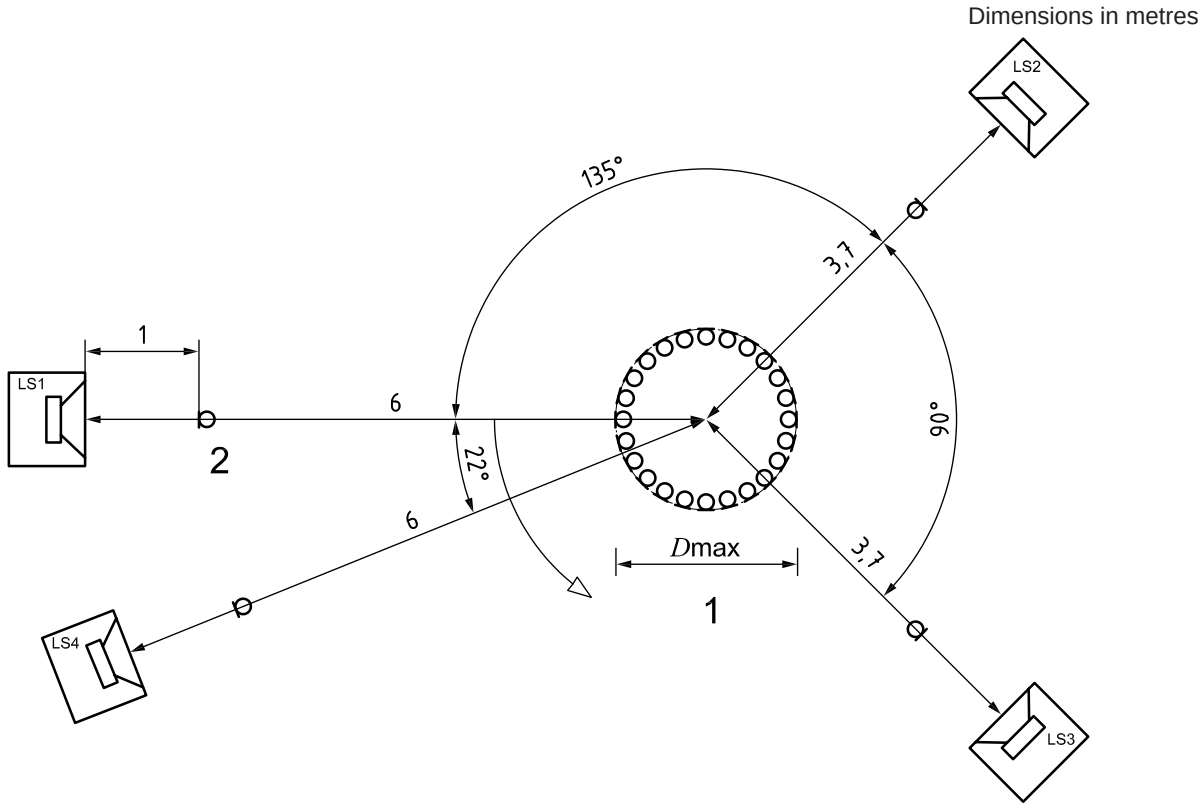
Test facility type test methodology

B.1 Test set-up

The following test set-up was chosen for the measurements:

LS = Loud Speaker, M = Microphone, red circle = reference microphones.

The number of microphones employed in the sound reception system is specific to the manufacturer. The depiction of the sound reception system in Figure B.1 is to define the maximum dimension only.



Key

1 Sound Reception System

2 Reference Microphone(s)

Figure B.1 — Suggested test set-up for measurement

The test set-up shall meet the following requirements:

a) Noise from multiple sources in different directions.

b) Signal/noise from individual sources, which include directional information.

c) A combination of uncorrelated noise, a noise with directional reference and a signal.

B.2 Test set-up procedure

Source for the reproduction of the signal (LS1).

Sources for the reproduction of uncorrelated noise (LS2-LS4).

A noise ($1/f^2$), with 45 dB (SPL) on 1 kHz or the in IALA E-109 defined spectrum (see Figure B.2) shall be used.

The measurement of the distance detection requires the injection of defined signal spectrum [Hz] with a known level [dB], therefore use several signals which represent the spectrum and SPL of sources in COLREG 72.

Table B.1 — Example table for the measurement of distance detection

Distance	**Frequency** [Hz]									
[NM]	70	140	210	280	350	420	490	560	630	700
0,2										
0,4										
0,6										
0,8										
1,0										
1,2										
1,4										
1,6										
1,8										
2,0										
2,2										
2,4										
2,6										

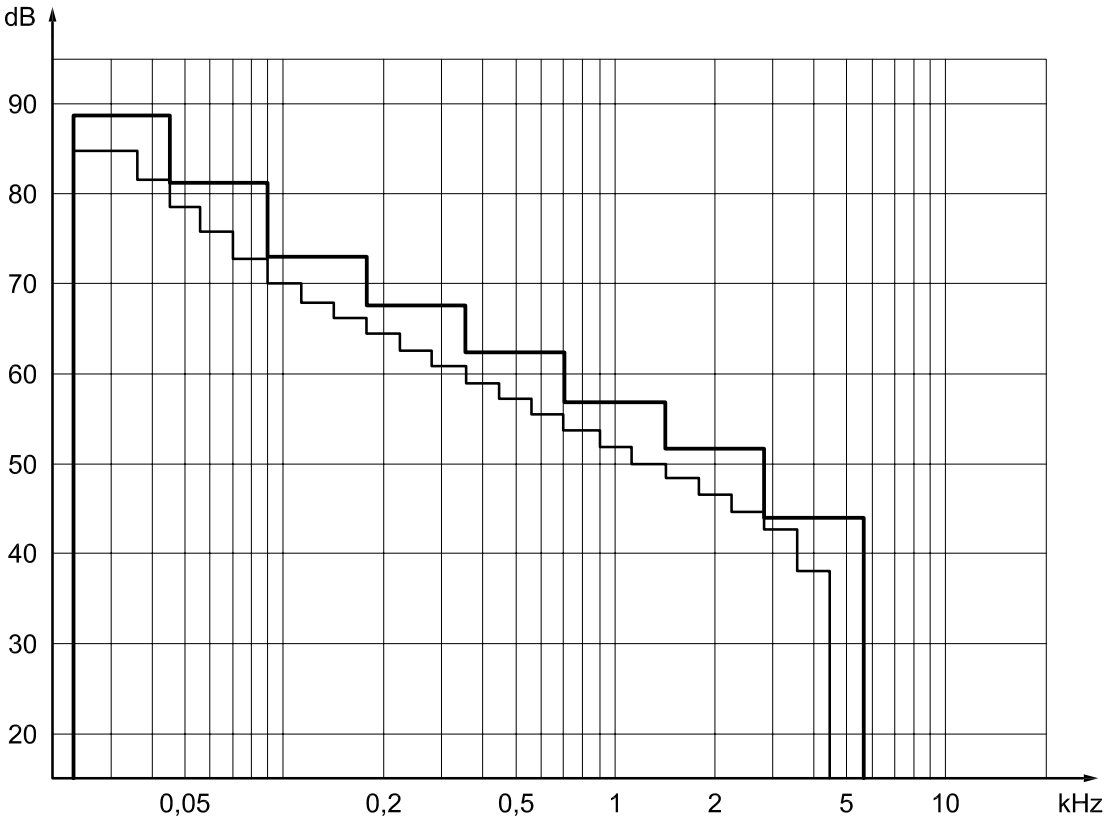


Figure B.2 — Noise spectrum according to IALA E-109, third octave band and octave band levels

Bibliography

[1] <unknown>IALA Recommendation E-109, *Recommendation on the calculation of the range of a sound signal*</unknown>

[2] <unknown>IMO Resolution A.343(IX), *Recommendation on Methods of Measuring Noise Levels at Listening Posts*</unknown>

[3] <lgl>International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974)</lgl>

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