INTERNATIONAL STANDARD

ISO 16273

First edition
2003-12-15

Ships and marine technology — Night vision equipment for high-speed craft — Operational and performance requirements, methods of testing and required test results

Navires et technologie maritime — Équipement de vision nocturne pour navires à grande vitesse — Exigences opérationnelles et de performance, méthodes d'essai et résultats d'essai exigés

Reference number
ISO 16273:2003(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16273 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

Ships and marine technology — Night vision equipment for high-speed craft — Operational and performance requirements, methods of testing and required test results

1 Scope

This International Standard applies to operational and performance requirements and methods of testing for night vision equipment fitted to high-speed craft in accordance with the International Code of Safety for High-Speed Craft (HSC code), Chapter 13, of the International Maritime Organisation (IMO) and the IMO performance standards MSC.94 (72) for night vision equipment for HSC.

All texts of this International Standard, whose wording is identical to that in IMO MSC.94 (72), are printed in italics and the resolution and paragraph numbers are indicated in brackets.

It is expected that both performance requirements and test procedures will need to be reviewed in the near future as data on candidate night vision systems are accumulated and correlated with performance.

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 61162, *Maritime navigation and radiocommunication equipment and systems — Digital Interfaces*

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

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*

IMO Resolution MSC.94 (72), *Performance standards for night vision equipment for high speed craft*

International Code of Safety for High-Speed Craft (HSC Code)

STANAG 4349 (MAS/186-Land/4349, 19 June 1996)

3 Terms and definitions

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

3.1
night vision equipment
any technical fixed *means enabling the position and aspect of objects above the water surface relative to one's own craft to be detected at night*

[IMO MSC.94 (72) 4]

3.2
high-speed craft
any craft to which the definition in chapter 1 of the HSC Code applies

[IMO MSC.94 (72) 4]

3.3
test target for sea trials
a target that simulates the real hazard of a surface object that can be found at sea such as, small unlit boats, floating logs, oil drums, containers, buoys, ice, hazardous waves and whales

[IMO MSC.94 (72) 4]

3.4
lit vessel
a vessel that, in addition to the standard navigation lights, has a row of five 21 W, 12 V unshielded lamps at 1 m horizontal spacing and 4 m above sea level

4 General and operational requirements

4.1 Introduction

Requirements contained in this clause are requirements not taken up in other clauses and which cannot be verified by repeatable methods of measurement.

These requirements include the applicable general and operational requirements of IEC 60945.

The manufacturer shall declare compliance with these requirements and shall provide relevant documentation. The declarations, documentation and, where necessary, the equipment under test (EUT) shall be checked.

The manufacturer shall also declare the composition of the EUT and the category for durability and resistance to environmental conditions specified in IEC 60945 for each unit of the EUT.

4.2 Required functions and their availability (IMO MSC.94 (72) 5.1)

At night, night vision equipment shall *be capable of detecting objects above the water's surface within a certain distance from one's own craft, and of displaying the information pictorially in real time, to assist in collision avoidance and safe navigation.*

4.3 Continuous operation (IMO MSC.94 (72) 5.2.1)

Night vision equipment on board HSC, while navigating at sea, shall *be capable of continuous operation from after sunset until before sunrise. After the equipment has been switched on it* shall *be operational in less than 15 minutes.*

4.4 Standard test target (IMO MSC.94 (72) 5.2.2)

The standard test target shall *be a black metal target of such a size that when at least 50 % is immersed, 1,5 m long and 0,5 m high remains above the water at right angles to the desired direction of detection. Administration may use other smaller targets to reflect local conditions.*

4.5 Detection range (IMO MSC.94 (72) 5.2.3)

With the required field of view, the equipment shall *detect the standard test target at a distance of not less than 600 m with a minimum probability of 90 %, when the target has been immersed in the sea for at least 24 hours under mean starlight conditions without clouds and without moon.*

4.6 Field of view (IMO MSC.94 (72) 5.2.4)

The required horizontal field of view shall *be at least 20°, 10° on either side of the bow. The vertical field of view* shall *be at least 12° and* shall *be sufficient to enable the equipment to fulfill the performance requirements of this International Standard as well as being able to see the horizon.*

Optionally other fields of view may be provided. Their selection shall *be made with a non-locking switch, which returns to the required field of view when released.*

4.7 Pan and tilt ranges of the fields of view (IMO MSC.94 (72) 5.2.5)

The axis of the field of view of the equipment shall *be capable of being moved at least 20° horizontally to either side.*

The elevation axis of the field of view shall *be capable of being adjusted of at least 10° to compensate for the trim of the craft.*

4.8 Speeds of panning of the fields of view (IMO MSC.94 (72) 5.2.6)

By activation of a single control element, the axis of the field of view shall *be capable of being returned automatically to the ahead position at a minimum angular speed of 30°/s. The system* shall *be capable of panning at a minimum angular speed of 30°/s.*

4.9 Heading marker indication (IMO MSC.94 (72) 5.2.7)

When inside the field of view, the graphical ahead mark *of the craft* shall *be indicated on the display with an error not greater than ± 1°.*

When outside the field of view, a visual indication of relative bearing with an error not greater than ± 1° shall *be provided.*

4.10 Roll or pitch (IMO MSC.94 (72) 5.2.8)

The performance of the night vision equipment shall *be such that when the craft is rolling and/or pitching up to ± 10°, the performance requirements in this International Standard* shall *be complied with.*

4.11 Clear view (IMO MSC.94 (72) 5.2.9)

Arrangement shall *be provided to ensure efficient cleaning of the sensor head/lens from the operating position. Administration may require some additional facilities such as de-icing.*

4.12 Optical interference (IMO MSC.94 (72) 5.2.10)

Measures shall *be taken, to ensure that objects commonly encountered at sea and in ports* shall *not be displayed less clearly on the monitor of the night vision equipment because of dazzle effects, reflection, blooming, or any other effects due to the surroundings.*

4.13 Malfunctions, warnings, alarms and indications (IMO MSC.94 (72) 5.3)

Night vision equipment shall *include a visual indication of any failure.*

4.14 Software requirements (IMO MSC.94 (72) 5.4)

The operational characteristics of the software shall *meet the following requirements in particular:*

(IMO MSC.94 (72) 5.4.1.1) *self-description of the functions implemented by means of software;*

(IMO MSC.94 (72) 5.4.1.2) *display of user interface status; and*

(IMO MSC.94 (72) 5.4.1.3) *software protection against unauthorized changes.*

If certain functions of night vision equipment are implemented using software, such software shall *meet the applicable requirements of IEC 60945.*

If any software is used, the manufacturer shall provide a description of the functions implemented by means of software and state how the requirements have been complied with.

"Self-description of the functions implemented by means of software" means that the functions available through menus (or similar) rather than separate controls shall be clear from the menu description.

"User interface status" can be an indicator of which functions are operational.

"Software protection" can be a password or lockable cover.

4.15 Controls and ergonomics (IMO MSC.94 (72) 6)

The night vision equipment shall *be designed in accordance with sound ergonomic principles.*

The number of operational controls shall *be limited to the minimum required for operation.*

Whilst in operational mode, *double functions of controls* shall *be avoided* on such controls as for pan, vertical trim, field of view and other essential functions.

The functions of the individual operational controls shall *be clearly labelled.*

The operational *functions of night vision equipment* shall *be activated directly through the operational controls; menu-driven controls* shall *be avoided.*

The operational controls shall *be clearly identifiable in the dark. If illumination is used, the brightness* shall *be adjustable.*

The operational controls of night vision equipment shall *meet the requirements of IMO Resolution A.694 (17) as well as applicable requirements of IEC 60945.*

4.16 Presentation of information (IMO MSC.94 (72) 6.3)

The status of operation of the equipment shall *be continuously displayed.*

The display shall *be non-dazzling and non-flickering. The display* shall *be capable of displaying a visible image of at least 180 mm in diagonal.*

The selected field of view, if more than one is provided, (see 4.6) shall *be continuously indicated at the operating position.*

The image shall be presented on the display, with the same aspect ratio as the sensors, as default (natural picture).

4.17 Durability and resistance to environmental conditions (IMO MSC.94 (72) 7.1)

Night vision equipment shall *withstand the environmental conditions specified in IMO Resolution A.694 (17) and in IEC 60945.* Provisions shall be made, if necessary, to protect the night vision equipment against high light conditions.

4.18 Electrical and electromagnetic interference (IMO MSC.94 (72) 7.2)

With respect to electrical and electromagnetic interference, night vision equipment shall *meet the requirements of IMO Resolution A.694 (17) and IEC 60945.*

4.19 Power supply (IMO MSC.94 (72) 7.3)

The power supply of night vision equipment shall *meet the requirements of IMO Resolution A.694 (17) and IEC 60945.*

4.20 Installation (IMO MSC.94 (72) 7.4)

Full installation instructions to meet the following *requirements of 4.20* shall *be included in the documentation (see 4.26).*

The controls of night vision equipment shall be installed in the workstation for navigating and manoeuvring, within easy reach of the navigator.

The observation distance from a dedicated display shall *not exceed 2,3 times the image diagonal* (i.e. a dedicated night vision workstation).

For a general bridge display, the observation distance from the display shall not exceed 8 times the image diagonal, but shall be situated such that observation from a distance of 2,3 times the image diagonal is also possible.

The sensor of the night vision equipment shall *be installed in such a way that:*

a) *the horizontal panning area required in 4.7 is free of blind sectors up to 30° on either side; and*

b) *in the required field of view, in the direction right ahead, visibility of the water surface for the vertically tilted sensor is not reduced by more than two craft's lengths by the blind angle of own craft.*

Night vision equipment shall *be installed in such a way that its operation and detection functions are not impaired by head wind and/or true wind up to 100 knots and roll and/or pitch angles up to ± 10°.*

Its performance shall *not be impaired by vibration occurring during normal craft's operation.*

4.21 Maintenance (IMO MSC.94 (72) 7.5)

With respect to maintenance, night vision equipment shall *meet the requirements of IMO Resolution A.694 (17) and IEC 60945. Where the manufacturer requires maintenance at specific periods, an operating hours meter* shall *be provided.*

4.22 Interfacing (IMO MSC.94 (72) 8)

Interfaces with other radio and navigation equipment shall *meet IEC 61162. A recognized international standard video output for image recording* shall *be provided.*

4.23 Back up and fall back arrangements (IMO MSC.94 (72) 9)

In the event of failure of the pan-tilt device, the sensor shall *be capable of being fixed in the ahead position while underway.*

4.24 Safety precautions (IMO MSC.94 (72) 10)

The safety features of night vision equipment shall *meet the requirements of IMO Resolution A.694 (17) and IEC 60945.*

4.25 Marking and identification (IMO MSC.94 (72) 11)

Night vision equipment and any ancillary equipment shall be marked clearly and durably with the following data:

- identification of the manufacturer;
- equipment type number or model identification under which it was type tested;
- serial number of the unit; and
- magnetic compass safe distance.

Night vision equipment shall additionally *be marked in accordance with the requirements of IMO Resolution A.694 (17) and IEC 60945.*

4.26 Documentation (IMO MSC.94 (72) 12)

Night vision equipment shall *be delivered complete with its technical documentation. Such documentation* shall *include the following information, if applicable:*

General information:

- *manufacturer;*
- *type designation;*
- *general description of equipment; and*
- *ancillary equipment and description.*

Instructions for installation:

- *general installation instructions;*
- *power supply (voltage, power consumption, frequency) and earthing information;*
- identification of exposed or protected equipment.

Operation of equipment:

- *description of functions, controls, display;*
- *description of start-up procedures;*
- *calibration of equipment and error messages;*
- *testing capabilities of equipment;*
- *description of software used and interfaces.*

Troubleshooting; maintenance and service:

- *special tools required, maintenance material and spare parts (e.g. fuses, spare bulbs);*
- *equipment care and maintenance on board HSC;*
- *available services.*

Documentation for night vision equipment shall *also meet the requirements of IMO Resolution A.694 (17) and IEC 60945.*

4.27 Environmental requirements

Each item which appears in this clause is a requirement from IMO Resolution A.694 (17) as detailed in IEC 60945 and for which a repeatable method of measurement has been defined in Clause 6.

5 General test conditions

5.1 General

Environmental and safety tests shall be carried out first, followed by laboratory tests and sea trials to verify whether the same EUT meets all technical requirements. Where electrical tests are required, they shall be carried out using the normal test voltage as specified in IEC 60945.

Requirements detailed in Clause 4 for which a specific test is not detailed, shall be confirmed by a visual check of the equipment or documentation. The manufacturer shall provide a full technical specification for the EUT.

5.2 Normal temperature, humidity and extreme test conditions

Test conditions shall comply with IEC 60945.

6 Environmental tests

6.1 General

Environmental tests are intended to assess the suitability of the construction of the equipment under test (EUT) for its intended physical conditions of use. After each environmental test and, if specified, also during the test, the EUT shall comply with the requirements of a performance check. No preconditioning of the equipment shall be necessary.

6.2 Range of environmental tests

6.2.1 Test according to IEC 60945

Night vision equipment shall, as far as applicable, meet the requirements and pass the tests according to IEC 60945.

6.2.2 Roll and pitch test

This test is intended to prove the ruggedness of the system under the ship motions of 4.10.

The EUT shall be mounted on a surface capable of producing a rolling cycle from + 10° to – 10° from the horizontal in 8 s. The EUT shall be subject to the rolling cycle for 30 min during which a functional performance check (6.3) shall be performed. The EUT functions shall continue to operate without degradation during the rolling cycle.

The test shall be repeated with the EUT positioned such that a pitching cycle of ± 10° is produced.

6.2.3 Optical interference

The EUT shall meet the requirements of 4.12 when tested in accordance with 8.4.3.

6.3 Performance check

The performance check is to verify that the EUT is still operational after being subjected to the environmental tests and any other test where it is specified.

The performance check shall ensure that the EUT meets the requirements of

- re-selection of field of view if available;
- pan range;
- pan speed;
- vertical trim adjustment;
- sensor and display operation.

The equipment shall provide a clear picture of objects consistent with that at ambient conditions.

7 Laboratory tests

7.1 Introduction

Laboratory tests shall be performed with the EUT which has passed the environmental tests specified in Clause 6.

The purpose of these technical tests is to provide a means of performing laboratory controlled tests on all types of night vision equipment. The results of these tests will be used to compare the measured performance to pre-established standards that have been validated via at-sea tests to meet the navigational needs for night navigation of HSCs.

The laboratory tests have been developed to measure the various capabilities of the EUT, including man-machine interfaces, displays, mechanical operation, and sensor.

The methods and procedures of the laboratory tests have been derived such that, when the results are compared to previous test results, they will reliably predict the at-sea performance of the system.

7.2 Measurement of thermal imaging systems

7.2.1 Thermal imager system

Minimum Resolvable Temperature Difference (MRTD) and/or Minimum Detectable Temperature Difference (MDD) shall be measured according to the STANAG 4349 (MAS/186-Land/4349, 19 June 1996). A general description including the number of observers, room and target temperature and other relevant data shall be presented.

Figures from both the horizontal and the vertical measurements shall be recorded in a diagram with the Spatial Frequency (cycles/mrad), linear scaled, on the horizontal axis and the Temperature Difference Δt (degrees Celsius), logarithmic scaled, on the vertical axis.

At least four targets shall be measured. In the diagram, the desired target shall be plotted at a Δt of 1 °C. The targets used at the measurement shall have a spatial frequency both larger and equal to / smaller than:

Horizontal: Target equivalent Instant Field of View ($IFoV_t$) = 1,5/600 = 0,0025 rad = 2,5 mrad or target equivalent frequency (Fr_t) = 1/$IFoV_t$ = 1/2,5 = 0,4 cycles/mrad

Vertical: Target equivalent Instant Field of View ($IFoV_t$) = 0,5/600 = 0,00083 rad = 0,83 mrad or target equivalent frequency (Fr_t) = 1/$IFoV_t$ = 1/0,83 = 1,2 cycles/mrad

7.2.2 Range predictions

The following procedure is under consideration for a future edition of this International Standard and it is recommended that the procedure be followed and the results recorded.

A range-prediction calculation shall be performed using a generally accepted software model such as Acquire FLIR 92 or the TRM 3 or the attached algorithm in Annex A (informative) and Figures A.1 and A.2. The detection probability at 600 m shall be calculated.

The measured MRTD figures and the following input data shall be used:

Different atmospheric constants shall be used for different types of images in accordance with Table 1.

Table 1 — Atmospheric constant for type of images

Cut-on and cut-off wavelength	Atmospheric constant[a]
Mid: 3,2 µm to 5 µm : σa1	0,56 km^{-1}
Long: 8 µm to 12 µm : σa2	0,21 km^{-1}
[a] See Annex A.	

Path length: 0,6 km

Temperature equivalent Δt: 1,0 °C

Three different calculations with the following number of line-pairs per target size shall be supplied:

— 0,66

— 1,3

— 1,6

7.3 Active image-intensifier systems

7.3.1 Illuminator spectrum

The illuminators shall not interfere with the night vision of the bridge personnel of the HSC or other craft.

In order to protect night vision of the bridge personnel, the illuminator shall include optical filters such that light emission in the visible spectrum (450 nm to 650 nm) does not exceed a luminance of 0,2 % (when calculated using the scotopic response of the human eye).

7.3.2 Measurement of active image-intensifier systems

The following procedure is under consideration for a future edition of this International Standard and it is recommended that the procedure be followed and the results recorded.

7.3.2.1 Image-intensifier sensor

The image-intensifier sensor under test shall be placed on an optical measurement bench in a laboratory capable of controlling the illumination level (in the same spectrum as used by the illuminators) down to 1×10^{-4} lx. Such dark tunnels shall have a known record of performance.

The following procedure is used to establish the performance and provide an acuity curve for evaluating the performance.

a) Arrange one of the system illuminators with a variety of aperture stops employed to vary the illumination level so that it provides the only illumination in the dark laboratory.

b) Mount the sensor at a fixed range of at least 25 m, such that the acuity chart is in-focus.

c) Select an acuity chart of 25 %, 40 % and 60 % target contrast. Adjust the aperture stops on the illuminator and determine the limiting spatial frequency of the system, in the dark laboratory for each of the patterns on the Acuity chart.

d) The incident illumination level at the chart position shall be measured.

e) The acuity curve (spatial frequency vs. illumination level) can then be plotted. The spatial frequency axis can be replotted as a range by assuming a number of cycles across the target for a detection task at 90 % probability.

7.3.2.2 Infrared illuminators

The infrared illuminators used by the system under test shall be placed on an optical measurement bench and the following measurements taken.

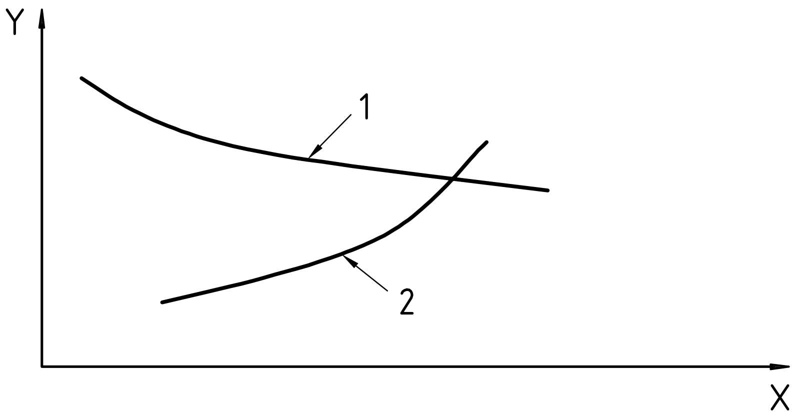
a) The optical spectrum of the light emission.

b) The intensity of the light emission (this may be taken at any convenient distance). The measured intensity of light emission is used to produce the illumination fall-off curve in Figure 1.

c) Plots of the horizontal and vertical emission intensity of the illuminator. The light emission (corrected for distance) shall be maintained over at least 20° if the illuminator tracks the sensor head movement. If the illuminator(s) is (are) fixed relative to the craft's heading then the light emission shall be maintained over at least 60°. Combination plots may be used to provide this data if more than one illuminator is declared by the supplier.

7.3.2.3 Range predictions

The imager acuity curve and the illuminator fall-off curve should be plotted. The crossing point of these two curves determines the range performance of the active system, see Figure 1.



Key

1 illumination fall-off curve

2 image acuity curve

X Range (m)/Spatial frequency (cycles/mrad)[a]

Y Illumination level (lx)

[a] There are two scales on the axis. The range can be calculated from the spatial frequency using the formula given in Annex A.

Figure 1 — Range prediction for active image-intensifier systems

The extinction coefficient for calculating the illumination fall-off due to atmospheric effects is σa3 = 0,22 km^{-1}. The fall-off due to the “photometric distance law” must be considered additionally (illuminance ≅ $1/R^2$, where R is the range).

Required result:

The point on the curve at which the two curves cross shall show a range equivalence of at least 600 m.

Typical plots are shown in Annex B, Figure B.1.

7.4 Other technology

At the present time, active illuminated intensifier systems and thermal imager systems are available. This section is under consideration for future revisions of this International Standard for future technologies.

8 Sea trials

8.1 Introduction

Sea trials shall be performed with the same EUT which has passed the environmental tests according to Clause 6 and which has been subjected to laboratory tests according to Clause 7.

Night vision equipment shall pass a sea trial before approval. Test conditions and test results shall be recorded. A suitable report form can be found in Annex C (informative). The sea trial shall be conducted at night under normal test conditions (see 8.3), which shall be measured and recorded.

Approval agencies shall maintain a matrix of sea trial results and laboratory test results. Initial input shall be generated using the EUTs' sensors to conduct sea trials on various vessels under the defined environmental conditions. During sea trials, illuminators shall be used when defined as part of the EUT. The sea trial shall measure the actual performance of the EUT.

NOTE The accurate recording of sea trial data may allow future development of a robust laboratory validation process in future editions of this specification.

8.2 Test target for sea trials

The test target for sea trails shall be an enclosed black sea-proofed aluminium box of 6 mm thickness which has been immersed in the sea for at least 24 h. The box shall either be anodized or painted black. If painted, the colour shall not be brighter and the reflection shall not be higher than that of anodized aluminium in the spectral band used by the EUT.

Provisions shall be made to measure the actual temperature at the centre of the test side of the target.

The size of the box is such that, when at least 50 % is immersed:

- 1,5 m long;
- 1,5 m wide;
- 0,5 m high;

remains above the water.

Administrations may use other smaller targets to reflect local conditions.

8.3 Test conditions

Sea trials shall be conducted at night under the following test conditions:

- apparent sea state: 2 to 5, according to the Beaufort-scale;
- wind speed: 4 kn to 22 kn;
- sea temperature: 1 °C to 25 °C;
- air temperature: 0 °C to 35 °C;
- humidity: 40 % to 96 %;
- natural illumination level: mean starlight conditions without clouds and without moon (5×10^{-4} lx to $1{,}3 \times 10^{-3}$ lx);
- at least 2 h after sunset;
- good visibility: not less than 5 NM (nautical miles);
- speed of vessel: $\geqslant$ 8 kn;
- height of sensor above waterline: 8 m to 10 m.

8.4 Test procedures

8.4.1 General

The test target (as defined in 8.2) shall be immersed in the water at the test side for at least 24 h such that the approach to the test target can be performed against an open-water background.

The sensor of the EUT shall be mounted on the craft used for the sea trials in a height of 8 m to 10 m above the waterline and according to the installation requirements defined in 4.20. Before starting and during the sea trials, the following data shall be measured by using calibrated measurement equipment and recorded:

- sea temperature;
- air temperature;
- humidity;
- height of sensor above waterline;
- test target temperature;
- target-background contrast;
- barometric pressure;
- speed over ground of the vessel;
- natural illumination level;
- visibility;
- wind speed.

The following shall be observed and recorded:

- sea state according to the Beaufort-scale;
- sky condition;
- target condition and identification;
- location of trials.

If the actual conditions are outside the range of the test conditions, no sea trial shall be conducted.

The measurements and observations, including times, shall be recorded in accordance with the form shown in Annex C.

8.4.2 Detection-range evaluation

The target shall be placed in the test area 24 h before the test. The craft, on which the EUT is installed, shall proceed away from the test target up to a minimum distance of 1 200 m and then proceed with a minimum speed of 8 kn towards the target, in such a way that the target remains within a sector of ± 5° from the craft's bow.

The target shall be placed in open water with no background sources of interference such that the test can be performed against an open-water background. The craft shall approach the target at 90° ± 10° to one of the target faces.

The target shall be observed by the radar operator to measure continuously its actual distance. The observer (or observers) for night vision equipment shall observe the monitor of the EUT and may operate the EUT as usual.

When the target is detected on the monitor, the actual distance of the target shall be measured by the radar operator. The measured data shall be recorded. This procedure shall be repeated ten times. One failure (e.g. detection range less than 600 m with the required field of view) is allowed in 10 times. If two failures occur in the 10 runs, it is permissible to go to a total of 20 runs and, if no further failures occur, the EUT has passed.

8.4.3 Optical interference

The craft on which the EUT is installed shall maintain a position 500 m from the test target that shall be within 5° of the craft lubber line. The target shall present a side at 90° ± 10°.

A lit vessel (as defined in 3.4) shall proceed at about 5 kn approximately on a bow-crossing course with a closest point of approach of 1 500 m.

The observer shall monitor the target during the crossing to confirm that the displayed target remains clearly visible during the crossing.

Annex A
(informative)

Range prediction calculation

Convert “spatial frequency” of MRTD (Minimum Resolvable Temperature Difference) curve into “range (R)” by using the following formula.

$$R = \frac{\sqrt{A_t}}{N_{90\,\%}} f$$

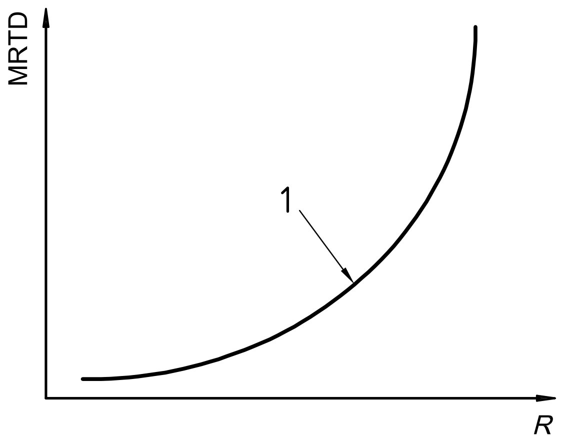
where

R is the predicted range, in which a target can be detected;

A_t is the target area (= 1,5 m x 0,5 m);

$N_{90\,\%}$ is the number of line pairs for 90 % detection probability (= 1,3 line pairs);

f is the spatial frequency in cycles/mrad.



Key

1 $MRTD_{2D}$

Figure A.1 — Typical MRTD versus range curve

Calculate the target apparent temperature difference (Δt) by using the following formula, and draw a line of Δt curve on the MRTD versus R graph.

$$\Delta t = \Delta t_0 \exp(-\sigma R)$$

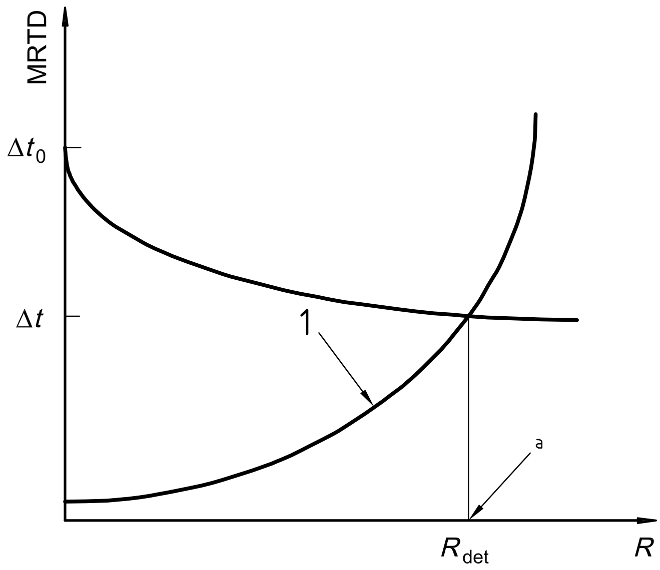
where

Δt_0 is the initial temperature difference, 1 °C;

σ is the atmospheric extinction coefficient:

— 0,56 km^{-1} for 3,2 µm to 5 µm systems;

— 0,21 km^{-1} for 8 µm to 12 µm systems.



Key

1 MRTD$_{2D}$

[a] Detection range.

Figure A.2 — Prediction of range performance from MRTD curve

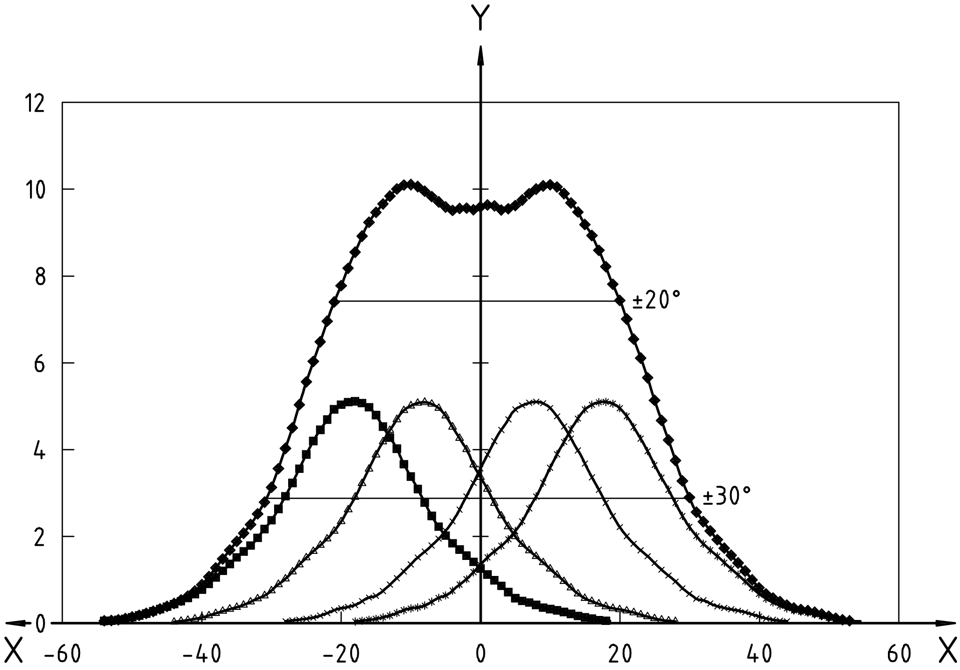
Determine the detection range (R_{det}) by using the graph, in Figure A.2.

The detection range shall be not less than 0,6 km.

NOTE The number of line pairs for 90 % detection probability ($N_{90\ \%}$ = 1,3 line pairs) is calculated by $N_{50\ \%}$ = 0,75 line pairs according to “Electro-Optical Imaging System Performance” (SPIE Optical Engineering Press).

Annex B
(informative)

Infrared illuminator, typical plots



Key

X degrees

Y illumination level, lx

Figure B.1 — Horizontal angular power distribution of 4 IR illuminators and composite response

The four illuminators shown in this example are at:

+ 18°, + 8°, – 8°, – 18°

relative to own craft heading.

Annex C
(informative)

Sea trial record

Company/Applicant ....

Equipment Name ....

Equipment Type/Class ....

Testing Organization ....

Trials Vessel..

File Reference..

C.1 Equipment Identity

The equipment listed below has been supplied for testing.

C.1.1 Sensor Head	
Type	
Sensor technology	
Lens/Optic system	
C.1.2 Display Unit	
Type	
Size	
Monochrome/Colour	
C.1.3 Illuminators (Only applicable for Active Image Intensifier Systems)	
Type	
Number used	
Position on test vessel	

Remarks/Comments

....

....

....

Accepted for test

Signature .... Date..

C.2 Trial Installation Details

Date of Test ....

Location of Trails Site ....

Latitude .... Longitude ....

C.2.1 Trial Vessel	Detail
Name of Vessel	
Length of Vessel	
Mounting Height of Sensor	
Mounting Height of Illuminators (if fitted)	
Number of Illuminators (if fitted)	

C.2.2 Test Target	Detail
Designation/Serial Number	
Size of Face above water	
Test Target Temperature	
Colour of Face	
Nature of surface finish (delete)	Paint/Anodizing/Other (state)

C.2.3 Trial Conditions		Detail	
		Start of Trial Runs	End of Trial Runs
Air Temperature	°C		
Water Temperature	°C		
Visibility	NM		
Target-background contrast			
Humidity	%RH		
Barometric Pressure	mBar		
Wind Speed	kn		
Sea State	Bft		
Sky Condition			
Natural Illumination	lx		

Remarks/Comments

....

....

....

C.3 Detection-Range Evaluation (See 8.4.2)

C.3.1	Standard Detection Runs			
Run	Time	Vessel Speed over Ground	Detection Range	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

C.3.2	Second-Series Detection Runs			(If needed)
Run	Time	Vessel Speed over Ground	Detection Range	Remarks
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

C.4 Optical Interference (See 8.4.3)

C.4.1	Crossing Lit Vessel				
			Confirm target clearly observed ✓		
Run	Time	Sensor	Before crossing	At same bearing	After crossing
1		Static			
2		Static			

Remarks/Comments

....

....

Trials complete

Trials engineer Name ....

Signature .... Date...

Bibliography

[1] IMO Resolution A.830 (19), *Code on alarms and indicators*

ICS 47.020.70

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