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Navires et structures maritimes — Compas magnétiques marins, habitacles et alidades

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 25862:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Clause 1: an overview of the annexes was added.

— Clause 2: moved IMO Resolution A. 382 (X) to the Bibliography.

— Clause 3: 3.4 and 3.5 were added.

— Clause 4: 4.1 was added. The temperature range of Class B magnetic compasses was changed to "−30 °C to +60 °C" (4.2.6). The magnetic moment of Class B magnetic compasses was added to Figure 1. Table 2 was updated (Equal interval of the graduation of Class B magnetic compasses was changed to "1°, 2°, 2,5° or 5°". Card numbered of Class B magnetic compasses was changed to "Every 30° or every 10°".) and 4.7 was updated.

— Clause 5: 5.1, 5.2.1, and 5.3.1 were added. 5.2.6 and 5.3.6 were updated.

— Clause 6: 6.1 was added.

— Annex D: D.2.4.1 and D.2.6.1 were added.

— Annex H: H.2.1 was added.

— Bibliography: IMO Resolution A. 382 (X) and EN 166 were added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Marine magnetic compasses, binnacles and azimuth reading devices

1 Scope

This document specifies requirements for the construction and performance of marine magnetic compasses for navigation and steering purposes, binnacles and azimuth reading devices.

Two types of binnacle are specified; the appropriate type for a given vessel is determined by the design of the ship (see Clause 5).

This document applies to liquid-filled magnetic compasses:

— intended for use in ship's navigation and steering in sea navigation;

— having a direct reading system; and

— which can be of the reflecting, projecting or transmitting types.

In the context of this document, a magnetic compass is an instrument consisting of a directional system supported by a single pivot inside a bowl that is completely filled with liquid and supported by gimbals inside or outside the bowl. However, this document also addresses compasses without gimbals; the requirements relating to gimbals do not apply to such compasses.

This document applies to magnetic compasses carried on board:

a) all ships required to carry a standard compass as per SOLAS Chapter V, the Class A magnetic compass;

b) lifeboats and rescue boats as per the IMO Lifesaving Appliances (LSA) Code, fitted with the Class B magnetic compass; and

c) all ships to which a) and b) above do not apply, but which are fitted with a Class A or B magnetic compass.

This document does not apply to:

a) dry card compasses;

b) types of compass designed on principles different from those stated above or not complying with the descriptions given; or

c) hand bearing compasses.

The requirements for the testing and certification of marine magnetic compasses, azimuth reading devices and binnacles are given in Annexes A, B, C, and D. The requirements for the positioning in ships, the determination of safe distances and the deviation adjustment of compasses are given in Annexes E, F and G, respectively. The special requirements of the magnetic compass for lifeboats/rescue boats are given in Annex H.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 1069, *Magnetic compasses and binnacles for sea navigation — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1069 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
magnetic control sensor
sensor using the geomagnetic field for feeding an automatic heading-control system, or controlling an off-course alarm unit, or feeding other devices

3.2
minimum distance
distance measured between the nearest point of magnetic material which is part of the ship's structure and the centre of the compass

Note 1 to entry: The minimum distance for a standard compass is given in Figure E.1 and for a steering compass is given in Figure E.2.

3.3
safe distance
distance measured between the nearest point of the item concerned and the centre of the compass

Note 1 to entry: The safe distance is determined as specified in Annex F.

3.4
settling time
time taken to return finally to within ±1° of the magnetic meridian after an initial deflection of 90° from that meridian

3.5
pelorus
device used for taking bearings of distant objects or the sun, which are obscured from view at the compass position and whose altitudes are between 5° below and 30° above the horizontal

4 Magnetic compasses

4.1 General

4.1.1 Class A magnetic compass

— intended for ship's navigation and steering purposes in sea navigation;

— liquid-filled magnetic compass, with or without gimbals; and

— having a direct reading system, which can be of the reflecting, projecting or transmitting types.

4.1.2 Class B magnetic compass

— intended for sea navigation on board ships for "restricted service, lifeboats or rescue boats";

— liquid-filled magnetic compasses, with or without gimbals; and

— having a direct reading system; which can be of the reflecting, projecting or transmitting types.

4.2 Construction and materials

4.2.1 Magnetic material

The magnets used in the directional systems of magnetic compasses shall be of a suitable magnetic material having a high remanence and coercivity of at least 18 kA/m. All other fixtures used in magnetic compasses, other than transmitting compasses, shall be made of non-magnetic material.

4.2.2 Lubber mark

In class A compasses, the distance between the lubber mark and the outer edge of the card shall be between 1,5 mm and 3,0 mm for direct reading and reflecting types and between 0,5 mm and 1,5 mm for projecting compasses. The width of the lubber mark shall not be greater than 0,5° of the graduation of the card.

In class B compasses, the compass shall be fitted with at least one lubber mark, indicating the direction of the ships head (the main lubber mark). Additional lubber marks are permissible.

The lubber mark shall be of such design as to allow the compass to be read from the steering position when the bowl is tilted 10° in the case of a gimbal compass or 30° in other cases.

4.2.3 Position of the card (class A only)

When the verge ring and the seating for the azimuth reading device are both horizontal, the graduated edge of the card, the lubber mark if a point, the pivot point and the outer gimbal axis shall lie within 1 mm of the horizontal plane passing through the gimbal axis fixed to the bowl.

4.2.4 Angle of gimbal axes and intersection of vertical planes passing through them

The angle formed by the outer and inner gimbal axes shall be of the values given in Table 1. The vertical planes through the gimbal axes shall intersect to within 1 mm of the pivot point. Any end play shall not cause these tolerances to be exceeded.

Table 1 — Angle of gimbal axes

Magnetic compasses	Angle of gimbal axes
Class A	(90 ± 1)°
Class B	(90 ± 2)°

The outer gimbal axis shall be in the fore and aft direction. For compasses without gimbals, which are also covered by this document, the requirements relating to gimbals do not apply.

4.2.5 Thickness of the top glass cover (class A only)

The thickness of the top glass cover and of the bottom glass of the compass shall be not less than 4,5 mm, if non-toughened, and not less than 3,0 mm, if toughened. These values do not apply to the thickness of the top glass in hemispherical compasses. If material other than glass is used, it shall fulfil the requirement of B.1 d).

4.2.6 Constructional condition within the temperature range

All class A and class B compasses shall operate satisfactorily throughout the temperature range −30 °C to +60 °C, and:

a) the liquid in the compass bowl shall remain clear and free from bubbles and neither emulsify nor freeze;

b) there shall be neither inward leakage of air nor outward leakage of liquid. No bubble shall form in a compass unless it is specially provided to compensate for expansion. A bubble provided in a compass to compensate for expansion shall not inconvenience the functioning and reading of the compass;

c) the internal paint shall not blister, crack or discolour appreciably;

d) the supporting force shall be such that the directional system always remains in contact with its pivot;

e) the material of the compass card shall not distort.

4.2.7 Horizontal position

The compass bowl shall be balanced so that its verge ring or top glass cover settles within 2° of the horizontal plane when the gimbal ring is fixed in a horizontal position; this shall be so with, or without, an azimuth reading device or magnifying glass is in place.

4.3 Mounting

4.3.1 Tilt of supporting device

The bowl of the compass shall be mounted in such a manner that the compass cannot be dislodged under any conditions of sea or weather and so that the verge ring remains within 2° of the horizontal plane when the binnacle is tilted in any direction to a maximum of:

a) 40° for class A compasses, and

b) 30° for class B compasses.

The inner and outer gimbal bearings shall be of the same type.

4.3.2 Freedom of the compass card with no supporting gimbal

In compasses in which no supporting gimbal is provided, the card shall be free to move at least 30° in all directions.

4.4 Directional system

4.4.1 Moment of inertia

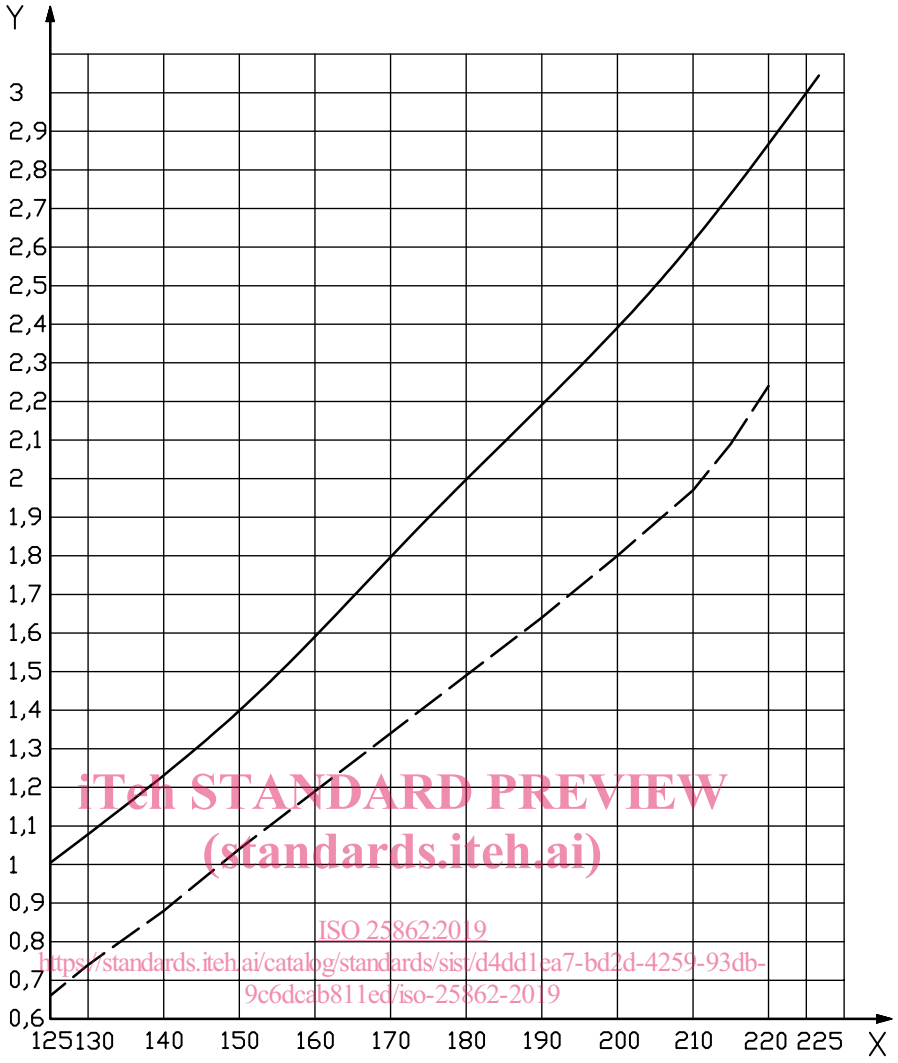
The moment of inertia of the directional system shall be approximately the same about all horizontal axes passing through the point of support on the pivot jewel.

4.4.2 Suspension (class A only)

The directional system shall be retained in position by suitable means and remain free when the bowl is tilted 10° in any direction.

4.4.3 Magnetic moment

The magnetic moment of the magnets in the directional system shall not be less than the value given in Figure 1.



Key

X card diameter, expressed in mm

Y magnetic moment, expressed in $A \cdot m^2$

——— class A magnetic compass

— — — class B magnetic compass

Figure 1 — Magnetic moment of liquid filled compasses (minimum requirements)

4.4.4 Settling time

The settling time of a directional system shall not exceed $240/\sqrt{H}$ s at a temperature of (20 ± 3) °C, where H is the horizontal component of the magnetic flux density in microteslas (μT) at the place of testing.

4.4.5 Tilt of the directional system with regard to the vertical field (class A only)

The directional system shall be so constructed, or balanced in such a way, that it does not incline more than 0,5° from the horizontal plane when the vertical flux density is zero. The inclination shall not change by more than 3° when the vertical flux density changes by 100 μT.

4.4.6 Supporting force (class A only)

The force exerted on the pivot bearing, in the liquid used at a temperature of (20 ± 3) °C, by the directional system shall be between 0,04 N and 0,14 N.

4.5 Compass card

4.5.1 Graduation

The compass card shall be graduated in 360 single degrees, starting from North in the clockwise direction as viewed from above. The marks shall be at intervals as given in Table 2. In addition, as given in Table 2, at least every ten degrees (class A) and every ten or thirty degrees (class B) shall be marked with their corresponding three figure number (e.g. 030). North shall be indicated by "000°".

The cardinal points shall be indicated by the capital letters "N", "S", "E" and "W"; the intermediate points may also be marked. Alternatively, the North point may be indicated by a suitable symbol.

Table 2 — Graduation of the card

Magnetic compasses	Equal interval of the graduation	Card numbered
Class A	1°	Every 10°
Class B	1°, 2°, 2,5° or 5°	Every 30°or every 10°

Where the compass card is printed on both sides, the graduations shall coincide with a tolerance of 0,2°.

4.5.2 Diameter of the card

The diameter of the compass cards shall be as given in Table 3.

Table 3 — Diameter of the card

Magnetic compasses	Binnacle types	Diameter of the card
Class A	A1	165 mm or more
	A2	125 mm or more
Class B	A1	125 mm or more
	A2	
NOTE 1 Binnacle types are defined in 5.2 (Type A1) and 5.3 (Type A2).		
NOTE 2 The required diameter of a compass card for use in lifeboats/rescue boats is given in H.2.2.		

4.5.3 Readability

Steering compasses of each class shall be able to be read by a person with normal vision at a distance from the magnetic compasses as given in Table 4 in both daylight and artificial light, the graduations on the card being contained within a sector whose width is not less than 15° to each side of the lubber mark. The use of a magnifying glass is permitted.

For reflecting and projecting compasses, the lubber mark shall be visible, and the 30° sector of the card shall be readable by a person with normal vision at a distance of 1 m from the reproduced compass image.

Table 4 — Readable distance

Magnetic compasses	Readable distance of compasses
Class A	1,4 m
Class B	1,0 m

4.5.4 Bearing compasses

If a bearing compass is provided with a scale for the measurement of bearings relative to the ship's head, the scale shall be graduated in degrees from 0° to 360° in a clockwise direction, where zero, as seen through the azimuth reading device, indicates the direction of the ship's head.

4.6 Accuracy

4.6.1 Directional error

The directional error results from inaccuracies in the construction of a directional system. It is composed of:

a) misalignment between magnet orientation and the graduation of the system compass card (collimation error);

b) inaccuracies of the compass card graduation;

c) eccentricity of the compass card graduation in relation to the centre of rotation of the card.

Irrespective of heading, the directional error shall not exceed the values given in Table 5.

Table 5 — Directional error

Magnetic compasses	Permissible directional error
Class A	0,5°
Class B	1,5°

In transmitting magnetic compasses, the directional error applies to the compass without magnetic sensor and electronics for generating a suitable output signal for other devices. The magnetic sensor of a transmitting magnetic compass shall be placed so that the influence on the card heading shall not exceed 0,5° in the case of class A.

NOTE If the test is undertaken in the compass bowl, the resulting value then includes the deviation due to any magnetic material in the compass and/or in the magnetic sensor and electronics for generating a suitable output signal for other devices.

4.6.2 Error of lubber marks

The lubber error is a constructional error of the compass bowl and gimbal, which depends on the relative position of the main lubber mark (if it is fixed), the pivot bearing, and the direction of the outer gimbal axis.

No lubber error shall exceed the values given in Table 6.

Table 6 — Lubber error

Magnetic compasses	Permissible lubber error
Class A	0,5°
Class B	1,0°

4.6.3 Error due to friction

With the compass at a temperature of (20 ± 3) °C, the card is given an initial deflection (for values see Table 8) first on one side of the meridian and then on the other. It shall return to its original position within the values given in Table 7, where *H* is as defined in 4.4.4.

Table 7 — Friction error

Magnetic compasses	Initial deflection	Permissible friction error
Class A	2°	Less than $(3/H)°$
Class B	5°	Less than $(9/H)°$

4.6.4 Swirl error

With the compass at a temperature of (20 ± 3) °C and rotating at a uniform angular speed of 6°/s in the horizontal plane, the card deflection from the magnetic meridian when the bowl has been rotated 180° shall not exceed the values given in Table 8.

Alternatively, when rotating at a uniform angular speed of 1,5°/s, the card deflection, measured after the bowl has been rotated 360°, shall at no point exceed the values given in Table 8, where *H* is as defined in 4.4.4.

Table 8 — Swirl error

<table>
<tr><th colspan="2" rowspan="2">Magnetic compasses</th><th colspan="2">Permissible card deflection</th></tr>
<tr><th>Angular speed: 6°/s
measured after 180° rotation</th><th>Angular speed: 1,5°/s
measured after 360° rotation</th></tr>
<tr><td rowspan="2">Class A</td><td>Card diameter: 200 mm or more</td><td rowspan="3">(108/H)°</td><td>(54/H)°</td></tr>
<tr><td>Card diameter: less than 200 mm</td><td>(36/H)°</td></tr>
<tr><td colspan="2">Class B</td><td>(40/H)°</td></tr>
</table>

4.6.5 Induction error (class A only)

If the arrangement of magnetic elements in a directional system is inadequate, magnetic induction in correctors (soft iron spheres or similar conventional correctors) of coefficient *D* due to those elements results in a compass error. Such an error is described as induction error.

In order to avoid the effect of induction error, one of the following requirements shall be fulfilled:

a) the ratio of coefficient *H* to coefficient *D* shall not exceed 0,08; or

b) the coefficient *F* of the sextantal deviation (caused by a small magnet, less than 50 mm in length — placed in the same horizontal plane as the magnetic elements and at a tangential distance of about 40 cm from the centre of the directional system) shall be less than 0,01 of coefficient *B* of the semicircular deviation.

NOTE The coefficients *B*, *D*, *F*, and *H* are defined in ISO 1069.

4.6.6 Mounting error of azimuth reading device

Where the azimuth reading device is pivoted on an arrangement within the compass bowl, the vertical axis of the device shall be within 0,5 mm of the pivot point.

4.6.7 Error due to eccentricity of the verge ring (class A only)

If the verge ring is graduated, the perpendicular to the plane of this ring through the centre of the graduations shall be within 0,5 mm of the pivot point.

4.7 Environmental conditions tests of magnetic compasses (class A only)

The magnetic compass shall be subjected to, and meet the requirements of, the following environmental tests specified in IEC 60945:

a) damp heat;

b) rain and spray.

Optionally, the vibration test may be additionally carried out assembled in the binnacle as specified in IEC 60945.

NOTE Environmental conditions tests of the magnetic compass for lifeboat/rescue boats are given in H.2.4.

5 Binnacles

5.1 General

There are two types of binnacle that may be used in ships, type A1 or type A2. Selection of the correct type to be used is dependent upon the nature of the ship in which the binnacle will be fixed. Descriptions of, and performance requirements for, the two types are given in 5.2 and 5.3.

Magnetic compasses and binnacles are combined to be used as shown in Table 9.

Table 9 — Types of binnacles

Magnetic compasses	Binnacles	
Class A	Type A1	Type A2
Class B	Type A1	Type A2

5.2 Binnacle type A1

5.2.1 General

Binnacles type A1 shall be of such a height that the magnets of the directional system of the compass are at least 1,0 m above the bottom-most part of the binnacle deck fittings and meet the requirements given in 5.2.2 to 5.2.6.

5.2.2 Construction and materials

5.2.2.1 Only high-quality non-magnetic materials of sufficient strength shall be used for the construction of type A1 binnacles and the helmet and boxes, brackets and holding-down bolts.

5.2.2.2 Provision shall be made in the binnacle to allow correction of any misalignment thereof in respect of the fore and aft line of the ship, by an angle of not less than 4° and not more than 6°.

5.2.3 Provision for correction of deviation (if combined with class B compasses)

5.2.3.1 Material

Where corrector magnets are used, they shall be of a suitable magnetic material of high remanence and coercivity of not less than 11,2 kA/m.

Material used for correcting induced fields shall have a high permeability, a low coercivity and a negligible remanence.

Built-in magnets shall be capable of being put into a neutral position or be removable. Built-in magnets for *B* and *C* correction shall not produce a heeling error.

