INTERNATIONAL STANDARD

ISO 25862

First edition
2009-05-15

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

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

Reference number
ISO 25862:2009(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.

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ISO 25862 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

This first edition of ISO 25862 cancels and replaces ISO 449:1997, ISO 613:2000, ISO 694:2000, ISO 2269:1992 and ISO 10316:1990.

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

1 Scope

This International Standard gives requirements regarding construction and performance of marine magnetic compasses for navigation and steering purposes, binnacles and azimuth reading devices.

According to the design of the ship, two types of binnacle are specified.

This International Standard applies to liquid-filled magnetic compasses:

— intended for ship's navigation and steering purpose in sea navigation according to regulations in force;

— having a direct reading system;

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

In the context of this International Standard, a magnetic compass is an instrument consisting of a directional system supported by a single pivot inside a bowl which is completely filled with liquid, and which is supported in gimbals inside or outside the bowl. Compasses without gimbals are also covered by this International Standard; the requirements relating to gimbals do not apply to such compasses.

This International Standard applies to

— all ships to which SOLAS applies (ships of gross tonnage $\geqslant$ 150 t, engaged on international voyages and ships of gross tonnage $\geqslant$ 500 t not engaged on international voyages) fitted with class A magnetic compasses,

— all ships to which SOLAS does not apply, fitted with the class A or class B magnetic compasses, and

— lifeboats/rescue boats fitted with a class B magnetic compass (as specified in Annex H).

This International Standard 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, positioning in ships and the deviation adjustment of compasses are given in the Annexes.

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.

ISO 1069:1973, *Magnetic compasses and binnacles for sea navigation — Vocabulary*

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

IMO Resolution A.382(X) *Recommendations on performance standards for magnetic compasses*

3 Terms and definitions

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

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 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 The safe distance is determined as specified in Annex F.

4 Magnetic compasses

4.1 Construction and materials

4.1.1 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 materials used in magnetic compasses, other than transmitting compasses, shall be of non-magnetic material.

4.1.2 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.

4.1.3 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.

4.1.4 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	$(90 \pm 1)°$
Class B	$(90 \pm 2)°$

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

4.1.5 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 apply also to the thickness of the top glass in hemispherical compasses. If material other than glass is used, it shall be of equivalent strength.

4.1.6 Constructional condition within the temperature range

Within the temperature ranges given in Table 2:

a) the compass shall operate satisfactorily;

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

c) 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;

NOTE A bubble provided in a compass to compensate for expansion shall not inconvenience the functioning and reading of the compass.

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

e) for class A compasses, that the force exerted on the pivot bearing, in the liquid at 20 °C, by the directional system is between 0,04 N and 0,1 N when the card diameter is 165 mm or less, and is between 0,04 N and 0,14 N when the card diameter is larger than 165 mm;

f) for class B compasses, the supporting force shall be such that the directional system always remains in contact with its pivot;

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

Table 2 — Temperature range

Magnetic compasses	Temperature ranges
Class A	−30 °C to +60 °C
Class B	−20 °C to +60 °C

4.1.7 Horizontal position

The compass bowl shall be balanced so that its verge ring or top glass cover settles in the horizontal plane to within 2° when the gimbal ring is fixed in a horizontal position; this shall be so whether the azimuth reading device or magnifying glass is in place or not.

4.2 Mounting

4.2.1 Tilt of supporting device

The bowl of the compass shall be mounted so that the verge ring remains horizontal to within 2° when the binnacle is tilted 40° in class A, 30° in class B in any direction and in such a manner that the compass cannot be dislodged under any conditions of sea or weather.

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

4.2.2 Freedom of the card of the compass with no supporting gimbal

In compasses in which no supporting gimbal is provided, the freedom of the card shall be 30° in all directions.

4.3 Directional system

4.3.1 Moment of inertia

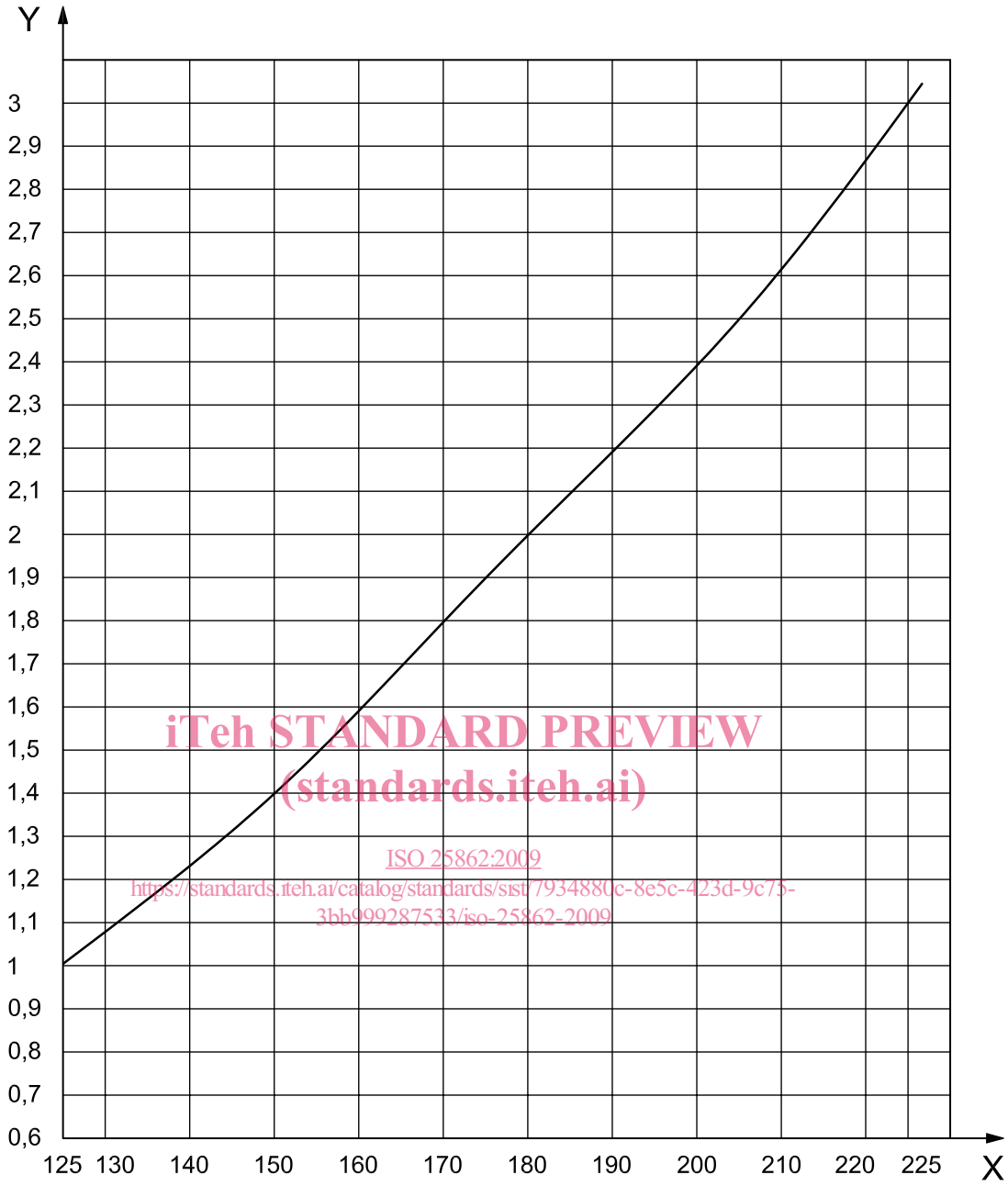
The moment of inertia of the directional system shall be approximately the same about all horizontal axes passing through the point of support on the pivot jewel.

4.3.2 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.

4.3.3 Magnetic moment (class A only)

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 moments, expressed in $A \cdot m^2$

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

4.3.4 Settling time

Following an initial deflection of the card of 90° from the magnetic meridian, the time taken to return finally to within 1° of the magnetic meridian shall not exceed $240/\sqrt{H}$ 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.

4.3.5 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 100 μT.

4.3.6 Supporting force (class A only)

The force exerted on the pivot bearing, in the liquid used, by the directional system shall be between 0,04 N and 0,1 N when the card diameter is 165 mm or less, and shall be between 0,04 N and 0,14 N when the card diameter is larger than 165 mm.

4.4 Compass card

4.4.1 Graduation

The compass card shall be graduated with 360 single degrees, starting from North in the clockwise direction as viewed from above. Each tenth degree should be marked with the three corresponding numbers. North should also 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.

The card shall be numbered as given in Table 3.

Table 3 — Graduation of the card

Magnetic compasses	Equal interval of the graduation	Card numbered
Class A	1°	Every 10°
Class B	Not more than 5°	Every 30°

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

4.4.2 Diameter of the card

The diameter of the compass card for binnacles of the following types are as given in Table 4.

Table 4 — 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 type A1 (see 5.1) is defined as the height of the binnacle being not less than 1 m; if the height of the binnacle is less than 1 m, it is binnacle type A2 (see 5.2).

NOTE 2 Diameter of the card of the magnetic compass for lifeboat/rescue boats is given in H.2.1.

4.4.3 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 5 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 periscope tube.

Table 5 — Readable distance

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

4.4.4 Bearing compasses

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

4.5 Accuracy

4.5.1 Directional error

The directional error is a directional system constructional error. It is composed of:

a) error of magnet orientation with regard to the graduation of the card (collimation error);

b) inaccuracies of the compass card graduation;

c) eccentricity of the compass card graduation with regard to the rotation centre of the card.

The directional error shall on no heading exceed the values as given in Table 6.

Table 6 — Accuracy of the directional errors

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

In transmitting compasses, the directional error applies to the compass without fluxgate. The fluxgate of a transmitting 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 fluxgate.

4.5.2 Error of lubber marks

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 7.

Table 7 — Lubber errors

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

4.5.3 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 8, where H is as defined in 4.3.4.

Table 8 — Error due to friction

Magnetic compasses	Initial deflection	Maximum angle to return
Class A	2°	Less than $(3/H)$°
Class B	5°	Less than $(9/H)$°

4.5.4 Swirl error

With the compass at a temperature of (20 ± 3) °C and rotating at a uniform rotational 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 9.

Alternatively, when rotating at a uniform rotational 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 9, where H is as defined in 4.3.4.

Table 9 — Swirl error

Magnetic compasses		Card deflection	
		Rotational speed: 6°/s measured after rotated 180°	Rotational speed: 1,5°/s measured after rotated 360°
Class A	With a card 200 mm or more in diameter	$(108/H)$°	$(54/H)$°
	With a card less than 200 mm in diameter		$(36/H)$°
Class B			$(40/H)$°

4.5.5 Induction error (class A only)

To avoid the induction error which is caused by an inadequate arrangement of magnetic elements in the directional system and introduced by magnetic induction in correctors (iron spheres or similar conventional correctors) of coefficient D due to the magnetic elements in the directional system, one of the following requirements shall be fulfilled:

a) The value of the ratio of coefficient H to coefficient D shall not exceed 0,08.

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 at a tangential distance of about 40 cm from the centre of the directional system, is less than 0,01 of coefficient B of the semicircular deviation.

4.5.6 Mounting error of azimuth reading device

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

4.5.7 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.

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

Damp heat test and rain and spray tests shall be carried out as specified in IEC 60945 and all requirements shall be met.

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

NOTE Environmental conditions tests of the magnetic compass for lifeboat/rescue boats are given in H.2.3.

5 Binnacles

Depending on the type of ship on which it shall be fixed, one of two types of binnacle may be used: type A1 or type A2. The characteristics of the two types are as specified in 5.1 and 5.2.

Magnetic compasses and binnacles are combined to be used as given in Table 10.

Table 10 — Types of binnacles

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

5.1 Binnacle type A1

Binnacle 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 under-surface of the binnacle deck fittings and meet the requirements given in 5.1.1 to 5.1.5.

5.1.1 Construction and materials

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

5.1.1.2 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°.

5.1.2 Provision for correction of deviation (if fitted in class B compasses)

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

5.1.2.2 Compensation for horizontal permanent magnetism

Binnacles shall contain a device for correcting the deviation due to the horizontal components of the ship's permanent magnetism. This device shall be capable of correcting a coefficient B of up to at least (720/H)° and a coefficient C of up to at least (720/H)°, where H is as defined in 4.3.4.

Provision shall be made in binnacles so that no magnets of the correcting system come so close to the directional system as to distort the field and produce a deviation of more than (20/H)° on any course, even when there is a heel or pitch of 15°.

5.1.2.3 Correction for heeling error

Binnacles shall contain a device for correcting heeling error. This device shall be adjustable and capable of providing a vertical magnetic field at the magnets of the directional system over the range +75 μT to −75 μT.

Provision shall be made in binnacles so that no magnets of the correcting system come so close to the directional system as to distort the field and produce a deviation of more than (20/H)° expected heeling errors on any course, even when there is a heel or pitch of 15°, where H is as defined in 4.3.4.

5.1.2.4 Compensation for horizontal induced fields due to the horizontal component of the earth's magnetic field in the soft iron in a ship

Binnacles shall be provided with a device for compensating the horizontal magnetic fields due to induction caused by the horizontal component of the earth's magnetic field in the soft iron in a ship. This device shall be capable of correcting a coefficient D of up to 10°.

When binnacles are vertical, and compensation is effected by spheres, the centre of the device shall not be further than 15 mm from the horizontal plane passing through the magnetic element of the directional system.

5.1.2.5 Compensation for horizontal induced fields due to the vertical component of the earth's magnetic field in the soft iron in a ship

Binnacles shall be provided with a device for compensating the horizontal magnetic fields due to induction caused by the vertical component of the earth's magnetic fields in the soft iron in a ship. When a Flinders' bar is used, it may be hollow, provided the diameter of the hole does not exceed 40 % of the diameter of the bar.

When binnacles are vertical, the magnetic pole of the compensating device shall lie in the same horizontal plane as the centres of the magnets of the directional system. When a Flinders' bar is used, its magnetic pole shall be taken at 1/12 of its length from the end.

5.1.2.6 Positions and attachment of correcting devices

Provision shall be made in binnacles for recording the positions of the correcting devices referred to in 5.1.2.2, 5.1.2.3 and 5.1.2.4.

Provision shall be made for all correcting devices to be satisfactorily secured after adjustment.

5.1.2.7 Corrector coils

Provision may be made for the fitting of corrector coils to provide compensation, if the ship is fitted with degaussing coils.

5.1.3 Accuracy of fore and aft marks

Where fore and aft marks are provided on binnacles, they shall be in the same vertical plane to within 0,5° as the axis of the fore and aft gimbal bearings.

5.1.4 Illumination

The binnacle shall contain adequate provision for illuminating the card and the lubber mark by the ship's electric supply and from an emergency light source.

In projector and reflector binnacles these shall provide a clear image at the helmsman's position.

A device shall be provided for dimming the electric light from the ship's mains.

The electric lamps, fittings and wirings shall have no influence on the directional system.

5.1.5 Other requirements

Binnacles shall satisfy the following tests specified in IEC 60945 (Ed.4, 2001-02).

1) damp heat,

2) corrosion (salt mist).

5.2 Binnacle type A2

This binnacle is used in sea navigation when the design of the ship makes the provision of a full-sized binnacle impracticable.

With regard to height, there are no requirements provided that binnacles meet the following requirements.

5.2.1 Construction and materials

Only high quality non-magnetic material of sufficient strength shall be used.