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Ships and marine technology — Magnetic compasses, binnacles and azimuth reading devices — Class A

Navires et technologie maritime — Compas magnétiques, habitacles et alidades — Classe A

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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.

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.

International Standard ISO 449 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation.*

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Ships and marine technology — Magnetic compasses, binnacles and azimuth reading devices — Class A

1 Scope

This International Standard gives general requirements regarding construction and performance for magnetic compasses, binnacles and azimuth reading devices, class A. According to the design of the ship, two types of binnacle are specified.

This International Standard applies to liquid-filled magnetic compasses:

— intended for 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 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.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 613:1982, *Shipbuilding — Magnetic compasses, binnacles and azimuth reading devices — Class B.*

ISO/R 694:1968, *Positioning of magnetic compasses in ships.*

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

ISO 2269:1992, *Shipbuilding — Class A magnetic compasses, azimuth reading devices and binnacles — Tests and certification.*

ISO 10316:1990, *Shipbuilding — Class B magnetic compasses — Tests and certification.*

IEC 945:1994, *Marine navigational equipment — General requirements — Methods of testing and required test results.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 1069 apply.

4 Marking

The following parts shall be marked with the information given and in the position shown in table 1.

Table 1 — Marking requirements

Part	Position of manufacturer's name or other means of type identification	Position of serial number on the part
Magnetic compass	a) card b) verge ring	a) card b) verge ring c) gimbal ring or rings
Binnacle	Any convenient position	Not required
Azimuth reading device	On top of the base of the azimuth reading device	On top of the base of the azimuth reading device
NOTE — The type of liquid used, if other than alcohol, shall be indicated on the bowl in the vicinity of the filling plug.		

5 Magnetic compasses

5.1 Construction and materials

5.1.1 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.

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

5.1.3 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.

5.1.4 The gimbal axes shall be mutually perpendicular within a tolerance of 1°. The outer gimbal axis shall be in the fore-and-aft direction of the ship.

5.1.5 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.

5.1.6 Within the temperature range – 30 °C to + 60 °C

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

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

5.1.7 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.

5.2 Mounting

5.2.1 The bowl of the compass shall be mounted so that the verge ring remains horizontal when the binnacle is tilted 40° 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.

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

5.3 Directional system

5.3.1 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.

5.3.2 Suspension

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

5.3.3 Magnetic moment

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

5.3.4 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 $\sqrt{57\,600/H}$ at a temperature of 20 °C ± 3 °C, where H is the horizontal component of the magnetic flux density in microteslas (μT) at the place of testing.

5.3.5 Tilt of the directional system with regard to the vertical field

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.

5.3.6 Supporting force

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.

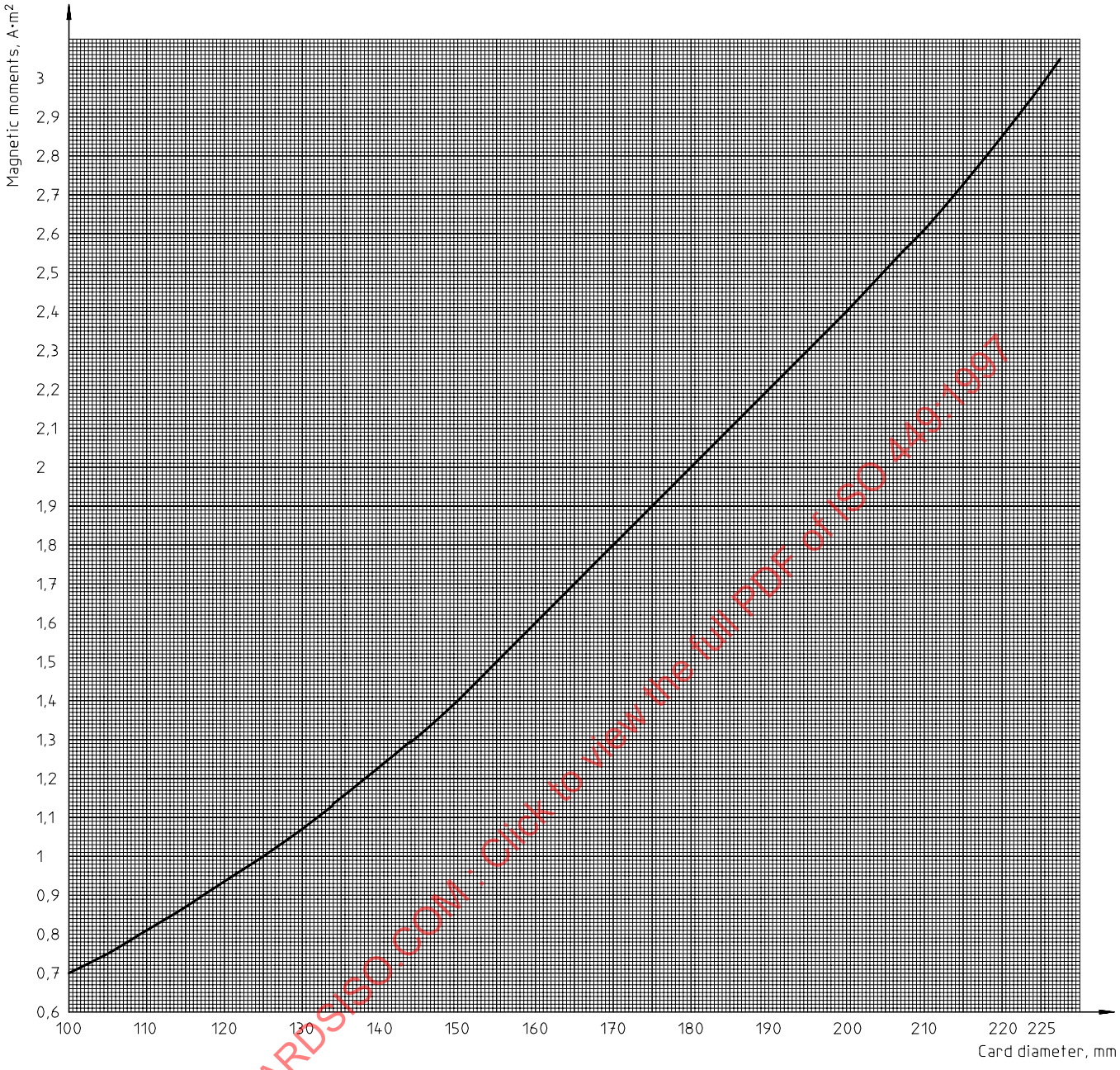

Figure 1 — Magnetic moments of liquid filled compasses (minimum requirements)

5.4 Graduation

5.4.1 Compass card

The compass card shall be graduated in 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.

5.4.2 Diameter of the cards

The diameter of the compass card for binnacles of the following types are:

— type A1, 165 mm , or more;

— type A2, 125 mm, or more.

5.4.3 Readability by the helmsman

If a steering compass is provided for the helmsman, it shall be possible for a person with normal vision to read at a distance of 1,4 m, in both daylight and artificial light, those graduations on the card which are 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.

5.4.4 Standard compass

If the standard 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 in 360 degrees in a clockwise direction, zero, as seen through the azimuth reading device, indicating the direction of the ship's head.

5.5 Accuracy

5.5.1 Constructional errors

5.5.1.1 The directional error shall not exceed 0,5° on any heading.

5.5.1.2 The fixed lubber error shall not exceed 0,5°.

5.5.2 Error due to friction

With the compass at a temperature of 20 °C ± 3 °C, the card, when given an initial deflection of 2°, first one side of the magnetic meridian and then on the other, shall return to within (3/H)° of its original position, H being as defined in 5.3.4.

5.5.3 Swirl error

With the compass at a temperature of 20 °C ± 3 °C, and rotating at a uniform speed of 1,5° per second, the deflection of the card, measured after the bowl has been rotated through 360° and the motion of the card has ceased, shall at no point exceed the following values:

a) (54/H)° for compasses with cards 200 mm or more in diameter;

b) (36/H)° for compasses with cards less than 200 mm in diameter;

H being defined as in 5.3.4.

5.5.4 Induction error

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 sextantial 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.

5.5.5 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.

5.5.6 Error due to eccentricity of the verge ring

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.

5.6 Resistance to vibration

Should the compass be required to operate under conditions of severe vibration, it shall perform satisfactorily under the test described in 5.6.1.

A separate certificate shall then be issued.

5.6.1 Method of testing

The compass shall be subjected to the tests in its binnacle.

The compass bowl shall be substantially horizontal at the start of the test.

Test 1: Apply vibrations successively in the fore-and-aft, athwartship and vertical directions of the compass with the following frequencies and amplitudes:

— for the frequencies between 7 Hz and 11,2 Hz, the value of the amplitude shall be ± 1 mm;

— for the frequencies between 11,2 Hz and 40 Hz, the values of the amplitude, A, in millimetres, are determined from:

$$A = \pm \frac{124}{f^2}$$

where f is the frequency, in hertz, corresponding to a constant amplitude of acceleration of ± 0,5 g.

The rate of change of the frequency shall be slow enough to discern positively any deviation of the card or any resonance of the compass.

Test 2: Submit the compass to the resonant frequency (or 40 Hz if no pronounced resonance is observed) for a period of 2 h.

5.6.2 Test results

During test 1, the card shall not deviate by more than ± (90/H)°, H being as defined in 5.3.4. During test 1 and test 2, the card shall not lift off the pivot under the influence of the test vibrations.

After the test, the requirements of 5.5.1.1 (directional error) and 5.5.3 (swirl error) shall be fulfilled.

5.7 Other requirements

Magnetic compasses shall satisfy the requirements of the following tests specified in IEC 945:

— damp heat cycle test, class B (IEC 945:1994, 4.4.3);

— rain test (IEC 945:1994, 4.4.8).

6 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 indicated in 6.1 and 6.2.

6.1 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 following requirements.

6.1.1 Construction and materials

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

6.1.1.2 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°.

6.1.2 Provision for correction of deviation

6.1.2.1 Material

Where corrector magnets are used, they shall be of a suitable magnetic material of high remanence and coercivity of not less than 11 200 A/m. Material used for correcting induced fields shall have a high permeability, a low coercivity and a negligible remanence.

6.1.2.2 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)°, H being as defined in 5.3.4.

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 may be a heel or pitch of 15°.

6.1.2.3 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)° exceeding expected heeling errors on any course even when there may be a heel or pitch of 15°, H being as defined in 5.3.4.

6.1.2.4 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.

6.1.2.5 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.

6.1.2.6 Positions and attachment of correcting devices

Provision shall be made in binnacles for recording the positions of the correcting devices referred to in 6.1.2.2, 6.1.2.3 and 6.1.2.4.

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

6.1.2.7 Corrector coils

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

6.1.3 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.

6.1.4 Illumination

The binnacle shall contain adequate provision for illuminating the card 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.

6.2 Binnacles 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, no descriptions are laid down, provided that binnacles meet the following requirements.

6.2.1 Construction and materials

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

6.2.2 Provision for correction of deviation

6.2.2.1 Material

Where correcting magnets are used they shall be of suitable magnetic material of high remanence and coercivity not less than 11 200 A/m. Material used for correcting induced fields shall have a high permeability, a low coercivity and a low remanence.

6.2.2.2 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)°, H being as defined in 5.3.4. 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 (40/H)° on any course even when there may be a heel or pitch of 15°.

6.2.2.3 Correction for heeling error

Binnacles shall contain a device for correcting the heeling error. This device shall be adjustable and capable of providing a vertical field at the position of the directional system over the range of + 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 (80/H)° on any course even when there may be a heel or pitch of 15°, H being as defined in 5.3.4.

NOTE — The magnetic fields produced by the devices referred to in 6.2.2.2 and 6.2.2.3 shall be as uniform as possible in the space swept by the directional system and should in no case introduce a significant sextantial error.

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

Binnacles may 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 of the ship. This device shall be capable of correcting a coefficient D of up to 7°.

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.

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

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

When binnacles are vertical, the magnetic pole of the 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.

The distance between the vertical axis of a Flinders bar from the centre of the card shall be at least 3,5 times the length of the magnetic needles.

6.2.2.6 Attachment of correcting devices

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

6.2.3 Accuracy of fore-and-aft marks

In order that the mounting may be undertaken accurately, fore-and-aft marks shall be provided and these shall be within 0,5° of the fore-and-aft axis of the gimbal bearings.

6.2.4 Illumination

The binnacle shall contain adequate provision for illuminating the card 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, fitting and wiring shall have no influence on the directional system.

6.2.5 Other requirements

Binnacles shall satisfy the following tests specified in IEC 945:

— damp heat cycle test, class X (IEC 945:1994, 4.4.3);

— corrosion test, class X (IEC 945:1994, 4.4.11).

7 Azimuth reading devices

There shall be an appropriate azimuth reading device for the standard compass. An A2 binnacle may be supplied with a suitable pelorus which may be fitted away from the binnacle.

7.1 Azimuth sight

The field of vision shall be at least 5° on each side of the line of sight and it shall be possible to take azimuths of celestial bodies and bearings of distant objects whose altitudes are between 5° below and 60° above the horizontal.

The required accuracy of the azimuth shall be fulfilled in the altitude range of 5° above to 50° above.

7.2 Azimuth reading devices with vanes

It shall be possible to take bearings of distant objects whose altitudes are between 5° below and 30° above the horizontal.

8 Designation

Magnetic compasses stated as complying with this International Standard shall be designated by the following indications, in the order given:

— type of compass (reflector, projector, transmitting);
— number of this International Standard;
— type of binnacle;
— card diameter, in millimetres.

EXAMPLE

Reflector magnetic compass, class A with binnacle type A2 and a card diameter of 180 mm is designated

Reflector magnetic compass ISO 449 — A2 — 180

9 Marking

Magnetic compasses shall be provided with an indication of the manufacturer, type and serial number.