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**Ships and marine technology —
Marine electromagnetic compasses**

Navires et technologie maritime — Compas électromagnétiques de marine



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Foreword

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International Standard ISO 11606 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

Annex A of this International Standard is for information only.

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Ships and marine technology — Marine electromagnetic compasses

1 Scope

This International Standard specifies general requirements, type tests and individual tests for marine electromagnetic compasses intended for steering purposes and/or taking bearings on board ships the overall length of which is normally not less than 24 m.

In this context an electromagnetic compass is an item of electronic equipment which uses the geomagnetic field to obtain information about the ship's heading. This information is conveyed to the main compass (which is used for steering and taking bearings), to additional repeater indicators and, if required, to other navigational equipment.

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 449:1977, *Ships and marine technology — Magnetic compasses, binnacles and azimuth reading devices — Class A.*

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

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

IEC 1162-1:1995, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 1: Single talker and multiple listeners.*

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.*

3 Definitions

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

3.1 magnetic sensor: Sensor which detects geomagnetic field and supplies appropriate output concerning direction to the processor.

3.2 processor: Device which processes the output of the magnetic sensor and provides the ship's magnetic heading and/or true heading.

3.3 main compass display: Display unit which shows the output of the processor in the form of a compass card.

3.4 repeater indicator: Additional indicator which may be equipped with a display which uses a different type of compass card.

4 Composition

The electromagnetic compass system shall consist of a magnetic sensor, a processor, a main compass display and facilities for other repeater indicators and equipment.

5 Construction and material

Electromagnetic compasses shall fulfil the following requirements.

5.1 Electrical wiring

Electrical wiring, such as that for the direct-current power supply and that for connecting the units, shall not produce any perceptible errors in the heading information.

NOTE — Twist cables are recommended for this purpose.

5.2 Non-magnetic housing

The housing of the magnetic sensor system shall be non-magnetic.

5.3 Fore-and-aft marks

Fore-and-aft marks shall be inscribed on the housing of the magnetic sensor system and the bottom part of the binnacle of the main compass. The units shall be installed on the fore-and-aft line of the ship.

The fore-and-aft marks shall be within $\pm 0,5^\circ$ of the fore-and-aft axis of the unit.

5.4 Graduation

5.4.1 Graduation of main compass card

The main compass shall be of the compass card type which shall be graduated in 360 single degrees, starting from North (000°) in the clockwise direction as viewed from above. Each tenth degree should be marked with the three corresponding numbers. The accuracy of the graduation shall be better than $0,2^\circ$ on any heading. 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 Indication of the repeater indicator

The graduation of the indicator, if of the card type, shall be the same as that of the main compass card. If a repeater indicator is used for steering purposes, it shall be of the card type.

In the case of numerical displays, three digit numbers, in degrees, shall be shown.

5.4.3 Centre of the graduation

The main compass and repeater indicators to be used for bearing purposes shall be fitted with a seat for a shadow pin which accommodates bearings or, if no seat is provided, the centre of the graduation shall be clearly indicated.

5.4.4 Graduation of the verge ring

The main compass and repeater indicators to be used for bearing purposes shall be provided with a verge ring, which is graduated in degrees, for the measurement of bearings relative to the ship's head, the scale shall be graduated in 360 single degrees in clockwise direction as viewed from above.

Both the zero mark indicating the bearing of the ship's head and the 180° mark indicating the bearing of the ship's stern shall be within $\pm 0,5^\circ$ of the fore-and-aft marks.

5.4.5 Accuracy of fore-and-aft marks

The fore-and-aft marks of the main compass and repeater indicators to be used for bearing purposes shall be in the vertical plane passing through the centre of the compass card and the main lubber mark to within $\pm 0,5^\circ$.

5.4.6 Readability of the graduation

It shall be possible for a person with normal vision to read the main compass card and the indication of the repeater indicator at a distance of 1,0 m, in both daylight and artificial light.

5.4.7 Horizontal position of the compass plane

The plane of the compass card of the main compass, and repeater indicators to be used for bearing purposes, shall be so balanced that it is horizontal to within $\pm 2^\circ$.

5.5 Lubber marks

The main compass display and the repeater indicator shall be fitted with at least one lubber mark, indicating the direction of the ship's head. Additional lubber marks indicating the direction of ship's stern and thwartship are permissible.

The width of the lubber mark shall not be greater than $0,5^\circ$ of the graduation of the card or 0,5 mm, whichever is smaller.

The distance between the lubber mark and the outer edge of the card shall be not more than 1,5 mm.

5.5.1 Accuracy of lubber marks

The main lubber mark shall be within $\pm 0,5^\circ$ of the 0° – 180° line of the verge ring.

Additional lubber marks shall be within $\pm 1^\circ$.

5.6 Illumination

The units shall be provided with adequate provision for illuminating the controls and displays. A device shall be provided for dimming the electric light.

5.7 Compensation of deviation and heeling error

Provision shall be made for correcting the heeling error and the coefficients *A*, *B*, *C*, *D* and *E*. It shall be possible to correct the following values:

- vertical component of the ship's magnetic field (producing the heeling error): up to $\pm 75 \mu\text{T}$;
- coefficient *A*: up to $\pm 3^\circ$;
- coefficient *B*: up to $\pm (720/H)^\circ$;
- coefficient *C*: up to $\pm (720/H)^\circ$;
- coefficient *D*: up to $\pm 7^\circ$;
- coefficient *E*: up to $\pm 3^\circ$;

where *H* is the horizontal component of the geomagnetic flux density in microteslas (μT).

The correcting devices for the coefficients *A*, *B*, *C*, *D* and *E* shall not produce any undesired deviation greater than 1° . The correcting device for heeling error shall not produce any undesired alteration of the vertical component of the ship's magnetic field greater than $1 \mu\text{T}$.

5.7.1 Indication of compensation

The values of compensation for the system shall be indicated.

5.7.2 Protection of compensation

The compensating devices should be protected against accidental alterations.

5.8 Output of heading information

The compensated heading shall be displayed on the main compass display and repeater indicators, as well as output to other equipment. The compensated heading may be the true heading or the magnetic heading. The type of heading displayed shall be conspicuously indicated at the display in addition to the value of the variation.

5.9 Output for other equipment

The electromagnetic compass shall be so designed that it is able to provide the azimuth information, with an accuracy of not less than $\pm 0,5^\circ$, to the navigational equipment, radars, direction finders, automatic pilots and additional position measurement instruments. If these navigational instruments have digital outputs they shall conform to IEC 1162-1.

5.10 Gimbals

5.10.1 Direction of gimbal axes

If gimbals are provided, the outer gimbal axis shall be in the fore-and-aft direction.

5.10.2 Angle between the gimbal axes

If gimbals are provided, the angle between the inner and outer gimbal axes shall be $90^\circ \pm 1^\circ$, except if the diameter of the outer gimbal ring is less than 150 mm; in this case the angle shall be $90^\circ \pm 2^\circ$.

5.10.3 Freedom of tilt of the main compass

The main compass shall be constructed in such a way that it can revolve about the inner gimbal axis freely up to 30° when the gimbal ring, if fitted, is horizontal.

5.10.4 Precaution against dislodging of the main compass and the repeater indicator

The main compass and repeater indicator shall be constructed in such a way that if they are fitted on gimbals, they return to their normal position and are not dislodged after tilting.

5.11 Fitting the main compass

Provision shall be made in the bottom part of the magnetic sensor, the main compass and card-type repeater indicators in order 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°.

5.12 Height of the compass card plane

Main compasses shall be so constructed that the plane of the compass card is at least 1 m above the lower surface of the binnacle deck fittings, and capable of taking bearings of celestial bodies and other distant objects.

5.13 Watertightness of repeater indicators

The main compass and the repeater indicator intended for use on an open deck shall be waterproof.

5.14 Azimuth reading devices

5.14.1 Provision of azimuth reading devices

There shall be at least one appropriate azimuth reading device to take bearings of distant objects and celestial bodies.

5.14.2 Azimuth sight

The field of vision shall be at least 5° on each side of the line 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. This accuracy of azimuth shall be fulfilled in the altitude range of 5° above to 50° above.

5.15 Construction for maintenance and inspection

Equipment shall be so constructed that it is capable of carrying out maintenance and inspection easily.

5.16 Means to extraordinary power supply

Means shall be incorporated for the protection of equipment from the effects of excessive current and voltage, transients and accidental reversal of the power supply polarity.

NOTE — Requirements that are extracted from IMO Resolution A 694(17), 4.2, are printed in italics.

6 Performance

6.1 Performance at the place where the value of the horizontal component of geomagnetic field is 18 μ T, and within the temperature range between

- 25 °C \pm 3 °C and 70 °C \pm 3 °C, for equipment or units intended to be exposed to the weather, and
- 15 °C \pm 3 °C and 55 °C \pm 3 °C, for equipment or units intended to be protected from the weather,

shall conform to the requirements of 6.2 to 6.7.

The use of temperature controllers is permitted.

6.2 Accuracy of the heading indication on the main compass

Any error of the heading indication on the main compass shall not be greater than $\pm 1^\circ$.

6.3 Bearing accuracy in the horizontal plane

Any error of the indicated compass bearing in the horizontal plane of the main compass and card type repeater indicator shall not be greater than $\pm 1^\circ$ under the conditions of various sea states, ship's motion, vibration, humidity and temperature likely to be experienced.

6.4 Follow-up accuracy of the transmission system

When rotated at a rate of one turn per minute ± 10 s, the follow-up error shall not be larger than $\pm 1,5^\circ$.

6.5 Synchronized accuracy between the repeater indicator and main compass

The difference between the readings of the repeater indicator and the main compass shall be not more than $\pm 0,5^\circ$.

6.6 Possibility of compensating the coefficients

It shall be possible to compensate the coefficients *A*, *B*, *C*, *D* and *E* so that the residual value of each coefficient is smaller than $\pm 0,5^\circ$.

6.7 Electromagnetic immunity

The electromagnetic compass shall not produce interference which affects the communication system and other navigational instruments in the steering room. The electromagnetic compass shall not be substantially influenced by interference produced by other equipment.

7 Precaution against failure

7.1 Power supply

A main power supply and an emergency power supply shall be provided. Both power supplies shall have automatic changeover facilities.

7.2 Backup of compensator data

Provision shall be made to ensure that the compensator data cannot be changed unintendedly or by a failure of the system.

7.3 Failure alarm

An automatic alarm shall be provided to indicate a power failure of the main supply to this compass.

8 Marking

Each unit of compasses shall be marked with the following:

- identification of the manufacturer;
- equipment type number or identification of the model which was type tested;

- serial number of the unit;
- year of manufacture;
- minimum safe distance for installation on a bridge.

9 Type test and individual test

9.1 General

Subclauses 9.2 and 9.3 specify the type test, the individual test method and acceptable limits of the characteristics necessary to guarantee conformity of electromagnetic compasses with the requirements of this International Standard.

Unless otherwise stated, all tests shall be carried out at a temperature of $20\text{ °C} \pm 3\text{ °C}$.

9.2 Type test

Type testing shall be carried out before the instruments come into regular service. For type testing, only new devices are acceptable.

9.3 Individual test

Individual testing shall be carried out before installation on board ship. It is also desirable to perform the test periodically and after repair, on board ship.

For individual testing, all devices shall be in a clean and serviceable state when tested.

10 Certification

10.1 Test certification

Devices which have passed the type test or the individual test and comply with the requirements shall be certified in the language of the test authority and in English.

Each type test certificate is valid exclusively for the model tested. In case of alterations or technical improvements which could affect its compliance with this International Standard, the model shall be given a new identification number or mark and the type test repeated. All alterations shall be submitted to the original test authority who will decide whether a new type test is necessary.

Copies of the certificate shall be issued on demand. They must explicitly be marked "copy".

Acceptance of type test certificates and individual test certificates between countries will be a matter for mutual agreement.

10.2 Statement issued by the manufacturer or importer

The following requirement applies to type testing only.

The manufacturer or importer shall produce a written statement covering those requirements which cannot be ascertained during the type test. The statement shall contain the following:

- detailed description of the elements;
- detailed description of the gimbal ring;
- description of the installation;

- operational guide to attain the most adequate performance;
- figures to support the application of type testing.

10.3 Marking check

10.3.1 The presence of the markings on the unit of the compass specified in clause 8 shall be checked by visual inspection.

10.3.2 When 10.3.1 is fulfilled, the markings specified in clause 8 shall be written on the certificate.

10.4 Sample checks

In order to check that the "Statement of manufacturer or importer" described in 10.2 has been fulfilled, sample checks may be carried out.

11 Testing

11.1 Testing of units

Testing shall be carried out on the following components in accordance with the class for which they are intended as specified in IEC 945:1994, 3.4.1.1:

- a) magnetic sensor: Class X;
- b) processor: Class B or Class X if intended for use on an open deck;
- c) main compass: Class B or Class X if intended for use on an open deck;
- d) repeater indicator: Class B or Class X if intended for use on an open deck.

Tests in the static magnetic field shall be carried out in an authorized test room.

11.1.1 Condition of the compass

Inspect the compass to ensure that it is undamaged, mechanically sound and operating satisfactorily. This test is carried out by visual inspection.

11.1.2 Non-magnetic properties (type test only)

Examine the housing of the magnetic sensor system (see 5.2) to ascertain its non-magnetic properties.

11.1.3 Graduation of the main compass card

This test is carried out by visual inspection, and the result shall fulfil the requirements specified in 5.4.1.

11.1.4 Fore-and-aft marks of the main compass

This examination may be carried out on a compass test stand. After having brought the outer gimbal axis (the fore-and-aft datum line may be used instead) into a vertical plane of sight coinciding with the centre of rotation, the stand is rotated until the fore-and-aft marks come into the vertical plane of sight. The fore-and-aft marks error is equal to the angle through which the test stand has related. The result shall fulfil the requirement specified in 5.3.

11.1.5 Azimuth error of the main compass

This examination may be carried out on a compass test stand. The result shall fulfil the requirements specified in 5.4.1.

11.1.6 Graduation of the card of card type repeater indicators

This examination may be carried out by visual inspection. The result shall fulfil the requirements specified in 5.4.2.

11.1.7 Graduation of the verge ring

This examination may be carried out by visual inspection. The result shall fulfil the requirements specified in 5.4.4.

11.1.8 Readability

This examination may be carried out by visual inspection. The result shall fulfil the requirement specified in 5.4.6.

11.1.9 Horizontal position of compass planes

The main compass and the card type repeater indicator shall be balanced so that the verge ring, or top glass cover, settles in the horizontal plane when the gimbal ring is fixed in a horizontal position. This requirement shall be met whether the azimuth reading device, or other attachment or magnifier, is in position or not. Measurement shall be carried out by placing a spirit-level of suitable sensitivity on the verge ring or top glass cover. The result shall fulfil the requirement specified in 5.4.7.

11.1.10 Lubber marks

11.1.10.1 Main lubber mark and additional lubber marks

The main lubber mark and additional lubber marks (if any) of the main compass and the compass-type repeater indicator shall be checked. These lubber marks shall fulfil the requirements specified in 5.5.

11.1.10.2 Width and location of lubber marks

These examinations shall be carried out by visual inspection, and shall fulfil the requirements specified in 5.5.

11.1.10.3 Lubber mark error

The examination may be carried out on a compass test stand. After having brought the outer gimbal axis (the fore-and-aft datum line may be used instead) into a vertical plane of sight coinciding with the centre of rotation, the stand is rotated until the main lubber mark comes into the vertical plane of sight. The lubber mark error is equal to the rotation angle of the test stand. The result shall fulfil the requirement specified in 5.5.

11.1.11 Dimmer systems

These examinations shall be carried out by visual inspection, and shall fulfil the requirements specified in 5.6.

11.1.12 Indication of the values of compensation

The check to determine whether the values of compensation of deviation and heeling error are indicated shall be carried out by visual inspection, and shall fulfil the requirements specified in 5.7.

11.1.13 Examination of the output

The requirements specified in 5.7, 5.8 and 5.9 shall be examined by visual inspection or electrical measurements.

11.1.13.1 Output of ship's heading

The check to determine that the output of the heading information, obtained after compensating with the values of coefficients A , B , C , D and E , is sent to the main compass, the repeater indicator and the output terminals, shall be carried out by visual inspection, and shall fulfil the requirements specified in 5.8.

11.1.14 Direction of gimbal axis and angle between the gimbal axes

The direction of the outer gimbal axis shall be examined by visual inspection, and shall fulfil the requirements specified in 5.10.1.

Measurement of the angle between the gimbal axes may be made by means of graduation of the testing stand, when first one and then the other gimbal axis is brought into the vertical plane of view passing through the centre of the graduation, by turning the compass support. The result shall fulfil the requirements specified in 5.10.2. This test is only a type test.

11.1.15 Freedom of tilt of the main compass

This test may be carried out using a clinometer placed on the top glass cover or verge ring. The result shall fulfil the requirements specified in 5.10.3. This test is only a type test.

11.1.16 Precautions against dislodging

This examination shall be carried out by visual inspection, and the result shall fulfil the requirements specified in 5.10.4. This test is only a type test.

11.1.17 Fitting the main compass

Measure the play by fitting the magnetic sensor in accordance with the manufacturer's instructions. Turn the sensor to determine the maximum angle of misalignment which can be corrected. The result shall fulfil the requirements specified in 5.11.

11.1.18 Height of the compass card plane

Measure the height of the compass card plane; it shall fulfil the requirements specified in 5.12.

11.1.19 Watertightness of repeater indicators

The main compass and the repeater indicator intended for use on an open deck shall fulfil the requirements specified in IEC 945 for Class X equipment.

11.1.20 Provision of azimuth reading device

The azimuth reading device for taking bearings shall fulfil the requirements specified in ISO 449:1997, clause 7.

11.1.21 Azimuth sight

This test may be carried out by visual inspection, and the result shall fulfil the requirements specified in 5.14.2.

11.1.22 Construction for maintenance and inspection

This test, to ensure that the requirements specified in 5.15 and IEC 945:1994, 3.6 are met, shall be carried out by visual inspection.

11.1.23 Means to extraordinary power supply

Means to extraordinary power supply shall be checked by the relevant method in accordance with IEC 945, and meet the requirements specified in 5.16.