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Ships and marine technology — Gyro-compasses for high-speed craft

Navires et technologie maritime — Compas gyroscopiques pour navires à grande vitesse

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Foreword

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The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

This second edition cancels and replaces the first edition (ISO 16328:2001), of which has been technically revised.

Annex A forms a normative part of this International Standard. Annexes B and C are for information only.

Ships and marine technology — Gyro-compasses for high-speed craft

1 Scope

This International Standard specifies the construction, performance, and type testing for gyro-compass for high-speed craft required by chapter X, SOLAS 1974 (as amended).

NOTE All requirements that are extracted from the recommendations of IMO Resolutions [Resolution A.821(19) on performance standards for gyro-compasses for high-speed craft and A.694(17)] are printed in italics.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 25862, *Ships and marine technology — Marine magnetic compasses, binnacles and azimuth reading devices*

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

IEC 61162-1, *Marine navigation and radiocommunication equipment and systems — Digital interfaces — Part 1: Single talker and multiple listeners*

IEC 61162-2, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 2: Single talker and multiple listeners, high-speed transmission*

IEC 61924-2, *Maritime navigation and radiocommunication equipment and systems — Integrated Navigation Systems (INS) — Part 2: Modular structure for INS-Operational and performance requirements, methods of testing and required test results*

IMO Resolution A.424 (XI), *Performance standards for gyro-compasses*

IMO Resolution A.694 (17), *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO Resolution MSC.252(83), *Adoption of the revised performance standards for alert communications with an Integrated Navigation System*

IMO Resolution MSC.302(87), *Adoption of performance standards for bridge alert management*

IMO Resolution A.821(19), *Performance standards for gyro-compasses for high-speed craft*

3 Terms and definitions

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

3.1
gyro-compass
complete equipment including all essential elements of the complete design, including *both the gyro-compass as heading sensor and the associated heading transmission system*

3.2
true heading
horizontal angle between the vertical plane passing through the true meridian and the vertical plane passing through the craft's fore and aft datum line

Note 1 to entry: *It is measured from true north (000°) clockwise through 360°.*

Note 2 to entry: When the gyro-compass equipment is tested on the test stand, this "true heading" is regarded as the true heading of the lubber line. Where a gyro-compass has the facility of introducing a correction by moving the lubber line, the correction is set for the local latitude.

3.3
settled
stable situation when *any three readings taken at intervals of 30 min are within a band of 0,7°,* with *the compass level and stationary*

Note 1 to entry: The settling time is the elapsed time between the time of switch-on at the initial heading error and the third recording of the settle.

3.4
settle point heading
mean value of ten readings taken at 20 min intervals after the compass has settled (3.3)

3.5
settle point error
difference between the settle point heading (3.4) *and* the *true heading*

3.6
error
difference between the observed value and the settle point heading (3.4)

3.7
repeater compass
device that reproduces the master compass card at a remote location

3.8
bearing repeater compass
device that reproduces the master compass card for the purpose of taking bearings

3.9
compass card
graduated dial of the compass which indicates the measured direction of the meridian

3.10
latitude error
error to which some gyro-compasses are subject, the magnitude and sign of which depend upon the local latitude

3.11
speed error
error to which gyro-compasses are subject, the magnitude and sign of which depend upon the speed, course, and latitude of the craft

3.12
lubber line
index line situated on the body of gyro-compass or repeater compass against which the compass card is read

3.13
master compass
main compass unit which supplies the heading information to the repeaters and other navigational aids

3.14
scorsby table
test machine which independently oscillates a platform about three axes, and is used to simulate the motion of a craft

4 Construction

Requirements for gyro-compass units.

4.1 Gyro-compass equipment[1)]

Gyro-compass equipment shall *include the provision of a compass card or analogue repeater for steering purposes and equipment for the purpose of taking a bearing.*

4.2 Continuous operation

The equipment shall be capable of continuous operation under conditions of vibration, humidity, change of temperature, and variations of the power supply, as specified in 6.10.

4.3 Bearing repeater compass[1)]

For those crafts which are required to carry a bearing repeater compass, the construction of these shall be as follows.

a) The bearing repeater compass shall be designed to be fitted with an azimuth-reading device.

b) A gimbal mechanism shall be provided to enable the bearing repeater compass card to be held horizontally against the craft's motion.

4.4 Graduation and digital display

The compass card shall *be graduated at equal intervals of 1° or a fraction thereof.* The graduation error shall be less than ±0,2°. *A numerical indication* shall *be provided* at least *at every 10°, starting from 000° clockwise through 360°.*

A digital display may be provided. When a digital display is provided, the course shall *be displayed as three digits plus, optionally, a fourth digit indicating tenths of a degree. When a gyro-compass with digital display is used, it* shall *incorporate a turning direction indicator.*

4.5 Illumination

Adequate illumination shall be provided to enable the reading of all compass cards at all times. Facilities for dimming shall be provided.

4.6 Lubber line

Devices using a compass card shall be provided with a lubber line to indicate the craft's heading.

4.7 Fore and aft mark

If technically necessary, the compass shall be marked in a way to facilitate installation so that the lubber line lies in a vertical fore and aft plane of the craft or parallel. Where a gyro-compass has the facility of introducing a correction by moving the lubber line, the correction during installation shall be set to zero.

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1) Advice to ship surveyors for installation on board craft is given in normative annex A.

If such marks or identifications are not in the same vertical plane as the uncorrected lubber line, then the horizontal angular relationship between them shall be clearly indicated in the manufacturer's installation instruction.

4.8 Installation

The master compass shall *be installed* or adjusted *in a craft with the fore and aft datum lines parallel to the craft's fore and aft datum line to within ±0,5°. The lubber line* shall *be in the same vertical plane* passing through *the centre of the card of the compass and* shall *be aligned accurately.*

4.9 Speed error correction

Means shall *be provided for correcting the errors induced by speed and latitude. An approved accurate speed source* shall *be used for automatic speed error corrections.*

4.10 Heading information

The gyro-compass shall be *designed to enable heading information to be provided to other navigational aids such as radar, ARPA, radio direction-finder, and* heading control system[2)]. *The accuracy of the other navigational aids shall not be degraded, and* shall *continue to comply with the standards specified for such aids.*

4.11 Status signal

A status signal shall *be provided to indicate that the gyro-compass is ready for use.*

4.12 Alert signal

An alert[3)] *signal* shall *be provided to indicate that the gyro-compass has suffered an external power supply failure or an internal system functional failure which would invalidate the heading information.* The alert shall conform to the presentation and handling requirements of Bridge Alert Management [(IMO Res. MSC.302(87)]. A suitable interface shall be provided for alert communications with an Integrated Navigation System [IMO Res. MSC.252(83) and IEC 61924-2].

The following sentences shall be provided for the alert communications interface.

Sentences transmitted by the gyro-compass:

— ALR, HBT: See IEC 61162-1;

— ALC, ALF, ARC: See IEC 61924-2.

Sentences received by the gyro-compass:

— ACK, HBT: See IEC 61162-1;

— ACN: See IEC 61924-2.

4.13 Power supply

The gyro-compass shall *be provided with or connected to an uninterruptable power supply.*

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2) The term of "automatic pilots" was replaced by "heading control system" in accordance with the new IMO resolution. [Draft amendment to resolution A.342(IX) on performance standards for automatic pilots, MSC Res. 64(67) , annex 3].

3) The term of "Alarm" was replaced by "Alert" in accordance with IMO Resolution MSC.252(83) and IMO Resolution MSC.302(87).

4.14 Interface

4.14.1 *The gyro-compasses equipment* shall *provide with an output of heading information with an accuracy as defined in* 5.1.6 *when interfaced by other equipment.*

4.14.2 The compass shall provide interface facilities which meet the relevant International Standards IEC 61162-1 and/or IEC 61162-2 as amended.

4.14.3 The gyro-compass equipment shall provide an appropriate data source and at least one output of heading information, which is able to comply with the IEC 61162-2. The IEC 61162-2 heading output shall be updated at a rate of once per 20 ms. The THS sentence detailed in IEC 61162-1 shall be provided for heading information.

5 Performance requirements

5.1 Accuracy in latitudes up to 70°

5.1.1 Settling time

When switched on *in accordance with the manufacturer's instructions, the compass* shall *settle within 6 h.*

5.1.2 Settle point error

5.1.2.1 *The settle point error* (3.5) *at any heading* shall *not exceed ±0,75° × secant latitude, and the RMS value of the differences between individual heading indications and the mean value* shall *be less than ±0,25° × secant latitude.*

5.1.2.2 *The repeatability of settle point error from one run-up to another* shall *be within 0,25° × secant latitude.*

5.1.3 Settling time under operational conditions

When switched on *in accordance with the manufacturer's instructions, the compass* shall *settle within 6 h when rolling and pitching with simple harmonic motion of any period between 6 s and 15 s, a maximum angle of 5°, and maximum horizontal acceleration of 0,22 m/s^2.*

5.1.4 Settle point error under operational conditions

The repeatability of the settle point error of the master compass shall *be within ±1° × secant latitude, including variations in magnetic fields likely to be experienced in the craft in which it is installed.*

5.1.5 Performance under operational conditions

In latitudes of up to 70° N or S in craft operating within a latitude band of 10°:

The requirements of 5.1.5.1 shall be checked by means of simulation. The requirements of 5.1.5.2 and 5.1.5.3 shall also be checked by means of simulation and by a vehicle test (sea or land) if necessary. The vehicle test shall only be performed if there is an indication of a physical problem or problems (see Annex B for information). The vehicle test shall be performed under realistic traffic conditions and the maximum acceleration in this test shall be in a band of 1 m/s^2 to 2 m/s^2.

5.1.5.1 *The residual steady-state error, after correction for speed and course influences at a speed of 70 kn,* shall *not exceed ±0,25° × secant latitude.*

5.1.5.2 *The maximum error due to a rapid alteration of speed of 70 kn* shall *be kept to a minimum, and* shall *not exceed ±2°.* The horizontal acceleration shall not exceed 2,0 m/s^2.

5.1.5.3 *The error due to a rapid alteration of course of 180°* up to *maximum rate of turn of 20°/s in any azimuth direction* up to *a speed of 70 kn shall not exceed ±3°.* The horizontal acceleration shall not exceed 2,0 m/s^2.

5.1.5.4 *The transient and steady-state errors due to rolling, pitching, and yawing, with simple harmonic motions of any period between 6 s and 15 s, maximum angles of 20°, 10°, and 5° respectively, and a maximum horizontal acceleration not exceeding 1 m/s^2, and at any course especially at 45°, 90°, and 315° shall not exceed ±1° × secant latitude.*

5.1.6 Synchronization between the master compass and repeaters

5.1.6.1 Once the repeaters have been synchronized with the master, *the maximum divergence in reading between the master compass and* repeater *under all operational conditions* shall *not exceed ±0,5°;* for the purposes of this requirement, the latitude and speed correction shall be assumed equal to zero.

5.1.6.2 *The follow-up rate of the transmission system* shall *be at least 20°/s.*

5.2 Other requirements

The gyro-compass shall *determine the direction of the head of the high-speed crafts (HSC) in relation to geographic (true) north.*

In addition to the general requirements contained in IMO *Resolution A.694 (17), the gyro-compass equipment installed in craft operating under the following conditions:*

1 *speed exceeding 30 kn and up to 70 kn;*

2 *maximum rate of turn 20°/s;*

3 *normal range of operation between 70° N and 70° S shall, as required by chapter 13 of the HSC Code, comply with the minimum performance requirements specified in these standards.*

The gyro-compass, within a speed range of up to 30 kn, shall *comply with the requirements of* IMO *Resolution A.424 (XI), and within a speed range of 30 kn to 70 kn* shall *comply with the requirements of* this document.

Other requirements shall be in accordance with the relevant clauses in IEC 60945.

6 Type tests

6.1 General

6.1.1 Unless otherwise stated in this International Standard, the requirements of IEC 60945 shall apply.

6.1.2 The construction of the gyro-compass shall conform to the requirements specified in Clause 4.

6.2 Settling time test

The master compass shall be securely positioned on a nominally level and stationary base. It shall be energized from nominal value power supplies and started in accordance with the manufacturer's instructions from an initial heading error (to east) of 30° or more.

The settling time (see 3.3) shall meet the requirements of 5.1.1.

6.3 Settle-point-error test

When the master compass has settled (3.3), the settle point error (3.5) shall conform to the requirements specified in 5.1.2.1.

6.4 Settle-point-heading repeatability test

The master compass shall be started in accordance with the manufacturer's instructions from an initial heading error (to east) of 30° or more and shall be allowed to settle.

The settle point heading shall be determined as specified in 3.4. The master compass shall then be switched off for a period of not less than 12 h and not more than 7 d, and then started again from an initial heading error (to west) of 30° or more and the settle point heading measured again.

The master compass shall then be switched off for a period of not less than 12 h and not more than 7 d, and started again from an initial heading error (to east) of 30° or more and the settle point heading determined. The three values of settle point heading obtained shall be recorded and the difference between any two shall not exceed 0,25° × secant latitude.

NOTE If this test follows the test described in 6.3, the "settle" obtained in 6.3 may be used as the first value required by this repeatability test provided that the second "settle" follows a switch-off period of not less than 12 h and not more than 7 d.

6.5 Settling time on a Scorsby table

The master compass shall be mounted on a Scorsby table with the master compass' fore and aft line nominally parallel with one axis of the table which shall be designated as the roll axis.

The other nominally horizontal axis, at right angles to the first, shall be designated as the pitch axis.

The compass shall then be switched on in accordance with the manufacturer's instructions with the following nominal simple harmonic table motions:

— roll axis: peak amplitude 5° ± 1°, period 15 s ± 1 s;

— pitch axis: peak amplitude 5° ± 1°, period 6 s ± 1 s.

The settling time measured between switch-on and compass settle (see 3.3) shall conform to the requirements specified in 5.1.3.

NOTE Compass readings to determine the settle condition may be taken with the Scorsby table stationary and nominally level, and with a minimum delay before resuming the specified table motion.

6.6 Scorsby test

The master compass shall be settled on the Scorsby table with the table stationary, nominally level and its roll axis aligned north–south within ±1°.

The compass lubber line shall be aligned to within ±1° of the table roll axis. The following nominal simple harmonic motions shall be applied simultaneously to the three axes of the table for 25 min:

— roll axis: peak amplitude 25° ± 2°, period 6 s ± 1 s;

— pitch axis: peak amplitude 15° ± 2°, period 10 s ± 1 s;

— yaw axis: peak amplitude 5° ± 1°, period 15 s ± 1 s.

At the end of 25 min, the table motion shall be stopped, the table returned to its original position and the compass heading recorded without delay.

This test shall be repeated with the roll axis of the motion table aligned at 045° ± 1°, at 090° ± 1° and at 315° ± 1°. At each of these headings, the compass settle point shall be determined before commencing the table motion, and any change of heading indication by the compass between the settle point heading, immediately prior to the motion and the heading at the conclusion of the motion, shall be recorded as error due to motion.

In each of the four tests, error due to the motion shall be less than ±1° × secant latitude.