Guideline No.N-05 (202111)

N-05

MAGNETIC COMPASS

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

Historical version and release date: N-05(201510) October 20, 2015

Main change: Update the test requirements of this guideline according to the new edition of ISO 25862(2019).

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MAGNETIC COMPASS

1 Application

1.1 The Guideline applies to the approval and inspection on the marine level-A magnetic compass and binnacle.

1.2 The Guideline applies to the navigation liquid magnetic compasses of reflection type, projection type or emission type (repeating type) with direct reading system.

2 Basis for approval and inspection

IMO A.382 (X) *Recommendation on Performance Standards for Magnetic Compasses*

IMO 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)*

ISO25862 (2019) *Ships and Marine Technology — Marine Magnetic Compasses, Binnacles and Azimuth Reading Devices*

ISO1069 (1973) *Magnetic Compass and Binnacle for Sea Navigation- Vocabulary*

ISO694 (2000) *Ships and Marine Technology - Positioning of Magnetic Compasses in Ships*

IEC60945-2002/COR1:2008 *Maritime Navigation d and Radio Communication Equipment and Systems-- General Requirements—Methods of Testing and Required Test Results*

3 Definitions and terms

3.1 Magnetic compass: The instrument consisting of the pointing system supported by single pivot in the bowl (the bowl is supported on the gimbal inside or outside the bowl full of liquid). The magnetic compass (hereinafter referred to as the compass) mentioned in the Guideline involves also the compass without gimbal. The requirement on gimbal does not apply to such compass.

3.2 Standard compass: The magnetic compass installed in the binnacle with corrector, provided with azimuth reading device, and acting as the main navigation tool of the ship.

3.3 Steering compass: The magnetic compass used by the helmsman when manipulating the ship.

3.4 Backup steering compass: The magnetic compass used to provide the second reference heading for manipulation of the ship.

3.5 Emergency compass: The magnetic compass used for controlling the manipulation or manipulating the ship in case of damage of any other similar tool.

3.6 Reflector compass: The compass that uses the reflecting system to observe the whole or part of the dial.

3.7 Projector compass: The compass that uses the optical system to project the image of the whole or part of the dial onto the direct observation screen.

3.8 Binnacle: The fixing device used to support the compass bowl (which can be provided with device used to shield or support the compass compensation and lighting equipment).

3.9 The design and height of type-A1 binnacle should be such that the magnet of the compass pointing system should be at least 1 m higher than the lower surface of the compass deck.

3.10 Type-A2 binnacle: It can be used when type-A1 binnacle is not practicable with no requirement on the binnacle height.

3.11 Azimuth reading meter (azimuth finder, azimuth circle or azimuth sighting device): The equipment installed or attached usually to the compass bowl for measuring the azimuth of celestial body or long-distance object.

3.12 Three types of azimuth reading meters

3.12.1 Type I: Collimator or telescope collimator that is required to aim at the long-distance target.

3.12.2 Type II: Azimuth mirror or prismograph with no accurate aiming requirement from which azimuth with lowered accuracy can be obtained when the drift angle does not exceed 5 °.

3.12.3 Type III: Dummy compass that is not installed at the binnacle but used together with A2 binnacle (when it is not convenient to read the azimuth from the A2 binnacle due to its size or position on the ship).

3.13 *H*: The horizontal component of the magnetic flux density at the test site, expressed in μT.

4 Plans and documents

4.1 The following plans and documents should be submitted to CCS for approval:

4.1.1 General assembly plan;

4.1.2 The main component plans include:

(1) Structural diagram of gimbal (including the bearing plans of the internal and external gimbals);

(2) Compass bowl assembly diagram (including the structural diagrams of pivot point and float chamber, azimuth ring diagram, and dial diagram;

(3) The body structure diagram of the binnacle involves the diagram of the spring suspension system, diagram of correction magnet arrangement, and diagram of lighting system arrangement;

(4) Structural diagram of azimuth reading meter;

(5) List of components.

4.1.3 Manufacturer's instruction: The technical documents meeting the requirements of B.1 and D.1.2 of ISO 25862;

4.1.4 Type test program.

4.2 Submit the following plans and documents to CCS for information.

4.2.1 Samples of product nameplate and delivery qualification certificate;

4.2.2 Product operation instructions;

5 Design and technical requirements

5.1 Material: The magnetic steel used for the magnetic compass pointing system should be the magnetic material with high remanence, and other materials used should be non-magnetic ones (except for the repeat compass).

5.2 Gimbal and compass bowl

5.2.1 The relationship between two axises: The intersection angle of the internal and external axises of the gimbal should be 90 °±1 °. Generally, the two vertical planes passing through the gimbal axis should intersect within the distance of 1 mm away from the pivot point.

5.2.2 The axis of the external gimbal should be parallel with the keel line of the ship; the axis of the external gimbal of the compass suspension in the binnacle should be within 0.5 ° of the keel line of the binnacle.

5.2.3 Bearings of the internal and external gimbals: They should be of the same type.

5.2.4 Compass bowl appearance: The compass bowl should be kept free of mechanical damage, leakage, crack or blister inside or on the dial coverage, and the liquid be colorless, and free of turbidness or flock.

5.3 Baseline

5.3.1 Each compass should be provided with a baseline to indicate the ship bow direction (the main baseline is the stem azimuth marker). The main baseline should be clear and distinguishable, and within 0.5 ° of the longitudinal gimbal axis.

5.3.2 Baseline width: The width of the compass baseline should not be 0.5 ° bigger than the range.

5.3.3 The distance between the lubber line and the compass dial edge as well as the projector compass should be 1.5~3.0 mm and 0.5~1.5 mm respectively. When the compass bowl or that of

the hemispherical compass inclines by 10 ° or 30 ° respectively, the compass should be read at the steering position according to the lubber line. The compass with gimbal can use the lubber line board.

5.4 Compass dial

5.4.1 Dial position (relationship of the compass dial edge and trunnion bearing:

When both the directional ring of the azimuth reading meter and foundation are level, the dial division edge, lubber line (if it is a point), pivot point and external gimbal axis should all be located within ±1 mm from the horizontal plane crossing the gimbal axis fixed on the compass bowl.

5.4.2 Division

The compass dial should be divided starting from the north clockwise in degree within 360 °. Corresponding 3 digits should be used to mark every 10 °. The north azimuth is indicated with 000 °. The main azimuth points should be indicated with capitals N, S, E and W; quadrantal points can also be marked. Proper sign can be selected to indicate the north azimuth. Scales, if provided on both sides of the dial, should be coincided within a tolerance of 0.2 °.

5.4.3 Dial diameter

The compass dial diameter for the following types of binnacles:

Type A1: 165 mm or bigger.

Type A2: 125 mm or bigger.

5.4.4 Readability

For steering compass, the helmsman should be able to read the dial clearly with normal eyesight at a distance of 1.4 m away from the compass under the sunlight or artificial light source, the division value of which should be located in a sector with a width of not less than 15 ° on both sides of the lubber line. Magnifying glass can be used.

For reflector and projector compass, the lubber line should be clear and visible, and division values in the sector with a width of not less than 15 ° on both sides of the lubber line should be readable by a person with normal eyesight at a distance of 1 m away from the periscope.

5.5 Compass bowl pivot and bearing

5.5.1 Height of the compass bowl pivot bearing

The deviation between the compass bowl pivot and the horizontal plane crossing the internal gimbal axis should not be bigger than 1 mm. If the pivot bearing is provided with a vertical spring suspension, such condition should be met when the pointing system is immersed.

5.5.2 The pointing system should be installed in the compass bowl in such a way that it can return to the initial position on the pivot after the compass bowl is turned over completely and returns to the normal position.

5.5.3 Pivot centering: The deviation between the pivot and the vertical line passing through the inner edge diameter center of the compass bowl should not be bigger than 0.2 mm.

5.5.4 Pivot support force: When the dial diameter is 165 mm or less, the force of the pointing system applied to the pivot bearing in the compass liquid should be 0.04~0.10N (or 0.04~0.14N when the dial diameter is bigger than 165 mm).

5.6 Magnet of the pointing system:

5.6.1 It should be made of magnetic materials with high remanence and coercivity of not less than 18 kA/m.

5.6.2 The magnetic moment of the pointing system varies with the dial diameter, which should not be less than the value shown in Fig. 5.6.2.

5.6.3 Magnetic steel of the pointing system should not be longer than 85 mm.

5.6.4 Magnet arrangement:

The magnet poles of the pointing system should be arranged in such a way that it should not cause a 6-halving or 8-halving deviation due to the corrector effect. The criteria is that the ratio of the 8-halving coefficient and 4-halving one (H/D) should not exceed 0.08.

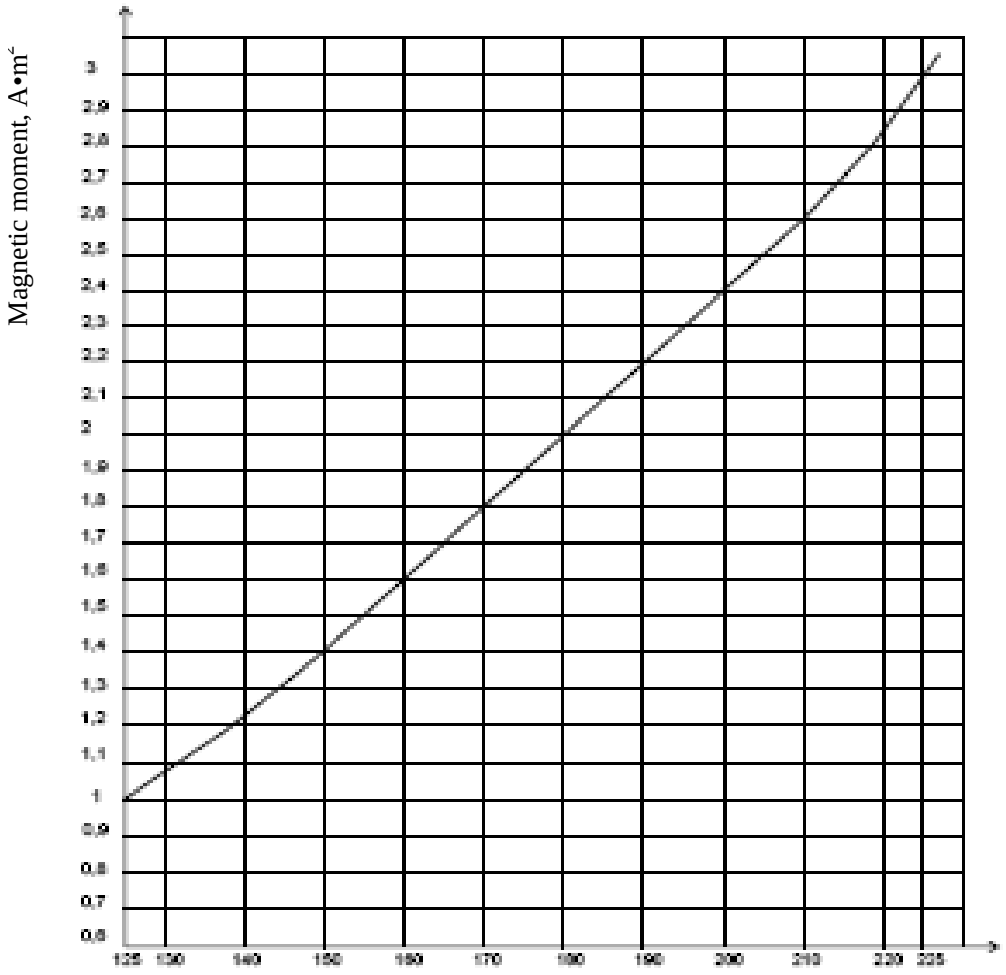

Fig.5.6.2 Magnetic moment of grade-A liquid-type magnetic compass - min. requirement

5.7 Settling time and half cycle

5.7.1 The time for the dial to conduct initial deflection by 90 ° from the magnetic meridian and then return to the position within 1 ° from the magnetic meridian finally at the temperature of 20℃ ±3℃ should not be bigger than $240/\sqrt{H}$ s (or 60s if *H*=18μT).

5.7.2 The half cycle of the pointing system should not be less than $\sqrt{2600/H}$ s (or 12 s if H=18μT).

5.8 Accuracy

5.8.1 The pointing error at any heading should not exceed 0.5 °.

5.8.2 Lubber line error: It should not exceed 0.5 °.

5.8.3 Frictional error: It should not exceed (3/*H)* °.

5.8.4 Swirl error: It should not exceed (108/*H*) °when the compass bowl rotates at a constant speed of 6 °/s on the horizontal plane, (54/*H*) °when it rotates at a speed of 1.5 °/s with dial diameter of not less than 200 mm, or (36/*H*) °when the dial diameter is less than 200 mm.

5.8.5 Induction error: It should meet one of the following requirements:

(1) The ratio of coefficients H and D should not be bigger than 0.08;

(2) The coefficient F of the 6-halving circle deviation value generated by the small magnet with length of less than 50 mm that is placed on the same horizontal plane as a magnetic part and has a tangent distance of about 40 cm away from the pointing system center is 0.01 smaller than coefficient B of the semicircular deviation.

5.8.6 Installation deviation of the azimuth reading meter

The azimuth reading meter is positioned on the compass bowl, and the eccentricity error between the vertical axis of the reading meter and the pivot point should not exceed 0.5 mm.

5.8.7 Eccentricity error of the directional ring

If the directional ring is divided, the vertical line crossing the relative directional ring center should be within 0.5 mm of the pivot point.

5.9 Corrector

Complete devices for correcting the semicircular deviation and quadrantal deviation should be provided for the compass or binnacle with dial diameter of more than 130 mm for correcting the following:

(1) Horizontal component of the permanent magnetic field;

(2) Heeling error;

(3) Horizontal component of the horizontal induced magnetism;

(4) Horizontal component of the vertical induced magnetism.

5.10 Lighting: The power of the lighting must be provided with two-way power, so as to facilitate the dial reading at any time. Brightness control should also be provided. The lamp, accessories and wiring should not affect the pointing system.

5.11 Adaptability of the ship environment:

5.11.1 The vibration should meet the vibration resistance requirement of Article 8.7 of IEC60945 (2002).

5.11.2 The product should meet the high/low temperature test requirements in B.3.1.3 and B.3.1.4 of ISO25862;

5.11.3 The product should meet the requirements on cyclic damp heat test, water spraying test and salt mist test in Articles 8.3, 8.8 and 8.12 of IEC60945 (2002).

6 Type test

6.1 Selection of typical samples

The sample selected for approval should reflect the processing capability and manufacturing level of the factory.

6.2 The test items of the magnetic compass and binnacle are shown in Table 1 below:

(All the functional tests should be carried on at the temperature of 20℃±3℃)

List of test items **Table 1**

No.	Inspection and test items	Inspection and test method	Technical requirement	Inspection type	
				Type Test	Factory test
1	Appearance	B.3.1.1 of ISO25862	B.3.1.1 of ISO25862	X	X
2	Non magnetism of materials	B.3.1.2 of ISO25862	B.3.1.2 of ISO25862	X	
3	Dry heat test	B.3.1.3 of ISO25862	B.3.1.3 of ISO25862	X	
4	Low-temperature test	B.3.1.4 of ISO25862	B.3.1.4 of ISO25862	X	
5	Thicknesses of the top and bottom glass covers	B.3.1.5 of ISO25862	4.2.5, B.3.1.5 of ISO25862	X	
6	Repeating system (if any)	B.3.1.6 of ISO25862	B.3.1.6 of ISO25862	X	
7	Relationship between two gimbal axises	B.3.2.1 and B3.2.2 of ISO25862	4.2.4, B.3.2.1 and B3.2.2 of ISO25862	X	
8	Ring movement DOF of the gimbal	B.3.2.3 of ISO25862	4.3.1, B.3.2.3 of ISO25862	X	X
9	Horizontal position	B.3.2.4 of ISO25862	4.2.7, B.3.2.4 of ISO25862	X	
10	Friction of the internal gimbal	B.3.2.5 of ISO25862	B.3.2.5 of ISO25862	X	
11	Inner and outer gimbal bearings	B.3.2.6 of ISO25862	B.3.2.6 of ISO25862		
12	Relative verge ring graduation (if any)	B3.3.1 of ISO 25862	B3.3.1 of ISO 25862	X	
13	Eccentricity error of the azimuth ring (if any verge graduation)	B.3.3.2 of ISO25862	B.3.3.2 of ISO25862	X	
14	Centering accuracy of the azimuth reading meter	B.3.3.3 of ISO25862	B.3.3.3 of ISO25862	X	
15	Height of the compass dial pivot bearing	B.3.4.1 of ISO25862	B.3.4.1 of ISO25862	X	
16	Protection of directional system against displacement	B.3.4.2 of ISO25862	B.3.4.2 of ISO25862	X	
17	Freedom of tilt of directional system	B.3.4.3 of ISO25862	B.3.4.3 of ISO25862	X	X
18	Baseline quantity	B.3.5.1 of ISO25862	4.2.2, B.3.5.1 of ISO25862	X	X
19	Baseline visibility	B.3.5.2 of ISO25862	4.2.2, B.3.5.2 of ISO25862	X	X
20	Baseline width	B.3.5.3 of ISO25862	B.3.5.3 of ISO25862	X	X
21	Distance between the baseline and the dial periphery	B.3.5.4 of ISO25862	B.3.5.4 of ISO25862	X	X

Continued Table 1

No.	Inspection and test items	Inspection and test method	Technical requirement	Inspection type	
				Type Test	Factory test
22	Graduation	B.3.6.1.1 of ISO25862	B.3.6.1.1 of ISO25862	X	X
23	Diameter of the card	B.3.6.1.2 of ISO25862	4.5.2, B.3.6.1.2 of ISO25862	X	
24	Readability of compass card	B.3.6.1.3 of ISO25862	4.5.3, B.3.6.1.3 of ISO25862	X	
25	Relationship of edge of compass card and pivot bearing	B.3.6.1.4 of ISO25862	B.3.6.1.4 of ISO25862	X	
26	Magnetic moment and length of the magnet of the pointing system:	B.3.6.2.1 of ISO25862	B.3.6.2.1 of ISO25862	X	X (The factory conducts the test before assembly and submits the test report)
27	Magnet coercive force of the pointing system:	B.3.6.2.3 of ISO25862	B.3.6.2.3 of ISO25862	X	
28	Effect of vertical magnetic flux density on system inclination	B.3.6.2.4 of ISO25862	B.3.6.2.4 of ISO25862	X	
29	Induction error	B.3.6.2.2 of ISO25862	4.6.5, B.3.6.2.2 of ISO25862	X	
30	Cycle (Settling time and half cycle)	B.3.6.3 of ISO25862 and IMO A.382 (X)	4.4.4, B.3.6.3 of ISO25862 and IMO A.382 (X)	X	X
31	Pointing error	B.3.7.1 of ISO25862	4.6.1, B.3.7.1 of ISO25862	X	X
32	Baseline error	B.3.7.2 of ISO25862	4.6.2, B.3.7.2 of ISO25862	X	X
33	Frictional error	B.3.7.3 of ISO25862	4.6.3, B.3.7.3 of ISO25862	X	X
34	Swirl error	B.3.7.4 of ISO25862	4.6.4, B.3.7.4 of ISO25862	X	
35	Construction and material of binnacles	D.2.1 of ISO 25862	D.2.1 of ISO 25862	X	
36	Compass suspension	D.2.2 of ISO 25862	4.3.1, D.2.2 of ISO 25862	X	
37	Provisions of correct misalignment	D.2.3 of ISO 25862	D.2.3 of ISO 25862	X	
38	Correcting devices, marking, coercivity and securing (type A1 binnacles and, if fitted, type A2 binnacles)	D.2.4 of ISO 25862	D.2.4 of ISO 25862	X	

Continued Table 1

No.	Inspection and test items	Inspection and test method	Technical requirement	Inspection type	
				Type Test	Factory test
39	Corrector coils	D.2.5 of ISO 25862	D.2.5 of ISO 25862	X	
40	Illumination	D.2.6 of ISO 25862	D.2.6 of ISO 25862	X	X
41	Azimuth reading device	C.2.1 of ISO25862; C.2.2 of ISO25862; C.2.3 of ISO25862; C.2.5 of ISO25862;	C.2.1 of ISO25862; C.2.2 of ISO25862; C.2.3 of ISO25862; C.2.5 of ISO25862;	X	X
42	Field of view and range of altitude	C.2.4 of ISO25862	C.2.4 of ISO25862	X	
43	Shadow pin (if any)	C.2.6 of ISO25862	C.2.6 of ISO25862	X	
44	Pelorus	C.2.7 of ISO25862	C.2.7 of ISO25862	X	
45	Damp heat	Article 8.3 of IEC60945	Article 8.3 of IEC60945	X	
46	rain and spray	Article 8.8 of IEC60945	Article 8.8 of IEC60945	X	
47	Vibration (may be carried out assembled in the binnacles)	Article 8.7 of IEC60945	Article 8.7 of IEC60945	X	
48	Salt mist (compass for use in lifeboats/ rescue boats)	Article 8.12 of IEC60945	Article 8.12 of IEC60945	X	
49	Solar radiation (compass for use in lifeboats/ rescue boats)	8.10 of IEC60945	8.7 of IEC60945	X	

Note: Items marked with X should be carried out.

6.3 Determination of test items

During type approval, all the applicable test items in Table 1 should be conducted.

7 Unit/batch inspection

7.1 After the CCS type approval is granted, the marine magnetic compass manufactured by the factory according to the approved condition (including the equipment and process) cannot be installed on the ship until the unit/batch inspection of CCS is passed.

7.2 After approval, CCS will inform in written the factory of specific inspection method via the approved product inspection plan when issuing the type approval certificate.

7.3 After product approval, the factory should test each product as per the factory test items specified in Table 1, and submit the test report for CCS Surveyor approval. The Surveyor should select 10% of the products applied for inspection (at least 2 sets) for witness test. The product certificate will be issued after passing the test.