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N-12
ELECTRONIC INCLINOMETER

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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.

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Table of Contents

1 Scope of Application 4

2 Normative References 4

3 Terms and Definitions 4

4 Drawings and Documents 5

5 Product Requirements 5

6 Type Test 8

7 Unit/batch inspection 11

ELECTRONIC INCLINOMETER

1 Scope of Application

This Guideline applies to the approval and inspection for electronic inclinometers installed on international voyage ships as per requirements of IMO MSC.363(92), as well as for those installed on Chinese voyage ships for reference.

During product approval, the latest version of the cited documents shall be applicable if the normative document referred is revised. If related certificates have been issued for approved products, the latest version of reference document shall be complied with for the certificate renewal, except in exceptional circumstances.

2 Normative References

2.1 IMO MSC.363 (92): *Performance Standards for Electronic Inclinometers*

2.2 IMO A.1021 (26): *Code on Alerts and Indicators*

2.3 IEC 60945: 2002/COR1 2008: *Maritime Navigation and Radiocommunication Equipment and Systems - General Requirements - Methods of Testing and Required Test Results* (IMO A.694(17))

2.4 IEC 62288-2008: *Maritime Navigation and Radiocommunication Equipment and Systems - Presentation of Navigation-related Information on Shipborne Navigational Displays - General Requirements, Methods of Testing and Required Test Results* (IMO MSC.191(79))

2.5 IEC 61162 series standard

2.6 IACS UR E10 (Rev.6): *Guidelines for Type Approval Test of Electric and Electronic Products*, issued by International Association of Classification Societies.

3 Terms and Definitions

3.1 Rolling: oscillating motions of ships about their longitudinal axes.

3.2 Actual heel angle: the lateral tilting angle of ship horizontal axis relative to the horizontal line during the oscillating motions of ship about its longitudinal axes. The angle is defined as “negative” (for example, -15 °) if the larboard is lower than the horizontal line (unification is required for CCS).

3.3 Roll period: the time interval for ship reaching two maximum continuous lateral heel angles on the same side (1s as the minimum resolution indicated).

3.4 Roll amplitude: the maximum heel angle towards the larboard and the starboard within a period.

4 Drawings and Documents

4.1 The following drawings and documents shall be submitted to CCS for approval:

4.1.1 Technical conditions of product

4.1.2 Outline structure of complete equipment (including panel layout)

4.1.3 Schematic circuit diagrams

4.1.4 Type test program

4.2 The following drawings and documents shall be submitted to CCS for future reference:

4.2.1 Schematic block diagram

4.2.2 Product instructions

4.2.3 External wiring diagram

4.2.4 Factory test program

5 Product Requirements

5.1 Technical requirements

5.1.1 Measurement of actual heel angle

The electronic inclinometer shall be capable of measuring the actual heel angle of ship and its reciprocating roll amplitude within ±90 º.

The measurement accuracy shall be 5% of the reading or ±1 º, and the greater value is preferred.

5.1.2 Measurement of roll period

The electronic inclinometer shall be capable of measuring the time interval between the maximum roll oscillations and the roll period within the minimum range (4-40 seconds).

The measurement accuracy shall be 5% of the reading or ±1 second, and the greater value is preferred.

5.1.3 The accuracy of actual heel angle and time measurement shall not be affected by other linear or rotary motions (such as surging, swaying, heaving, pitching and yawing) or the transverse acceleration from -0.8 g to +0.8 g.

5.2 Display requirements

5.2.1 The roll period with minimum resolution of 1s; and

5.2.2 The roll amplitude to the larboard or the starboard, with minimum resolution of 1 º.

5.2.3 At least, the actual heel angle within ±45 ºto the larboard or the starboard through the analog mode.

5.2.4 The display may be the special or integrated to other cabin systems.

5.2.5 The special display shall be featured with clear data displayed and adjustable brightness, and shall be visible at the minimum brightness at night.

5.2.6 Display contents also include:

(1) Audible and visual indication for alarming of overlimit heel angle (with the alarm limit settable);

(2) Audible and visual indication for internal failure alarming;

(3) Power indication and failure alarming.

5.2.7 Color of display indicator shall comply with Clause 4.8.1.1 in IEC 62288;

5.2.8 Letter codes and abbreviations of display shall comply with Table B.1 of IEC 62288;

5.2.9 Unit symbols and abbreviations of display data shall comply with Table B.2 of IEC 62288;

5.2.10 If the analog mode is adopted for display of actual heel angle and the electronic inclinometer is installed on the front wall or rear wall of cabin, the actual movement direction of the simulator (pointer, and pendulum, etc.) shall be the same as that of rolling track,

5.2.11 The flash frequency of alarm (failure) indicator shall be within 0.5 - 1.5 Hz, and the duration shall be greater than 50% within a period (see Clause 6.2 of IMO A.1021(26)).

5.2.12 If the flash mode is adopted for some information indication of display (such as “breathing” light indicating system is normal), the information flash frequency shall be different from alarm flash frequency (see Clause 4.6.4.1 of IEC 62288).

5.2.13 The display shall be featured with adjustable brightness and shall be visible at the minimum brightness in the nighttime. In case of alarm at the low brightness, the display brightness will be automatically increased, ensuring that the alarm information is so clear that it can be noticed by crew.

5.2.14 Dimming, alarm verification and layout of light testing device of electronic inclinometer shall be convenient for crew’s operation.

5.3 Data interface

5.3.1 The electronic inclinometer shall be configured with a standardized digital interface, to provide the following data to the voyage data recorder (VDR) and other systems:

(1) Instantaneous heel angle, with the update rate no lower than 5 Hz (VDR);

(2) Digital display of roll period and roll amplitude (see Clause 5.2.1 and 5.2.2 for accuracy);

(3) Installation location of electronic inclinometer sensor (VDR).

5.3.2 The electronic inclinometer shall be configured with a bidirectional communication interface, transmitting the alarm signal from the inclinometer to the external system and receiving alarm response and acoustic damping signals from the external system.

5.3.3 Communication protocol and format of the standardized digital interface shall be in compliance with requirements of IEC 61162-1.

(1) The statement “heeling data and equipment status” from the inclinometer shall be in compliance with Clause 8.3.11 in IEC 61162-1, and the data update rate shall be ≤200 ms.

(2) The statement “coordinate” of the inclinometer location shall be in compliance with Clause 8.3.65 in IEC 61162-1. Modes of regular transmission and irregular transmission for coordinate statement are available.

5.3.4 Communication protocol and format of the bidirectional communication interface shall be in compliance with IEC 61162-1.

(1) Considering data reception of the bidirectional interface, transmission of inclinometer data “heeling data and equipment status” can be delayed (such as once per second or every two seconds).

(2) The statement “alarm confirmed” from the external equipment to the inclinometer shall be in compliance withClause 8.3.6 in IEC 61162-1.

(3) If the “dimming” or “light test” instruction is received by the inclinometer from external equipment, “dimming” and “light test” statements can be complied in the standard format specified in IEC 61162-1.

5.4 Signal interface

5.4.1 The electronic inclinometer shall be set with relevant interfaces, to transmit system failure, overlimit alarming signals and those triggering external alarm. In addition, the system failure alarm contact shall be the normally closed type, i.e. the contact is open in case of system failure (such as power failure and system crushing) and the contact is close in case of normal operation.

5.4.2 The electronic inclinometer shall be configured with the interface enabling dimming, alarm verification and light test with external elements (for example, connection between the external system and electronic inclinometer specified in Clause 5.3.2 can be also realized through the external system).

5.4.3 The electronic inclinometer shall be configured with the signal input interface, enabling “dimming”, “alarm verification” and “light test” for the electronic inclinometer with external elements.

5.5 Power supply

5.5.1 The electronic inclinometer shall be set with two circuits of power inputs.

5.6 Alarm

5.6.1 Alarm sound from internal alarm of electronic inclinometer or external alarm in the cabin shall be higher than 75 dB (A) but shall not exceed 85 dB (A) (see Clause 5.13 of IMO A.1021(26)).

5.6.2 The electronic inclinometer shall send relevant alarm signals, indicating the preset heel angle is exceeded.

Considering that ship roll caused by harsh climates or sea conditions may exceed the preset heel angle and trigger the over limit alarming, and the over limit condition is periodic, the over limit alarming sound from the electronic inclinometer can be eliminated manually. In addition, the automatic acoustic damping function of sound alarm system is also available, i.e. the sound alarm is activated in case of over limit condition and the sound alarm will exit automatically (visual alarm activated by overlimit condition shall be maintained and its automatic “exit” is unacceptable). But it is important to note that the sound alarm shall be maintained

for a certain period, even in the case of the instantaneous overlimit condition, so as to attract crew's attention.

5.7 Parameter setting

5.7.1 Reasonable protective measures shall be taken for the parameter setting function of the electronic inclinometer, to prevent misoperation.

5.7.2 Coordinate parameters of inclinometer sensor shall be input into the electronic inclinometer through proper ways, and shall be sent to VDR through the data interface concerned. The current coordinate parameters shall be accessible.

5.7.3 Digital display of heel angle shall be set with identifiers (such as +/-, P/S, etc.), distinguishing the "left-inclining" status from the "right-inclining" status. The "left-inclining" or "right-inclining" status display mode shall be optional.

5.8 Contents to be specified in installation instructions include:

5.8.1 It is necessary to ensure that the three-axis coordinate system of inclinometer sensor is consistent with the coordinate system of hull during installation of electronic inclinometer. The coordinate parameters of the inclinometer sensor shall be measured according to the hull drawings after installation, and the parameters shall be saved to the electronic inclinometer.

See Clause 8.3.65 in IEC 61162-1 for definitions of X, Y and Z coordinate systems of hull.

5.8.2 It is required to ensure the minimum safe distance to the magnetic compass equipment during installation of electronic inclinometer and inclinometer sensor.

5.8.3 If the electronic inclinometer is installed on the front wall or rear wall of cabin, the actual movement direction and indication symbols of the simulator shall be the same as that of rolling track,

6 Type Test

6.1 Items of type test

The type test items shall be conducted according to:

(1) Type test items specified in *CCS Guidelines for Type Approval Test of Electric and Electronic Products, Chapter 4: Navigation and Radiocommunication Equipment and Systems* and executive standards (IEC 60945:2002); and

(2) Routine test items not mentioned above (IACS UR E10 (Rev.6))

(3) See Table 6.2 for items of type test and executive standards.

6.2 Samples for type test

In principle, 1 set of samples can be selected randomly, and tested as per the type test items specified in Table 6.2.

Items of Type Test and Executive Standards Applicable to Electronic Inclinometer

Table 6.2

S/N	Test classification	Test items	Executive standards and clauses	
			IEC 60945: 2002	Others
1	General			
1.1		Appearance inspection	Appendix A: 7-9	UR E10 (Rev.6): Table-1
1.2		Operation check	6.1 ～ 6.4	This Guideline: 8.3
1.3		Performance test	5.1	This Guideline: 8.4
1.4		Measurement of insulation resistance		UR E10 (Rev.6): Table-9
1.5		Withstand voltage test		UR E10 (Rev.6): Table-10
2	Power supply			
2.1		Maximum power steady-state fluctuation	4.3.1, 5.2.2 and 7.1	
2.2		Abnormal power	4.3.2, 5.2.3 and 7.2	
2.3		Instantaneous power fluctuation	4.3.3, 7.3 and 10.7	
2.4		Power failure	4.3.3, 7.4 and 10.8	
3	Ambient conditions			
3.1		Dry heat	8.2 (8.2.2.2)	
3.2		Moist heat	8.3	
3.3		Low temperature	8.4 (8.4.2.4)	
3.4		Vibration	8.7	
3.5		Salt mist (corrosion)①	8.12	
4	Electromagnetic compatibility			
4.1		Conducted emission	9.2	
4.2		Radiated emission from enclosure port	9.3	
4.3		Immunity to conducted disturbance inducted by radio frequency field	10.3	
4.4		Radiated immunity of radio-frequency electromagnetic field (if applicable)	10.4	
4.5		Electric fast transient immunity	10.5	
4.6		Surge (impact) immunity	10.6	
4.7		Electrostatic discharge immunity	10.9	
5	Special			
5.1		Noise and acoustic signal	11.1	
5.2		Safe distance of magnetic compass	11.2	
5.3		Ship motion disturbance control		MSC.363(92): 6.2
6	Personal safety			
6.1		Insulation of dangerous voltage (it can be substituted by tests in Table 7.1)	4.6.1 and 12.1	
6.2		Radio-frequency electromagnetic radiation	4.6.2 and 12.2	
6.3		Transmission of visual display unit (VDU)②	4.6.2 and 12.3	
6.4		X-ray radiation②	4.6.3 and 12.4	
7	Others			
7.1		Ingress protection of enclosure		IEC 60529

Note: ① The test is not required if the certificate indicating that relevant parts and materials used in equipment and their final processing meet test requirements can be supplied by manufacturers. The salt mist test is only applicable to parts installed on deck;

② The test is not required if the certificate indicating conformity of equipment can be supplied by manufacturers.

6.3 Operation check

Operation check and function tests shall be completed for following basic items of the electronic inclinometer, and the check and test results shall meet requirements of Clause 6.1, 6.2 and 6.4-6.6 in this Guideline (details of test items and methods shall be specified in the product type test outline or document).

6.3.1 Function of overlimit alarming and verification for heel angle;

6.3.2 Sensor failure alarming;

6.3.3 Power auto-switching and failure alarming;

6.3.4 Self-test;

6.3.5 External button open-circuit and short-circuit failure alarming;

6.3.6 Parameter modification (over limit value and coordinate parameter of heel angle);

6.3.7 Dimming

6.4 Performance test

Performance test shall be completed for following items of the electronic inclinometer, and the test results shall meet requirements of Clause 5.1, 5.2 and 6.3 (details of test items and methods shall be specified in the product type test program or document);

6.4.1 Measurement and display

(1) Measurement and display of heel angle: within the range of ±90 °, the accuracy shall be 5% of the reading or ± 1 °(the greater value is preferred);

(Display through analog mode: within the range of ±45 °, the accuracy is to be defined);

(2) Measurement and display of roll period: it is the period from 4 s to 40 s;

the accuracy shall be 5% of the reading or ± 1 s (the greater value is preferred);

(3) Measurement and display accuracy of roll amplitude: 5% of the reading or ± 1 ° (the greater value is preferred);

6.4.2 Alarm sound: 75 dB (A) ～ 85 dB (A) (in compliance with Clause 5.13 in IMO A.1021(26)).

6.4.3 Data communication

(1) The actual heel angle, roll period and roll amplitude are transmitted through the standard protocol to VDR, and the data update rate is ≤200 ms;

(2) Coordinate parameters of the sensor are transmitted through the standard protocol to VDR;

(3) Alarm and failure signals are transmitted through the standard protocol to external equipment, and alarm response and acoustic damping signals from the external system are received.

7 Unit/batch inspection

7.1 The application of unit/batch inspection can only be submitted to CCS after type approval.

7.2 The application of unit/batch inspection can only be submitted by manufactures to CCS after factory tests for all products and verification of conformity.

7.3 Proportion of CCS sampling inspection: it is 5% and samples shall not be less than 2 sets (excepting that only 1 set of products are submitted for inspection application).

7.4 Factory test shall be completed according to items, methods and procedures approved. Basic test items are as follows:

7.4.1 Appearance inspection;

7.4.2 Operation test (function test);

7.4.3 Performance test;

7.4.4 Withstand voltage test.