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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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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 first edition cancels and replaces ISO/PAS 19697:2014.

Introduction

An electronic inclinometer is an electronic device that provides information about roll period, roll amplitude and the heel angle of the ship. *Electronic inclinometers are intended to support the decision-making process on board in order to avoid dangerous situations, as well as assist in and facilitate maritime casualty investigation*. The requirements in this document take into account human factors, ergonomic principles and advances in technology.

Ships and marine technology — Navigation and ship operations — Electronic inclinometers

1 Scope

This document specifies the performance requirements, methods of testing and test results of electronic inclinometers required by the performance standard, IMO resolution MSC.363 (92), in addition to the general requirements contained in resolution A.694 (17) and is associated with IEC 60945.

The electronic inclinometers provide information about actual heel angle, roll amplitude, roll period to support decision-making process on board in order to avoid dangerous situations, in stability (see Annex A for information), as well as to assist in maritime casualty investigation. The electronic inclinometers are mainly composed of a set of sensors, a signal processor, a display, an input device and an interface to other systems.

It does not apply to the electronic inclinometers installed for purposes which are outside the scope of this document, e.g. monitoring of cargo status.

Where a requirement in this document is different from IEC 60945, the requirement in this document takes precedence.

NOTE All requirements that are extracted from the recommendations of IMO Resolution MSC.363 (92), performance standards for electronic inclinometers, are printed in italics and the resolution and paragraph numbers are indicated in brackets.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 61162-1, *Maritime 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 — Part 2: Modular structure for INS — Operational and performance requirements, methods of testing and required test results*

IEC 62288, *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 resolution MSC.191 (79), *Performance standard for the presentation of navigation-related information on shipborne navigational displays*

IMO resolution MSC.252 (83), Performance standards for Integrated Navigation Systems (INS)

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp/

3.1
actual heel angle
momentary angle of roll referenced to a levelled ship to port or starboard side

[SOURCE: IMO MSC.363 (92), Par. 3.1]

3.2
analogue type display
display (3.3) that shows *actual heel angle* (3.1), *roll amplitudes* (3.7) and *roll peak hold values* (3.9) in a continuous way, such as by means of an arrow pointer and graduated scale

3.3
digital type display
display (3.3) that shows *actual heel angle* (3.1), *roll amplitudes* (3.7) and *roll peak hold values* (3.9) in the form of numbers

3.4
display
means by which the roll behaviour of the ship and the state of the electronic inclinometer system are presented to an observer

3.5
inspection equipment
equipment for testing the performance of the electronic inclinometer

3.6
reset function for roll peak hold value
function for resetting *roll peak hold values* (3.9) to zero and for recording reset date (month, day and year) and time

3.7
roll amplitude
maximum values of heel angle to port or starboard side

[SOURCE: IMO MSC.363 (92), Par. 3.1]

3.8
roll period
time between two successive maximum values of heel angle on the same side of the ship

[SOURCE: IMO MSC.363 (92), Par. 3.1]

3.9
roll peak hold value
maximum values of *roll amplitude* (3.7) to port or starboard side from the last reset

3.10
rolling
motion around the longitudinal axis of the ship

Note 1 to entry: Positive roll is starboard down.

[SOURCE: IMO MSC.363 (92), Par. 3.1]

3.11
zero crossing method
way for measuring wave period by using a zero crossing which is a point where the sign of a measured value (roll angle) changes

EXAMPLE From positive to negative.

4 Requirements

4.1 General

Users of this document shall note that while attempting to implement the requirements, they shall ensure compliance with such statutory requirements, rules and regulations so as to be applicable to the individual ship concerned.

4.2 Functionality

[IMO MSC.363 (92) Par. 1.2] *The electronic inclinometers* shall *in a reliable form*

a) *determine the actual heel angle with the required accuracy,*

b) *determine the roll amplitude with the required accuracy,*

c) *determine the roll period with the required accuracy,*

d) *present the information on a bridge display, and*

e) *provide a standardized interface to instantaneous heel angle to the voyage data recorder (VDR).*

4.3 Information

4.3.1 Actual heel angle and roll amplitude

[IMO MSC.363 (92) Par. 4] *Electronic inclinometers* shall *be capable of measuring the actual heel angle and determining the amplitude of the rolling oscillation of the ship over a range of ±90°.*

4.3.2 Roll period

[IMO MSC.363 (92) Par. 5] *Electronic inclinometers* shall *be capable of measuring the time between the maximum values of the rolling oscillation and determining the roll period over a minimum range of 4 s to 40 s.*

If enough precision is not attained, the period may be measured by the “zero crossing method”.

4.3.3 Roll peak hold value

Electronic inclinometers may optionally record the roll peak hold values on both sides and present them on any kind of display.

If optional recording of the roll peak hold values is provided, electronic inclinometers shall have a mean of manually resetting the roll peak hold values by a single operator action.

If necessary, the following sentences may be provided for the reset of roll peak hold value:

$–TXT,01,01,01,EI_RPHVReset_yyyy_mm_dd_oo_nn_ss*hh < CR > < LF > (see IEC 61162-1)

where:

— “yyyy” is the reset year;

— “mm” is the reset month;

— “dd” is the reset day;

— “oo” is the reset hour;

— “nn” is the reset minute;

— “ss” is the reset second;

— “hh” is the check sum;

— TXT (see IEC 61162–1).

4.4 Display

[IMO MSC.363 (92) Par. 7.2] *The actual heel angle to port or starboard shall be indicated in an analogue form between the limits of ±45°*. When the actual heel angle exceeds 45° to either side, the analogue display is permitted to remain at 45°.

[IMO MSC.363 (92) Par. 7.1.2] *Electronic inclinometers* shall *display the roll amplitude to both port and starboard side with a minimum resolution of 1°*.

Electronic inclinometers may optionally display the roll peak hold value for both sides, port and starboard, with a minimum resolution of 1°. They may also optionally display its reset date/time or relative time from the reset, if the roll peak hold value function is installed.

[IMO MSC.363 (92) Par. 7.1.1] *Electronic inclinometers* shall *display the latest roll period with a minimum resolution of 1 s*.

[IMO MSC.363 (92) Par. 7.3] *The display may be implemented as a dedicated display or integrated into other bridge systems*.

4.5 Alerts

Electronic inclinometer may provide operational alerts as described in 4.5.1 and shall provide functional alerts as described in 4.5.2.

The alerts shall conform to protocol requirements of [IMO MSC.252 (83)] as specified in IEC 61924-2. The presentation of alerts shall conform to the presentation requirements of [IMO MSC.191 (79)] as specified in IEC 62288.

[IMO MSC.363 (92) Par. 10.2] *Electronic inclinometers* shall *have a bidirectional interface to facilitate communication, to transfer alerts from inclinometers to external systems, and to acknowledge and silence alerts from external systems*.

All alerts provided in the electronic inclinometer shall be output via alert communications interface.

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

Sentences transmitted by the electronic inclinometers:

— ALC and ALF (see IEC 61924-2).

Sentences received by the electronic inclinometers:

— ACN (see IEC 61924-2).

When an Integrated Navigation System (INS) is fitted, a suitable interface shall be provided for CAM-HMI with the Integrated Navigation System [IMO Res. MSC.252 (83) and IEC 61924-2].

4.5.1 Operational alerts

[IMO MSC.363 (92) Par. 8.2] *Electronic inclinometers may optionally provide a warning for indicating that a set heel angle had been exceeded*.

The alert on heel angle excess shall be classified as CAT B Warning. The electronic inclinometer shall have a method of manually setting the threshold value of heel angle excess. The warning is initiated and its warning state becomes "active – unacknowledged", when the measured heel angle exceeds the threshold value of heel angle excess. The electronic inclinometer shall have the means to acknowledge the alert on heel angle excess. If the alert is not acknowledged, it shall be repeated as warning within 5 min. Once the warning state becomes "active – acknowledged", the warning state shall not be returned to "normal" automatically regardless of the measured value. The electronic inclinometer shall have a method of changing the alert state from "active – acknowledged" to "normal".

ALF sentence is used to initiate a warning on other bridge systems when the actual heel angle exceeds the pre-set threshold.

The following sentence may be provided for the input of a threshold value of heel angle excess:

$–TXT,01,01,01,EI_SetRollThresholdAngle_xx_deg *hh < CR > < LF >

and the sentence for transmitting the pre-set value of the threshold:

$–TXT,01,01,01,EI_RollThresholdAngle_xx_deg *hh < CR > < LF >

where:

— "xx" is the threshold value of heel angle;

— "hh" is the check sum;

— TXT (see IEC 61162–1).

Also, the following sentence may be provided for changing the alert state from "active acknowledged" to "normal":

$–TXT,01,01,01,EI_ChangeToNnormalState*hh < CR > < LF >

where:

— "hh" is check sum;

— TXT (see IEC 61162–1).

NOTE The usual alert handling may not be appropriate in this document. According to the usual alert handling, a state of the warning "active acknowledged" becomes "normal" automatically when the measured heel angle becomes lower than the threshold. However, the measured heel angle changing cyclically in starboard side or port side causes frequent initiation of alerts because a state of warning "active acknowledged" becomes "normal" just after acknowledged and the alert initiated again when the ship rolls to the other side and the measured roll angle exceeds the threshold.

4.5.2 Functional alerts

[IMO MSC.363 (92) Par. 9.1] *Electronic inclinometers* shall *internally check and indicate to the user if all components are operative and if the information provided is valid or not*.

All functional alerts should be classified as CAT.B Warning.