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Introduction

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Date: xx/xx/20xx	Document: ISO/DIS xxxx

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex **(e.g. 3.1)**	Paragraph/ Figure/Table/Note	**Type of comment**	**Commend (justification for change) by the MB**	**Proposed change by the MB**	**Secretariat observations on each comment submitted**
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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DRAFT International Standard

ISO/DIS 16329

Ships and marine technology — Heading control systems for high-speed craft

Navires et technologie maritime — Systèmes de pilotage automatique pour les navires à grande vitesse

ICS: 47.020.70

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 document 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

This second edition cancels and replaces the first edition (ISO 16329:2003), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Clause 1: In line with the latest gyro-related standards, etc., it has been kept to a minimum and other applicable conditions have been moved to Application (4.1).

— Clause 3: Along with renewal of the overall structure of the document, the terms, definitions were also updated and abbreviated terms has been added;

— Clause 4: The IMO performance requirements that were defined in each clauses were summarized in Clause 4. In addition, Clause 4 was classified into Operational requirements (4.3), Functional requirements (4.4), and Control performance requirements (4.5) and the corresponding tests are specified in Clause 6, Clause 7 and Clause 8;

— in 4.4.4, requirements related to bridge alert management have been added;

— in 4.6, a requirement for display equipment has been added;

— Clause 5: To harmonize with IEC 62065:2014 and ISO 11674:2019, the test procedure positively utilizing the similar craft motion simulator for IEC 62065:2014 and the required test results were specified.

— in 6.3, test method for a requirement for display equipment has been added;

— in 7.4, test method for requirements related to bridge alert management has been added;

— in Annex A, heading stability test under the conditions of disturbance have been deleted and, to harmonize with IEC 62065:2014 and ISO 11674:2019, the craft model specification utilizing the similar craft motion simulator for IEC 62065:2014 was specified.

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— in Annex B, craft motion simulator have been deleted and, in connection with the change in Clause 8, the use of Annex A craft models and wave disturbances for the HCS performance test was specified.

— in Annex C, example of heading stability test under the conditions of disturbance have been deleted and the alerts with a standard alert identifier have been defined;

— in Annex D, equivalent requirements in ISO 16329 and IMO Resolution have been deleted and, the IEC 61162 interface requirements specified in the main body of this document were transferred to Annex D, and details were specified.

— the normative references and bibliography have been updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document is aligned with IMO Resolution A.822(19) on performance standards for automatic steering aids (automatic pilots) for high-speed craft.

Any text in this document which is a citation from the IMO Resolution A.822(19), appears in italics. Within these citations, any changes to the original wording of the IMO Resolution A.822(19) are written in upright font.

In this document, the following verbal forms are used:

— “shall” indicates a requirement;

— “should” indicates a recommendation;

— “may” indicates a permission;

— “can” indicates a possibility or a capability.

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Ships and marine technology — Heading control systems for high-speed craft

1 Scope

This document specifies the minimum operational, functional and performance requirements, as well as methods of testing and the corresponding required test results, for heading control systems for high-speed craft, which required to comply with the performance standards adopted by the IMO Resolution A.822(19).

This document assumes the use of a conventional arrangement. Where other arrangements are provided, the requirements of this document apply insofar as they are applicable, and appropriate justification provided where deviation from the requirements is necessary.

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 61162-450, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 450: Multiple talkers and multiple listeners — Ethernet interconnection*

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*

IEC 62065:2014, *Maritime navigation and radiocommunication equipment and systems — Track control systems — Operational and performance requirements, methods of testing and required test results*

IEC 62923-1, *Maritime navigation and radiocommunication equipment and systems — Bridge alert management — Part 1: Operational and performance requirements, methods of testing and required test results*

IEC 62923-2, *Maritime navigation and radiocommunication equipment and systems — Bridge alert management — Part 2: Alert and cluster identifiers and other additional features*

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

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 A.822(19), *Performance standards for automatic steering aids (automatic pilots) for high-speed craft*

IMO Resolution MSC.64(67), Annex 3, Amendment to resolution A.342(IX), *Performance standards for heading control systems*

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3 Terms and definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

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

3.1.1
heading
direction in which the longitudinal axis of the craft is pointed, defined by the angle between the meridian through its position and the fore-and-aft line of the craft, expressed in angular units from true north

Note 1 to entry: The heading is expressed in degrees from true north 000° clockwise through 360°, where 360° becomes identical to 000°

3.1.2
heading changing
function of the *heading* (3.1.1) control unit to change a craft's heading towards the altered *preset heading* (3.1.4) by taking the *rudder order* (3.1.13) within the *rudder limit* (3.1.20), while if possible turning with a preset turn rate or with a preset turning radius, within limits related to the craft's manoeuvrability

3.1.3
heading keeping
function of the *heading* (3.1.1) control unit to keep a craft's heading at the *preset heading* (3.1.4) by taking the *rudder order* (3.1.13) within the *rudder limit* (3.1.20), within limits related to the craft's manoeuvrability

3.1.4
preset heading
direction in which a craft is steered or intended to be steered as entered into the *heading* (3.1.1) control system

Note 1 to entry: Preset heading is expressed as the angular direction in degrees from true north 000° clockwise through 360°, where 360° becomes identical to 000°

3.1.5
adjustment control
control which changes the characteristics of an automatic *heading* (3.1.1) control unit

3.1.6
turn-rate control
method of controlling the rudder of a craft to perform turns with a preset turn rate

3.1.7
turning radius control
method of controlling the rate of turn of a craft to perform turns with a preset turning radius through the water

3.1.8
central alert management
CAM
functionality for the management of the presentation of alerts on the *CAM-HMI* (3.1.23), the communication of alert states between CAM-HMI and navigational systems and sensors

Note 1 to entry: The functions may be centralized or partly centralized in subsystems and interconnected via a standardized alert-related communication.

[SOURCE: IMO Resolution MSC.302(87), Appendix 1]

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3.1.9
central alert management system
CAM system
combined functionality of *CAM* (3.1.8) and *CAM-HMI* (3.1.23)

[SOURCE: IEC 62923-1, 3.1.18]

3.1.10
steering gear
the actuator for the heading change

Note 1 to entry: A general steering gear uses rudder to change the craft's heading, but in this document, actuator other than the rudder are also referred to as steering gear in a broad sense. (Example: Water jet, etc.)

3.1.11
steering gear control system
SGCS
function that calculates and provides commands to the actuator(s) for heading change to achieve the *rudder angle* (3.1.14) according to the *rudder order* (3.1.13) provided

3.1.12
rudder
A part/parts of the steering gear used to change the heading of the craft.

Note 1 to entry: This angle is generally proportional to the turn rate of the heading.

Note 2 to entry: The rudder is also sometimes used as an abbreviation for the rudder angle.

3.1.13
rudder order
order value to the actuator for the heading change

Note 1 to entry: If the actuator is general steering gear, it is the rudder angle itself for order. For other actuators, the value is equivalent to the rudder angle.

3.1.14
rudder angle
angle value of the actuator for the heading change

Note 1 to entry: If the actuator is general steering gear, it is the rudder angle itself.

Note 2 to entry: Correctly, this value is proportional to the turn rate of the craft, not to the heading.

3.1.15
manual steering
method of controlling the actuator for heading change manually

EXAMPLE Using a steering wheel.

3.1.16
automatic steering
method of controlling the actuator for heading change automatically to enable a craft to keep, or change to, a preset heading by processing the heading information obtained from a heading source, such as a gyro-compass or transmitting magnetic compass, etc.

Note 1 to entry: In this document, the word “automatic” means heading control, it does not include track control

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3.1.17
single operator action
one manual control
procedure achieved by no more than one hard-key or soft-key action, excluding any necessary cursor movements, or voice actuation using programmed codes

[SOURCE: IMO Resolution MSC.302(87), Appendix 1]

3.1.18
override function
intentional fast change-over from automatic to temporary manual control

3.1.19
change-over control
function for changing-over from automatic to *manual steering* (3.1.15) and vice versa

3.1.20
rudder limit / rudder angle limitation
limit value of the maximum actuator angle for the heading change set by the mariner

Note 1 to entry: To prevent the craft from making dangerous turns.

3.1.21
conning position
place on the bridge with a commanding view providing the necessary information and equipment for the officer of the watch

3.1.22
bridge alert management
BAM
overall concept for management, handling and harmonized presentation of alerts on the bridge

[SOURCE: IMO Resolution MSC.302(87), Appendix 1]

3.1.23
central alert management HMI
CAM-HMI
human machine interface for centralized presentation and handling of alerts on the bridge

[SOURCE: IMO Resolution MSC.302(87), Appendix 1]

3.1.24
off-heading
situation in *heading keeping* (3.1.3), where the craft's *heading* (3.1.1) has deviated from the *preset heading* (3.1.4) beyond a preset limit

3.1.25
power supply
connection point of the HCS to the electrical system on board

Note 1 to entry: A power supply is an external interface to the HCS and may include any AC or DC voltage as defined by the manufacturer. A HCS may have multiple power supplies.

3.1.26
total power failure
absence of sufficient electrical voltage on all power supplies of the EUT

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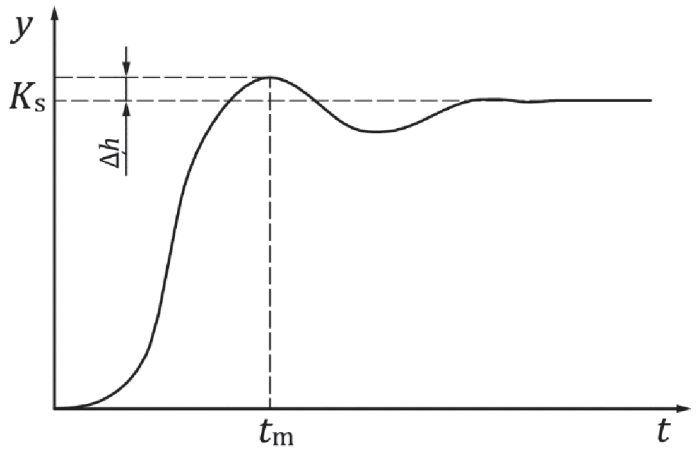
3.1.27
Overshoot
occurrence of a craft's *heading* (3.1.1) response exceeding the *preset heading* (3.1.4) during *heading changing* (3.1.2), when the preset heading is given as a step input to the HCS

Note 1 to entry: See Figure 1.



Key

Δh	absolute value of overshoot
y	craft's heading response relative to the previous preset heading during heading changing
k_s	change of the preset heading
t_m	time when craft's heading response reached the maximum value after exceeding k_s
t	time

Figure 1 — Overshoot

3.1.28
undershoot
occurrence that during *heading changing* (3.1.2), the craft's *heading* (3.1.1) has never reached the *preset heading* (3.1.4) and the difference between the preset heading and the heading is not within the specified range from the preset heading before/at specified time t_u

Note 1 to entry: See 4.5.3.1.

3.1.29
back-up navigator
individual, generally an officer, designated by the craft master to be on call if assistance is needed on the bridge

[SOURCE: IMO Resolution MSC.74(69), Annex 2, 4]

3.2 Abbreviated terms

BAM	bridge alert management
BNC	back-up navigator call
BNWAS	bridge navigational watch alarm system
CAM	central alert management
CAM-HMI	central alert management-human machine interface
CCW	counterclockwise

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CW	clockwise
EUT	equipment under test
HCS	heading control system
HMI	human machine interface
OOW	officer of the watch
ROT	rate of turn
SDME	speed and distance measuring equipment
SGCS	steering gear control system
SPD	speed of craft
STW	speed through water
UID	user input device

4 Requirements

4.1 Application

In accordance with IMO Resolution A.822(19), 1.1, *in addition to the general requirements contained in* IMO *Resolution A.694(17)* to which IEC 60945 is associated, and heading control systems *installed in craft operating under the following conditions:*

a) *speed exceeding 30 kn*[1)] *and up to 70 kn*[1)]*;*

b) *maximum rate of turn 20°/s; and*

c) *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.*

In this document, the craft models of simulators used for performance testing are intended for those crafts that combine a system of propeller propulsion and conventional rudder(s), and are considered also to be valid for systems that operator a rear thruster that acts like a rudder.

In accordance with IMO Resolution A.822(19), 1.2, the heading control systems shall*, within a speed range of up to 30 kn*[1)]*, comply with* IMO *Resolution A.342(IX)* as amended by IMO Resolution MSC.64(67) Annex 3*, and within a speed range of 30 kn*[1)] *to 70 kn*[1)] shall *comply with the requirements of* IMO *Resolution A.822(19)*.

4.2 General

In accordance with IMO Resolution A.822(19), 2.1, *within limits related to thecraft's manoeuvrability, the* heading control system*, in conjunction with its sources of heading information,* shall *enable a craft to keep within ±2. 0° of a preset* heading under no disturbance*.*

When the HCS performs the heading changing according to the preset heading, a turn rate (constant) control for performing turns can be provided by setting either the maximum desired preset turn rate or the maximum desired preset turning radius. (See IMO Resolution A.822(19), 5.5).

In accordance with IMO Resolution A.822(19), 2.2, the heading control system shall *be capable of* adapting manually *or* automatically *to different steering characteristics of the craft under various* speed, *weather and*

1) 1 kn = 1,852 km/h

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loading conditions, and provide reliable operation under prevailing environment and normal operational conditions.

In accordance with IMO Resolution A.822(19), 2.3, the heading control system shall *be connected to the gyro-compass if a gyro-compass is provided. Otherwise it* shall *be electronically connected to the magnetic compass.*

In accordance with IMO Resolution A.822(19), 2.4, *a qualitative description of the effects of the* heading control system *errors due to high speed, accelerations,* heading *changes, sea state, etc., and a qualitative description of corresponding errors in other* navigation system, shall *be provided to the user.* This information shall be provided by the manufacturer.

A heading control system (HCS) shall be composed, as a minimum, of the following components (see Figure 2):

— 4 components of HCS, in addition to an external heading monitor ([a] in Figure 2):

  preset heading setting control, adjustment controls, serial/DIO interface ports, heading control unit.

— The heading control unit includes the following functions:

  adjustment of control parameters (automatic/manual), heading keeping, display and indication of mandatory/relevant information, alert management. If possible, heading changing with preset turn rate or with preset turning radius. If applicable, automatic adaption control to craft speed (change) and/or disturbances, an internal heading monitor ([b] in Figure 2).

— The alert management includes the following functions:

  alert activation, alert presentation, alert handling, alert communication with CAM system, self-diagnostic function to notify OOW.

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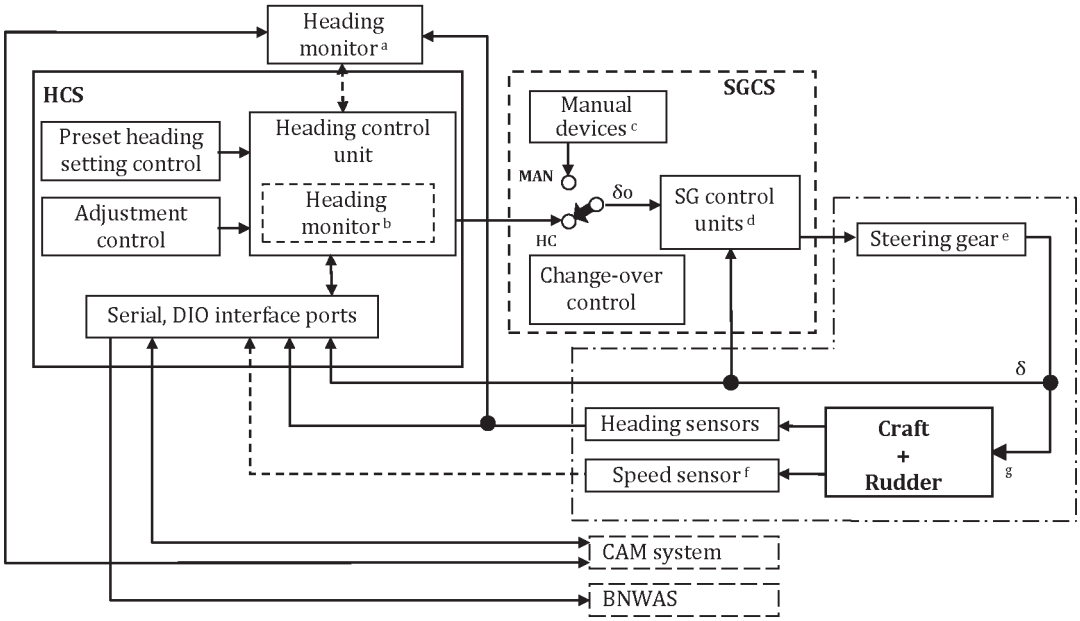

Key

δo	rudder order
δ	actual rudder angle
a	In case the heading monitor is (a function of) an external device. (e.g. heading information system composed of multiple heading sensors and heading distribution unit).
b	In case the heading monitor is an internal function of the heading control unit.
c	Manual devices for example include a steering wheel and steering UIDs installed on the bridge.
d	Plural SG control units are usually installed to drive hydraulic power units of steering gear.
e	Steering gear usually includes the plural hydraulic power units.
f	When the HCS utilizes speed information for automatic heading control adaptation. For example: a HCS adaptive to speed; a HCS with turning-radius control.
g	When a craft simulator is used for test, the part surrounded by a dash-dotted line is replaced by Annex A craft motion simulator.

NOTE 1 During the tests, the CAM system can be replaced by a CAM simulator.

NOTE 2 During the tests, the BNWAS can be replaced by a simulator.

NOTE 3 Dotted line: equipment/function is optional.

NOTE 4 Dashed line: not part of the system to be tested in this document.

Figure 2 — Typical block diagram for a heading control system installed on the bridge

4.3 Operational requirements

4.3.1 Change-over from automatic to manual steering and vice versa

In accordance with IMO Resolution A.822(19), 3.1, *change-over from automatic to manual steering and vice-versa* shall *be possible at any rudder position by means of a bumpless transfer and* shall be effected by single operator action (i.e one manual control) within 3 seconds.

In accordance with IMO Resolution A.822(19), 3.2, *change-over from automatic to manual steering* shall *be possible under any conditions, including any failure in the* heading *control system.*

In accordance with IMO Resolution A.822(19), 3.3, *when changing-over from manual to automatic steering, the* heading control system shall *take over the actual heading as the preset* heading.

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In accordance with IMO Resolution A.822(19), 3.4, *change-over controls* shall *be located close to each other in the immediate vicinity of the* position at which the equipment is normally operated.

The installation manual or drawings shall hold a requirement for the change-over control to be installed in the immediate vicinity of the position at which the equipment is normally operated.

In accordance with IMO Resolution A.822(19), 3.5, *adequate indication* shall *be provided to show which method of steering is in operation at a particular moment.* This indicator shall be fitted near the change-over control.

The installation manual or drawings shall hold a requirement for the indicator to be installed near the position of the change-over control.

In accordance with IMO Resolution A.822(19), 3.6*, the installation* shall *include manual steering with an override function.*

When the override function has been activated, return to automatic steering mode shall not be possible without an intended action of the craft's personnel.

4.3.2 Operational controls including adjustment controls

[SOURCE: IMO Resolution A.694(17), 3.2] All operational controls shall permit normal adjustments to be easily performed and shall be easy to identify from the position at which the equipment is normally operated. Controls not required for normal operation shall not be readily accessible*.*

The installation manual or drawings shall hold a requirement for the operational controls to be installed near the position at which the equipment is normally operated.

[SOURCE: IMO Resolution A.694(17), 3.3] Adequate illumination shall be provided in the equipment or in the craft to enable identification of controls and facilitate reading of indicators at all times. Means shall be provided for dimming the output of any equipment light source which is capable of interfering with navigation.

For a required external light source and/or dimming of external light sources, a requirement shall be stated in the installation manual or drawings.

In accordance with IMO Resolution A.822(19), 5.1, the heading control system shall *be provided with automatic and manually operated controls for operational use to adjust* the system to *the craft's steering performance to take account of the effects of* changing *weather.* The heading control systems may be provided with automatic or manually operated controls for operational use to adjust the system to the craft's steering performance to take account of changing speed and loading conditions.

In accordance with IMO Resolution A.822(19), 5.2, the heading control system shall *be* designed in *such* a way *as to ensure altering* the preset heading *to starboard by turning the* preset heading *setting control clockwise* or tilting it to the right-hand side*.* Turning the control counterclockwise or tilting it to the left shall effect a similar alteration to port. *If the control is digital then provision* shall *also be made forin*put of *the required turn sense. Normal alterations of* heading shall *be possible by one adjustment only of the* preset heading setting *control.* Requirements shall be made by means of the design and the construction of the preset heading setting control to preclude unintended alteration of heading. When changing heading, the clockwise (right-hand side) or counterclockwise (left-hand side) direction of preset heading setting control shall determine the craft's turning direction.

Where remote control stations are provided, facilities for the delegation of control to the remote station and unconditional return of control shall be incorporated in the master station.

In accordance with IMO Resolution A.822(19), 5.3, *except for the* preset heading *setting control, the actuation of any other control* shall *not significantly affect the* heading *of thecraft*.

In accordance with IMO Resolution A.822(19), 5.4, *additional controls at remote positions* shall *comply with the provisions of* this document *.*

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4.4 Functional requirements

4.4.1 Rudder angle limitation

In accordance with IMO Resolution A.822(19), 6, *means* shall *be incorporated in the equipment to enable* adjustable *rudder angle limitation in the automatic mode of operation. Means* shall *also be available to indicate when the angle of limitation has been* commanded or *reached.* When other means of directional control are used, the requirements of this subclause shall appropriately apply.

4.4.2 Heading monitor

[SOURCE: IMO Resolution MSC.64(67), Annex 3, 6.3] If the craft is required to carry two independent compasses, a heading monitor shall be provided to monitor the actual heading information from independent heading sources. The heading monitor is not required to be an integrated part of the heading control system. (See 4.4.4.4.)

In accordance with IMO Resolution A.822(19), 4.3, *the information required to actuate the heading monitor* shall *be provided from an independent source.*

4.4.3 Interfaces

[SOURCE: IMO Resolution MSC.64(67), Annex 3, 8.1] The heading control system shall be connected to a suitable source of heading information.

[SOURCE: IMO Resolution MSC.64(67), Annex 3, 8.2] The heading control system shall be connected to a suitable source of speed information when it is used in a turning radius mode or when any control parameters are automatically adapted to speed.

For the connection of a suitable source of heading information and, if applicable, speed information, a requirement should be stated in the installation manual or drawings.

In accordance with IMO Resolution A.822(19), 8, the heading control system shall *provide interface facilities conforming to relevant international marine interface standards.* Digital serial interfaces shall comply with IEC 61162-1, IEC 61162-2 and/or IEC 61162-450 as applicable.

The IEC 61162-1 sentences for transmitting and receiving data for the heading control system are specified in Tables D.1 and D.2 and shall be supported. (See Annex D.)

4.4.4 Alert management

4.4.4.1 General

In accordance with IMO Resolution A.822(19), 4.5, *the* alert *signalling facilities* shall *be fitted near the conning position* and easily accessible.

The installation manual or drawings shall hold a requirement for the alert signalling facilities to be installed near the conning position, such that they are easily accessible.

The general presentation, handling and communication for alerts shall comply with the requirements stated in IMO Resolution MSC.302(87), IEC 62923-1, Module A, and Module C, and IEC 62923-2, as a minimum.

The alerts with standard alert identifiers for heading control system are specified in Table C.1.

NOTE 1 In 7.4, these alerts are independently verified one by one by using Annex A craft motion simulator, CAM simulator, change-over control.

NOTE 2 Alert titles and alert description texts used in Table C.1 and in the body text of this document are not mandatory alert titles and alert description texts, but are regarded as guidance. Alert titles and alert description texts used in the body text of this document are therefore indicated between double quotation marks (“ ”).

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