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Ships and marine technology — Heading control systems

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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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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 third edition cancels and replaces the second edition (ISO 11674:2006), which has been technically revised.

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

— Clause 1: The bridge alert management (BAM) requirement was added.

— Clause 2: The referenced documents such as related to BAM were added.

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

— 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 (4.2), Functional requirements (4.3), and Control performance requirements (4.4) and the corresponding tests are specified in Clause 6, Clause 7 and Clause 8.

— 4.3.4, 7.4, Annex B: Because the HCS becomes the BAM compliant equipment, alerts with a standard alert identifier, BAM requirements, test methods, communication procedures, and other requirements regarding implementation were added.

— Clause 5: To harmonize with IEC 62065:2014, the test procedure positively utilizing the ship motion simulator of IEC 62065:2014 and the required test results were specified.

— Annex A: In connection with the change in Clause 8, the use of IEC 62065:2014 ship models and wave disturbances for the HCS performance test was specified.

— The IEC 61162 interface requirements specified in the main body of this document were transferred to Annex C, and details were specified.

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.

Ships and marine technology — Heading control systems

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 installed on board ships conforming to performance standards adopted by IMO Resolution MSC.64(67), Annex 3.

In addition, it takes into account parts of IMO resolution A.694(17) to which IEC 60945 is associated.

Also it takes into account IMO resolution MSC.302(87) on bridge alert management (BAM).

In this document, the ship models of simulators used for performance testing are based on those from ships with a combined system of propeller propulsion and conventional rudder, with a speed range of up to 30 knots.

The test results are considered also to be valid for ships with multiple parallel operated rudders.

NOTE The text in this document that is identical to that in IMO Resolution A.342(IX), as amended by IMO Resolution MSC.64(67) Annex 3, and IMO Resolution A.694(17), is printed in italics.

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 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 62923-1:2018, *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), *Performance standards for bridge alert management*

3 Terms, 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 terminological databases for use in standardization at the following addresses:

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

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

3.1.1
adjustment control
control which changes the characteristics of an automatic *heading* (3.1.7) control unit

3.1.2
back-up navigator
individual, generally an officer, designated by the ship master to be on call if assistance is needed on the bridge

[SOURCE: IMO Resolution MSC.74(69), Annex 2:1998, para 4]

3.1.3
change-over control
function for changing over from automatic to *manual steering* (3.1.10) and vice versa

3.1.4
central alert management
CAM
functionality for the management of the presentation of alerts on the *CAM-HMI* (3.1.5), 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):2010, Appendix 1]

3.1.5
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):2010, Appendix 1]

3.1.6
central alert management system
CAM system
combined functionality of *CAM* (3.1.4) and *CAM-HMI* (3.1.5)

[SOURCE: IEC 62923-1:2018, 3.1.18]

3.1.7
heading
direction in which the longitudinal axis of the ship is pointed, defined by the angle between the meridian through its position and the fore-and-aft line of the ship, 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°.

3.1.8
heading changing
function of the *heading* (3.1.7) control unit to change a ship's heading towards the altered *preset heading* (3.1.14) by taking the rudder order within the rudder limit, while if possible turning with a preset turn rate or with a preset turning radius, within limits related to the ship's manoeuvrability

3.1.9
heading keeping
function of the *heading* (3.1.7) control unit to keep a ship's heading at the *preset heading* (3.1.14) by taking the rudder order within the rudder limit, within limits related to the ship's manoeuvrability

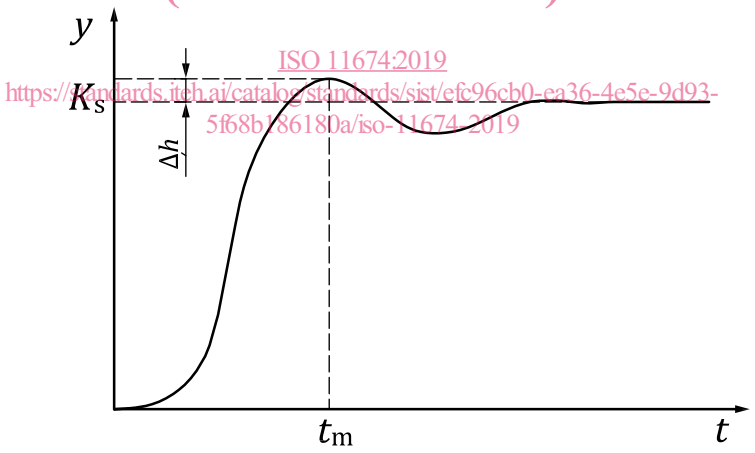
3.1.10
manual steering
method of controlling the steering gear manually

EXAMPLE Using a steering wheel.

3.1.11
off-heading
situation in *heading keeping* (3.1.9), where the ship's *heading* (3.1.7) has deviated from the *preset heading* (3.1.14) beyond a preset limit

3.1.12
overshoot
occurrence of a ship's *heading* (3.1.7) response exceeding the *preset heading* (3.1.14) during *heading changing* (3.1.8), 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	ship' s heading response relative to the previous preset heading during heading changing
k_s	change of the preset heading
t_m	time when ship's heading response reached the maximum value after exceeding k_s
t	time

Figure 1 — Overshoot

3.1.13
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.

3.1.14
preset heading
direction in which a ship is steered or intended to be steered as entered into the *heading* (3.1.7) 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°.

3.1.15
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):2010, Appendix 1]

3.1.16
steering gear control system
SGCS
function that calculates and provides commands to the rudder actuator(s) to achieve the rudder angle according to the rudder order provided

3.1.17
total power failure
absence of sufficient electrical voltage on all power supplies of the EUT

3.1.18
turning-radius control
method of controlling the rate of turn of a ship to perform turns with a preset turning radius through the water

3.1.19
turn rate control
method of controlling the rudder of a ship to perform turns with a preset turn rate

3.1.20
undershoot
occurrence that during *heading changing* (3.1.8), the ship's *heading* (3.1.7) has never reached the *preset heading* (3.1.14) 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 4.4.3.1.

3.1.21
waypoint
geographic position together with its associated data

[SOURCE: IEC 62065:2014, 3.1.43]

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
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 ship
TCS	track control system
UID	user input device

4 Requirements

4.1 General

[IMO Resolution MSC.64(67), Annex 3, para 2.1] *Within limits related to the ship's manoeuvrability the heading control system, in conjunction with* their sources *of heading information,* shall *enable a ship to keep a preset heading with minimum operation of the ship's steering gear.*

[IMO Resolution MSC.64(67), Annex 3, para 2.3] *A turn rate control or a turning-radius control for performing turns may be provided.*

NOTE The above IMO requirement (para 2.3) is interpreted as follows.

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 MSC.64(67), Annex 3, para 3.2).

[IMO Resolution MSC.64(67), Annex 3, para 3.1] *The heading control system* shall *be capable of adapting manually or automatically to different steering characteristics of the ship under various speed, weather and loading conditions, and provide reliable operation under prevailing environment and normal operational conditions*.

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):

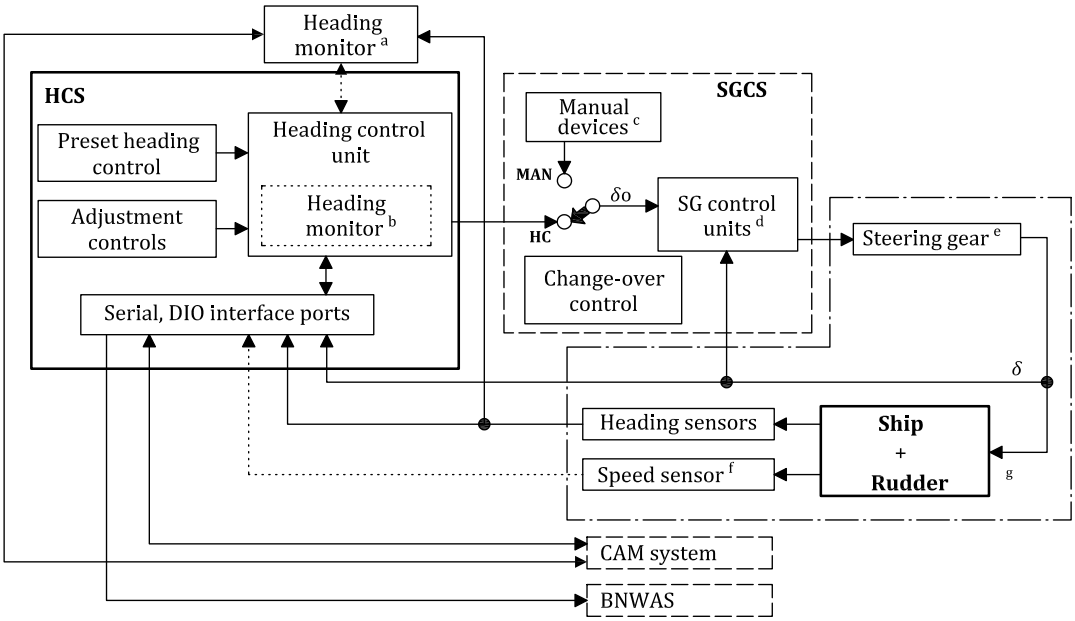
  preset heading control, adjustment controls, serial/DIO interface ports, heading control unit.

— 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 ship 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.



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: an autopilot adaptive to speed; a HCS with turning-radius control.

g When a ship simulator is used for test, the part surrounded by a dash-dotted line is replaced by IEC 62065:2014 ship 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

4.2 Operational requirements

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

[IMO Resolution MSC.64(67), Annex 3, para 4.1] *Change-over from automatic to manual steering and vice versa* shall be *possible at any position of the rudder and* shall *be effected by* single operator action (i.e. *one manual control*) *within 3 seconds.*

[IMO Resolution MSC.64(67), Annex 3, para 4.2] *Change-over from automatic to manual steering* shall *be possible under any conditions including any failure in the heading control system.*

[IMO Resolution MSC.64(67), Annex 3, para 4.3] *When changing-over from manual to automatic steering, the heading control system* shall *take over the actual heading as the preset heading.*

[IMO Resolution MSC.64(67), Annex 3, para 4.4] *There* shall *be a single change-over control which* shall *be located in such a position that it is easily accessible to the officer of the watch.*

The installation manual or drawings shall hold a requirement for the change-over control to be installed in a position in which *it is easily accessible to the officer of the watch*.

[IMO Resolution MSC.64(67), Annex 3, para 4.5] *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.

NOTE The word 'automatic' means heading control, it does not include track control.

4.2.2 Operational controls including adjustment controls

[IMO Resolution A.694(17), para 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.*

[IMO Resolution A.694(17), para 3.3] *Adequate illumination* shall *be provided in the equipment or in the ship 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 should be stated in the installation manual or drawings.

[IMO Resolution MSC.64(67), Annex 3, para 7.1] *The number of operational controls* shall *be such that easy and safe operation can be achieved. The controls* shall *be designed* and arranged *to preclude inadvertent operation.* Their manner of functioning, location and size shall provide for simple, quick and effective operation.

[IMO Resolution MSC.64(67), Annex 3, para 7.2] *Unless features for automatic adjustment are incorporated in the installation, the heading control system* shall *be provided with adequate controls to adjust* its performance *to effects due to weather and the ship's steering performance*.

[IMO Resolution MSC.64(67), Annex 3, para 7.3] *The heading control system* shall *be designed in such a way as to ensure altering the preset heading to starboard by turning the heading setting control clockwise or tilting it to the right-hand side.* Turning the control counterclockwise or tilting it to the left-hand side shall effect a similar alteration to port. *Normal alterations of heading* shall *be possible by one adjustment only of the preset heading control.* Requirements shall be made by means of the design and the construction of the preset heading control to preclude unintended alteration of heading. When changing heading, the clockwise or counterclockwise direction of the preset heading control shall determine the ship's turning direction.

[IMO Resolution MSC.64(67), Annex 3, para 7.4] *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.*

[IMO Resolution MSC.64(67), Annex 3, para 7.5] *Except for the preset heading setting control, the actuation of any other control* shall *not significantly affect the heading of the ship.*

[IMO Resolution MSC.64(67), Annex 3, para 7.6] *Additional controls at remote positions* shall *comply with the provisions of this* document.

4.2.3 Manual change-over from track control to heading control

[IMO Resolution MSC.64(67), Annex 3, para 2.2] *The heading control system may work together with a track control system adjusting its heading for drift.*

The manufacturer shall declare if the HCS is able to work together with a track control system.

NOTE The HCS is able to work together with a TCS, for example, if it can accept heading commands from a track control system.

[IMO Resolution MSC.64(67), Annex 3, para 5.1] *If the heading control system works as part of a track control system, then when switching from track control to heading control, the actual heading should be taken as the preset heading.*

[IMO Resolution MSC.64(67), Annex 3, para 5.2] *Any switching back to track control shall not be possible without intended action of the ship's personnel.*

4.3 Functional requirements

4.3.1 Rudder angle limitation

[IMO Resolution MSC.64(67), Annex 3, para 3.3] *Means* shall *be incorporated in the equipment to enable adjustable rudder angle limitation in the automatic mode. 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.*

NOTE The word 'automatic' means heading control, it does not include track control.

4.3.2 Heading monitor

[IMO Resolution MSC.64(67), Annex 3, para 6.3] *If the ship 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.*

4.3.3 Interfaces

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

[IMO Resolution MSC.64(67), Annex 3, para 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.

[IMO Resolution MSC.64(67), Annex 3, para 8.3] *If a heading control system is capable of digital serial communication with the ship's navigation system, the interface facilities* shall *comply with the relevant international marine interface standards* 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 C.1 and C.2 and shall be supported. (See Annex C.)

4.3.4 Alert management

4.3.4.1 General

The general presentation, handling and communication for alerts shall comply with the requirements stated in IMO Resolution MSC.302(87), in IEC 62923-1:2018, Module A — Presentation and handling of alerts on the bridge, and Module C — Interfacing, and in IEC 62923-2, as a minimum.

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

NOTE 1 In clause 7.4, these alerts are independently verified one by one by using IEC 62065:2014 ship motion simulator, CAM simulator, change-over control.

NOTE 2 Alert titles and alert description texts in Table B.1 and used in the body text of this document are not mandatory alert titles and alert description texts, but are to be regarded as guidance. Alert titles and alert description texts used in the body text of this document are therefore indicated between single quotation marks (‘ ’).

Manufacturer of heading control system shall declare the EUT function type for BAM compliance test.

NOTE 3 According to the EUT function type, the relevant test set-up and test items are specified in BAM test standards. Refer to the following clauses in IEC 62923-1:2018: 4.2, EUT function types; 5, Test methods; 6, Module A - Presentation and handling of alerts on the bridge; 8, Module C - Interfacing.

4.3.4.2 Failure and alert status of the heading sensor in use for control (‘Lost HDG control’ alert)

The heading information used by the HCS can be based on a single heading sensor or optionally can be based on multiple heading sensors.

In case the HCS is (can be) connected to multiple sensors (not integrated into an INS), the situation that heading information has failed or is unavailable means that all connected heading sensors fail or are unavailable at the same time.

If heading information has failed or is unavailable while heading control is active, then:

a) ‘Lost HDG control’ alarm shall be activated, giving advice to the OOW to switch to manual control.

   The actual rudder angle shall *be maintained* (i.e. stay in position), where the rudder angle shall be set to a fixed angle in such a way that:

   — if the ship’s heading is controlled to keep the preset heading, the actual heading shall be approximately maintained;

   — if the ship’s heading is controlled during turn, the actual rate of turn shall be approximately maintained.

   [SOURCE: IEC 62065:2014, 5.5.3]

b) When the HCS has been switched to manual steering by the operator, with or without acknowledgement of the ‘Lost HDG control’ alarm, this alarm shall be terminated (this alarm is changed to normal state and therefore removed from both HMI of the HCS and CAM-HMI automatically).

   After being switched to manual steering, for example a ‘HCS unavailable’ caution indicating that ‘HCS unavailable due to missing heading inputs’ could be activated.

c) When the ‘Lost HDG control’ alarm is not acknowledged by OOW within 30 s, and this alarm has not been terminated, a BNC shall be activated by giving appropriate signal to BNWAS (see IEC 62616).

   The BNC to the BNWAS is de-activated after the HCS has been switched to manual steering or the ‘Lost HDG control’ alarm has been acknowledged.