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Ships and marine technology — Heading control systems

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Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11674 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

This second edition cancels and replaces the first edition (ISO 11674:2000, ISO 11674:2000/Cor. 1:2001), of which it constitutes a minor revision.

Ships and marine technology — Heading control systems

1 Scope

This International Standard specifies the structure, performance, inspection and testing of heading control systems to be installed on board ships.

It applies to the heading control systems which enable a ship *to keep a preset heading with minimum operation of the ship's steering gear, within limits related to the ship's manoeuvrability in conjunction with* their *sources of heading information.*

The *heading control system may work together with a track control system adjusting its heading for drift.*

A turn rate control or a turning-radius control *for performing turns may be provided.*

NOTE All the text in this International Standard identical to that in IMO Resolutions [Resolution A.342(IX) as amended by resolution MSC.64(67), Annex 3 and Resolution A.694(17)] is printed in italics.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 694:2000, *Ships and marine technology — Positioning of magnetic compasses in ships*

IEC 60945:2002, *Maritime navigation and radiocommunication equipment and systems — General requirements — Methods of testing and required test results*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems — Digital interfaces*

3 Terms and definitions

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

3.1
adjustment control
device which changes the characteristics of an automatic steering device, including proportional rudder adjustment, derivative rudder adjustment, integral rudder adjustment and weather adjustment

NOTE The term “derivative rudder adjustment” is also called “counter rudder adjustment” customarily.

3.2
automatic steering
method of controlling the steering gear automatically to enable a ship to keep a preset heading, processing the heading information which is obtained from a gyro-compass or magnetic compass, etc.

3.3
automatic-steering device
device which controls automatic steering

3.4
change-over device
device for changing over from automatic to manual steering and vice versa

3.5
derivative rudder adjustment
counter rudder adjustment
adjustment of a component of the total rudder command which acts to control the rate of turn of the ship

3.6
heading
horizontal direction in which a ship actually points or heads at any instant

NOTE Heading is expressed in degrees from a reference direction, usually from 000° at the reference direction clockwise through 360°.

3.7
heading-signal processor
unit which processes the heading signal generated by a gyro-compass, magnetic compass, etc., and adapts it before its use by the heading control system

3.8
integral rudder adjustment
adjustment of a component of the total rudder command which is in proportion to the integral value of the heading deviation

3.9
manual steering
method of controlling the steering gear manually

EXAMPLE Using a steering wheel.

3.10
operational device
switch, key, knob, etc. which is used for operating a heading control system

3.11
preset heading
horizontal direction in which a ship is steered or intended to be steered

NOTE Preset heading is expressed as the angular direction in degrees with respect to north (true/magnetic), from 000° clockwise through 360°.

3.12
proportional rudder adjustment
adjustment of a component of the total rudder command in proportion to an instantaneous value of the difference between the preset heading and actual heading

3.13
turning-radius control
method of controlling the rate of turn of a vessel to perform turns with a preset turning radius through the water

3.14
turn-rate control
method of controlling the rudder of a vessel to perform turns with a preset rate of turn

3.15
weather adjustment
adjustment which minimizes unnecessary steering motion against yawing caused by waves, swells and wind

4 Performance

4.1 General

4.1.1 *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.*

4.1.2 Heading control systems shall conform to the environmental requirements of IEC 60945 for equipment categories protected from the weather.

4.2 Constituents

A heading control system shall be composed, as a minimum, of the following components (see Figure 1):

a) heading-signal processor (including an indicator of the heading);

b) operational control for preset heading;

c) operational controls for adjustments;

d) automatic steering device;

e) change-over device (with steering-mode indicator) which is not required to be an integrated part of the heading control system;

f) alarm signalling facilities compliant with the requirements of this International Standard;

g) indicators for steering mode and heading source in use.

4.3 Functional requirements

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

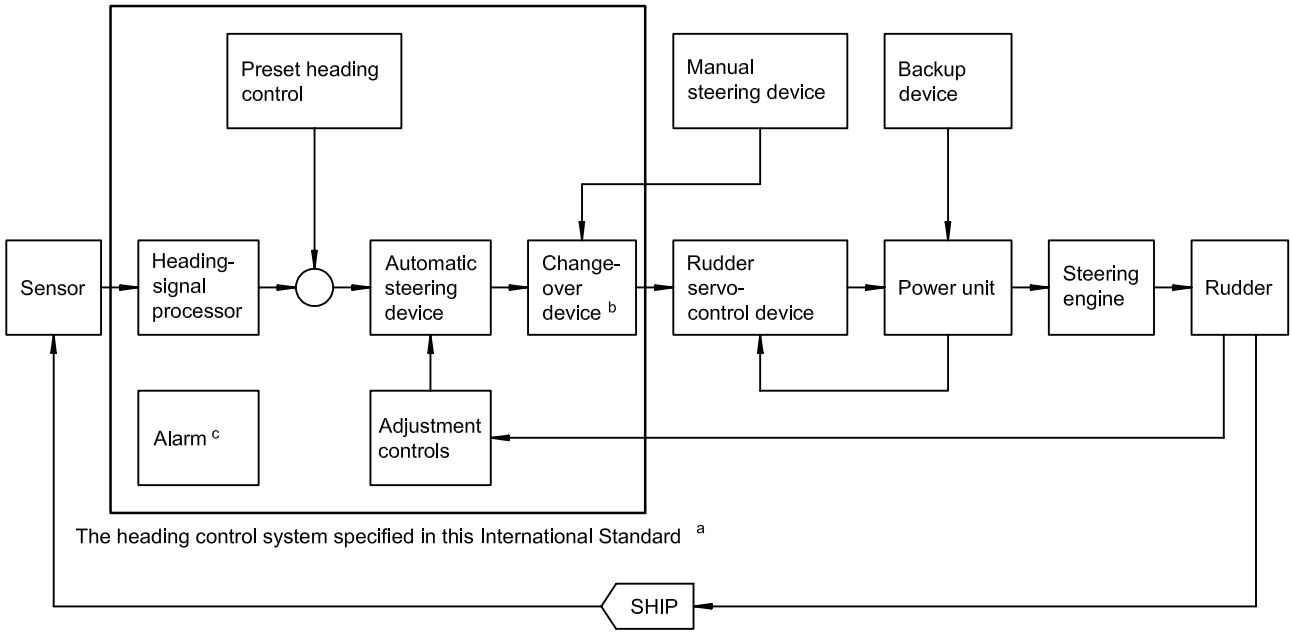
4.3.1.1 *Change-over from automatic to manual steering and vice versa* shall *be possible at any position of the rudder and* shall *be* activated *by one manual control within 3 seconds.*

4.3.1.2 *Change-over from automatic to manual steering* shall *be possible under any conditions including any failure in the* heading *control system.*

4.3.1.3 *When changing-over from manual to automatic steering,* if there is no new safe input of command, *the heading control system* shall *take over the actual heading* of this time *as the preset heading.*

4.3.1.4 *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.*

4.3.1.5 *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.



a The portion enclosed by the thick line shows the constituent devices of a heading control system which are specified in this International Standard.

b The change-over device is not required to be an integrated part of the heading control system.

c Alarm indicating devices may be external units.

Figure 1 — Typical block diagram for heading control system

4.3.2 Operational controls including adjustment controls

4.3.2.1 *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.*

4.3.2.2 *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.

4.3.2.3 *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 the light source which is capable of interfering with navigation.*

4.3.2.4 *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.*

4.3.2.5 *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 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.

4.3.2.6 When changing heading, the clockwise or counterclockwise direction of preset heading adjustment shall determine the ship's turning direction.

4.3.2.7 *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.*

4.3.2.8 *Except for the preset heading setting control, the actuation of any other control* shall *not significantly affect the heading of the ship.*

4.3.2.9 *Additional controls at remote positions* shall *comply with the provisions of this standard.*

4.3.3 Rudder angle limitation

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 section* shall *appropriately apply.*

4.3.4 Permitted yaw

Means shall *be incorporated to prevent unnecessary activation of the rudder due to normal yaw motion.*

4.3.5 Heading indication accuracy

If there is a heading indication, it shall not deviate from the heading sensor by more than 0,5°.

4.3.6 Preset heading

Any alteration of the preset heading shall *not be possible without* a form of activation by the *ship's personnel.*

4.3.7 Preset rate of turn

If the heading control system is provided with the function to perform turns with a preset rate of turn, the accuracy of the rate of turn after becoming constant in a turn, shall be within ± 10 % of its preset value or 3 °/min, whichever is the greater, with the ship's normal load condition and in a calm sea which is sufficiently broad and deep to be able to manoeuvre free from disturbances against the ship's manoeuvrability.

NOTE There are some cases where it is not possible to turn at the preset rate, even if steered at the maximum rudder angle, due to the effects of weather, sea state or ship’s manoeuvrability.

4.3.8 Preset turning radius

If the heading control system is provided with the function to perform turns with a preset turning radius, the accuracy of the radius after becoming constant in a turn, shall be calculated using the data of 4.3.7.

NOTE There are some cases where it is not possible to turn at the preset turning radius, even if steered at the maximum rudder angle, due to the effects of weather, sea state or ship’s manoeuvrability.

4.3.9 Limiting of overshoot

The heading control system shall include a counter rudder-angle adjustment control or similar system to allow the *change to a preset heading without significant overshoot.*

4.3.10 Power supply

4.3.10.1 A heading control system shall be capable of normal operation when its power supply varies as specified in IEC 60945.

4.3.10.2 *If provision is made for operating equipment from more than one source of electrical energy, arrangements for rapidly changing from one source to the other* shall *be provided but not necessarily incorporated in the equipment.* Means shall be provided to retain the current heading during alteration of the power source.

4.3.11 Alarms and signalling facilities

4.3.11.1 General

The alarm and signalling facilities shall be fitted near the conning position and shall be easily accessible.

4.3.11.2 Failure or reduction in power

An alarm both audible with mute function and visual shall *be provided in order to indicate failure or a reduction in the power supply to the heading control system or heading monitor, which would affect the safe operation of the equipment.* The alarm signalling facilities are not required to be an integrated part of the heading control system.

4.3.11.3 System failure

An alarm, both audible with mute function and visual, shall be provided in order to indicate any malfunction of the heading control system.

NOTE The term “heading control system” used in this subclause is shown schematically in Figure 1.

4.3.11.4 Off-heading alarm

An off-heading alarm, both audible with mute function and visual shall *be provided when the actual heading* information *deviates from the preset heading beyond a preset limit.* The preset limit shall be set within a minimum range of 5° to 15°.

NOTE 1 Off-heading is a situation where the ship has deviated from the preset heading.

NOTE 2 The “preset limit” specified in these provisions means an alarm threshold.

4.3.11.5 Heading monitor

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. An alarm both audible with mute function and visual* shall *be provided when the heading information in use deviates from the second heading source beyond a preset limit.* The preset limit shall be set within a minimum range of 5° to 15°.

NOTE The “preset limit” specified in these provisions means an alarm threshold.

4.3.11.6 Indication of heading source

A clear indication of the heading source in use shall *be provided.*

4.3.11.7 Sensor status

The heading control system shall *provide an indication when any input from external sensors used for control is absent. The heading control system* shall *also repeat any alarm on the status messages concerning the quality of the input data from its external sensors when they are used for control.*

4.3.12 Transformation error

The heading data supplied to the heading control system shall not deviate by more than 0,5° from the compass heading.

4.3.13 Heading stability

The heading stability shall be such that, under conditions of no disturbance, the average value of the difference between the preset heading and the heading is within ± 1° and the maximum single amplitude is within 1,5°.

4.3.14 Disturbance to the magnetic compass

The disturbance to the magnetic compass caused by the magnetic sensor, if driven and used, shall not be more than 0,5°. This shall be fulfilled on any heading with the power supply of the heading control system switched on or off.

4.3.15 Interfaces

4.3.15.1 *The heading control system* shall *be connected to a suitable source of heading information*.

4.3.15.2 *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*.

4.3.15.3 *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* in accordance with IEC 61162 as applicable.

4.4 Safety precautions

All safety precautions in the heading control system shall comply with IEC 60945.

5 Type testing

5.1 Testing and required results

The tests given in 5.2 to 5.5 shall be carried out in the following order. For tests carried out by means of the ship-motion simulator, refer to the specification given in Annex A.

5.2 Magnetic compass safe distance test

The determination of magnetic compass safe distance shall be carried out in accordance with the requirements of ISO 694. All parts of the system and their interconnections shall be considered.

5.3 EMC and environmental tests

EMC and environmental testing shall be performed according to IEC 60945.

5.4 Change-over from automatic to manual steering mode

The test for change-over from automatic to manual steering mode shall be carried out as follows.

a) During the mode of automatic steering, turn the steering wheel so that it produces a 0° rudder angle command.

b) Set the rudder angle limiter to maximum, then set the preset heading to obtain the maximum rudder angle.

c) Change from automatic steering to manual.

d) Measure the time required from the completion of the mode change-over operation to when the rudder midship command signal is given. This time shall comply with the requirements of 4.3.1.1.

5.5 Control characteristics

5.5.1 General

The following tests shall be carried out using a ship-motion simulator. The simulator described in Annex A shall be the standard simulator to be used for these tests.

5.5.2 Heading signal transformation accuracy

Set the simulator's ship heading to eight different values and compare them with the heading indicated by the heading control system. This measurement shall be carried out twice for both the clockwise direction and the counterclockwise direction respectively. The requirements of 4.3.12 shall be complied with.

5.5.3 200° turn

5.5.3.1 This test shall be made by means of the ship-motion simulator as specified in Annex A with L/v = 30. The automatic heading change is made, without the function of the preset rate of turn or the preset turning radius. The preset heading control shall be turned right or left to make a 200° heading change according to 4.3.2.6 and the following shall be checked.

a) When turning the preset heading control clockwise, a right heading change is made and when turning the preset heading control counterclockwise, a left heading change is made. (In each case the heading change is made with respect to the preset direction.)

b) After actuating a heading change, the rudder-angle limiting function is activated.

5.5.3.2 This test shall be made by means of the ship-motion simulator as specified in Annex A with L/v = 30, and the rudder-angle limiter shall be set to maximum. The preset heading control shall be turned right or left to make a 200° heading change. The requirements of 5.5.3.1a) shall be complied with, and the rate of turn or the turning radius shall be satisfied in accordance with the requirements of 4.3.7 and 4.3.8, respectively. Provided that the preset turning radius is tested, it is ensured that the ship's heading turns with the rate given by the following formula:

$$\dot{\psi} i = \frac{180}{\pi} \times \frac{v}{r}$$

where

$\dot{\psi} i$ is the preset rate of turn, in degrees per second;

r is the preset turning radius, in metres;

v is the ship's speed, in metres per second.

This test shall be carried out six times for both directions and with the maximum value, the mean value and the minimum value respectively.

NOTE 1 The horizontal acceleration $a = v_1$ does not exceed 1,0 m/s^2.

NOTE 2 In this test, the rate of turn or the turning radius should be selected so that the horizontal acceleration does not exceed 1,0 m/s^2.

5.5.4 Heading stability

This test shall be made by means of the ship-motion simulator as specified in Annex A with L/v = 30. 10 min after switching on the heading control system, it shall maintain the heading compliant with the requirements of 4.3.13 for 10 min.

5.5.5 Overshoot

This test shall be made by means of the ship-motion simulator as specified in Annex A with L/v = 30. Change the preset heading from the actual heading by 20° right and left. The overshoot shall not be more than 2°.

6 Marking and identification

Each unit of a heading control system shall *be marked with the following:*

— *identification of the manufacturer;*

— *equipment type number or model identification under which it was type tested;*

— *serial number of the unit;*

— safe distance of magnetic compass (for a unit installed in the bridge).

7 Information

Adequate information shall *be provided to enable the equipment to be properly operated and maintained. The information* shall

a) *in the case of equipment so designed that fault diagnosis and repair down to component level are practicable, provide full circuit diagrams, component layouts and a component parts list, and*

b) *in the case of equipment containing complex modules in which fault diagnosis and repair down to component level are not practicable, contain sufficient information to enable a defective complex module to be located, identified and replaced. Other modules and those discrete components which do not form part of modules* shall *also meet the requirements of* a) *above.*

c) If the heading control system is provided with functions for rate of turn or turning-radius control, it shall be notified that the preset values may not be reached under certain conditions of weather, sea, speed, load, draft, trim, etc. Furthermore it shall be pointed out that incorrect speed input will lead to incorrect radius control.

Annex A
(normative)

Ship-motion simulator

The following shall be the standard for a ship-motion simulator. The ship manoeuvrability model shall be the K – T (transfer function) model, represented by:

$$\frac{\dot{\psi}}{\delta} = \frac{K}{TS+1}$$

where

$\dot{\psi}$ is the rate of turn of the ship, in degrees per second;

δ is the actual rudder angle, in degrees;

K is the turning-ability constant of the ship, in reciprocal seconds;

T is the time constant of the ship, in seconds;

S is the Laplace operator.

K and T shall be converted from K' and T' as follows:

$$K = \frac{K'}{L/v}$$

$$T = T' \times \frac{L}{v}$$

where

K' is the turning ability of the non-dimensional manoeuvrability index: K' = 1;

T' is the course-retaining ability of the non-dimensional manoeuvrability index: T' = 1;

L is the length of the ship provided with a heading control system, in metres;

v is the speed of the ship provided with a heading control system, in metres per second.

Examples of L/v are given in Table A.1

Table A.1 — Example of L/v

Ship's Type	L	v(k't)	v(m/s)	L/v
Container	230	22,0	11,31	20,3
Container	273	23,0	11,82	23,1
Bulk Carrier	259	14,0	7,20	36,0
LPG Carrier	212	16,0	8,22	25,8
VLCC	308	15,4	7,92	38,9

The steering-engine model (transfer function) shall be based on the following expression:

$$\frac{\delta}{\delta^*} = \frac{1}{T_E S + 1}$$

where

δ is the actual rudder angle, in degrees;

δ^* is the commanded rudder angle, in degrees;

T_E is the time constant of the steering engine, in seconds;

S is the Laplace operator.

In this case, the rate of the rudder motion ($\mathrm{d}\delta/\mathrm{d}t$) shall be equal to, or less than, 3°/s, and T_E shall be equal to 2,5 s.

The bearing resolution and steering-engine model sensitivity shall be as follows:

— bearing resolution: 0,1° or less

— steering-engine model sensitivity: 0,2° or less

A diagram of a steering-engine is shown in Figure A.1.

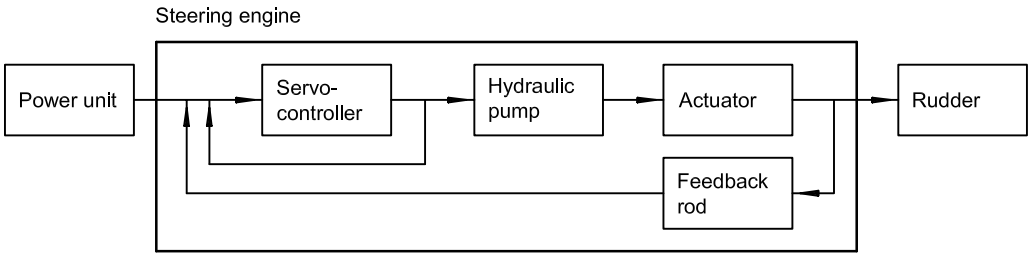


Figure A.1 — Block diagram of steering engine

Annex B
(informative)

Equivalent requirements in ISO 11674 and IMO Resolutions

Clause or subclause in this International Standard	Clause or subclause in IMO Resolution MSC 64(67) Annex 3:1997 or A.694(17):1991
1	MSC 64(67) Annex 3, 2.1, 2.2 and 2.3
4.1.1	MSC 64(67) Annex 3, 3.1
4.3.1.1	MSC 64(67) Annex 3, 4.1
4.3.1.2	MSC 64(67) Annex 3, 4.2
4.3.1.3	MSC 64(67) Annex 3, 4.3
4.3.1.4	MSC 64(67) Annex 3, 4.4
4.3.1.5	MSC 64(67) Annex 3, 4.5
4.3.2.1	A.694(17) 3.2
4.3.2.2	MSC 64(67) Annex 3, 7.1
4.3.2.3	A.694(17) 3.3
4.3.2.4	MSC 64(67) Annex 3, 7.2
4.3.2.5	MSC 64(67) Annex 3, 7.3
4.3.2.7	MSC 64(67) Annex 3, 7.4
4.3.2.8	MSC 64(67) Annex 3, 7.5
4.3.2.9	MSC 64(67) Annex 3, 7.6
4.3.3	MSC 64(67) Annex 3, 3.3
4.3.4	MSC 64(67) Annex 3, 3.4
4.3.6	MSC 64(67) Annex 3, 3.5
4.3.9	MSC 64(67) Annex 3, 3.6
4.3.10.2	A. 694(17) 4.3
4.3.11.2	MSC 64(67) Annex 3, 6.1
4.3.11.4	MSC 64(67) Annex 3, 6.2
4.3.11.5	MSC 64(67) Annex 3, 6.3
4.3.11.6	MSC 64(67) Annex 3, 6.4
4.3.11.7	MSC 64(67) Annex 3, 6.5
4.3.15.1	MSC 64(67) Annex 3, 8.1
4.3.15.2	MSC 64(67) Annex 3, 8.2
4.3.15.3	MSC 64(67) Annex 3, 8.3
6	A. 694(17) 9
7a)	A. 694(17) 8.3.1
7b)	A. 694(17) 8.3.2

Bibliography

[1] ISO 2412:1982, *Shipbuilding — Colours of indicator lights*

[2] ISO 8468:1990, *Ship's bridge layout and associated equipment — Requirements and guidelines*

[3] IEC 60092-204:1987, *Electrical installations in ships — Part 204: System design — Electric and electrohydraulic steering gear*

[4] IMO Resolution A.210(VII), *Recommendation on steering gear for large ships*

[5] IMO Resolution A.694(17):1991, *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids*

[6] IMO Resolution MSC.64(67), Annex 3:1997, Amendment to Resolution A.342(IX), Performance standards for heading control systems

[7] SOLAS 1974, Chapter II-1, *Regulations 29 and 30*

[8] SOLAS 1981, Chapter V, *Regulation 19*

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