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N-03

STEERING GEAR CONTROL

SYSTEMS

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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This version is a revised version. The main changes are:

IACS.UI.SC94 deletes the fourth point "Fault detection and response of the control system", while the content of URE25 "Fault detection and response of the steering control system" is completely derived from the fourth point of IACS.UI.SC94, this revision is in 2.1 Add URE25 Failure detection and response of all types of steering control systems to the approval and inspection basis, while retaining IACS.UI.SC94.

Incorporate URE25 requirements into normative references.

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STEERING GEAR CONTROL SYSTEMS

1 Application

1.1 This guideline applies to type approval and unit/batch inspection of steering gear control system including course control system and follow-up steering control system fitted on sea-going ships (high speed crafts excluded). On-off steering (non follow-up) may take reference for implementation.

1.2 Steering gear control system means the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables.

1.2.1 This guideline does not apply to hydraulic control pumps and their associated motors, piping and cables (equipment excluded) of the above mentioned steering gear control system.

1.2.2 This guideline does not apply to track control systems.

2 Normative references

2.1 The approval and inspection in this Chapter are to be based on the following documents:

2.1.1 SOLAS (1974) Reg. II-1/29 and the amendments thereto;

2.1.2 Chapter 13 of PART 3 of CCS Rules for Classification of Sea-going Steel Ships;

2.1.3 Annex 3 of Resolution MSC.64(67) on Performance Standards for Automatic Pilots;

2.1.4 ISO 11674(2006-09) Ships and Marine Technology- Heading Control Systems;

2.1.5 IACS UI SC94 Mechanical, Hydraulic and Electrical Independency and Failure Detection and Response of Steering Control Systems;

2.1.6 IEC 60945-2002 Maritime Navigation and Radio Communication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results;

2.1.7 IEC 61162 series;

2.1.8 IEC 62288 Ed.1.0(2008) Maritime Navigation and Radio Communication Equipment and

Systems – Presentation of Navigation-Related Information on Shipborne Navigational Displays – General Requirements, Methods of Testing and Required Test Results.

2.1.9 CCS GD22 - 2015 Guidelines for Type Approval Test of Electric and Electronic Products.(current valid version)

2.1.10 URE25 Failure detection and response of all types of steering control systems

3 Definitions and terms

Definitions in Chapter 13 of PART 3 of CCS Rules for Classification of Sea-going Steel Ships and ISO 11674 (2006-09) apply to this guideline. For the convenience of compilation and application, the following definitions are added or quoted:

3.1 Manual mode

Method of controlling steering gear manually is contrast with automatic steering mode (coursecontrol mode). Both follow-up and non follow-up modes may be considered as manual steering mode.

3.2 Automatic mode

Method of controlling steering gear automatically is to enable a ship to keep a preset heading (heading). Both course(heading) control mode and track control mode belong to automatic steering mode. The Guideline applies to course (heading) control mode only.

3.3 Follow-up mode (FU mode)

A kind of closed loop control mode. In this mode, the operator gives command of rudder angle manually and the steering gear will move the rudder according to the given rudder angle command.

3.4 Non follow-up mode (NFU mode)

A kind of open loop control mode. In this mode, the operator manually controls the direction of rudder motion.

3.5 Ship motion simulator

Ship motion simulation device used for the functional test for coursecontrol system as specified in Annex A of ISO 11674-2006.

3.6 Steering error (FU mode)

Within the specified range of rudder angle, the deviation between the actual position of rudder blades and the given rudder angle command.

3.7 Steering sensitivity (FU mode)

It means the minimum given rudder angle which enables the final element of the steering gear to act during the operation of steering gear.

3.8 Insensitivity of steering gear (FU mode)

It means the range of rudder angle for the inaction of the final element of the steering gear during the operation of steering gear (adjustable range of steering sensitivity).

3.9 Heading stability (coursecontrol mode)

Deviation between the actual heading and preset heading of the ship under the given sea conditions is expressed by the mean and maximum values of the deviation.

3.10 Operational device

Components used for operating heading control system, such as switch, button, key, handle, etc.

4 Plans and documents

4.1 The following plans and documents are to be submitted to CCS for approval:

4.1.1 Technical specifications (including the version No. of the major software);

4.1.2 System schematic diagram;

4.1.3 Schematic diagram of main units of the system (e.g. control unit, steering gear startup box, change-over device, alarm box (unit), feedback unit, etc.);

4.1.4 Outline and panel arrangement;

4.1.5 Type test program.

4.2 The following plans and documents are to be submitted to CCS for information:

- 4.2.1 Operation instructions for the products;
- 4.2.2 Block diagram of system configuration;
- 4.2.3 Wiring connection diagrams of subsystems or units;
- 4.2.4 Routine test record (sample);
- 4.2.5 List of major components and parts;
- 4.2.6 Product mark or nameplate, quality certificate/statement (sample).

5 Design and technical requirements

5.1 Electrical safety, adaptability to power supply conditions and environmental conditions and electromagnetic compatibility of the equipment are to be adaptable to the ambient environment of the ship and to comply with the test requirements for the “protected equipment” specified in IEC60945.

5.2 Function and performance requirements

5.2.1 Steering position and change-over

(1) Control from the steering gear compartment

The selector switch is to be fitted in the steering gear compartment for changing the steering position. When control position “steering gear compartment” selects the control of power unit of the steering gear and the steering control are to be achieved by the control box/console of steering gear compartment. The navigation bridge is not to have any influence on the control from steering gear compartment.

(2) Control from navigation bridge

When control position “navigation bridge” selects the control of power unit of the steering gear and the steering control are to be achieved by the control unit/console of navigation bridge.

(3) Remote control (if available)

Remote control mode may be selected by the change-over switch in the navigation bridge. Remote steering may be conducted through remote control console/box. In any case, the

navigation bridge may take over the control.

5.2.2 Steering mode and change-over

- (1) Steering mode change-over switch or dedicated button is to be fitted on the control unit/console of navigation bridge. Change-over among automatic mode (course control), follow-up mode, non follow-up mode and remote steering mode^① (if applicable) is to be possible through single operation. Such change-over switch or dedicated button is to be located in such a position that it is readily accessible and easy to operate.
- (2) Change-over from automatic to manual steering and vice versa is to be possible at any position of the rudder blade and is to be activated by the above mentioned switch or dedicated button within 3 seconds. Change-over from automatic to manual steering is to be possible under any conditions including any failure in the automatic steering control unit.
- (3) Change-over from follow-up to non follow-up steering is to be possible under any conditions including any failure in the follow-up steering control unit.
- (4) When changing-over from manual to automatic steering, if there is no new safe input of command, the heading control system is to take over the actual heading of this time as the preset heading.
- (5) The indicator is to be fitted on the change-over switch. Adequate illumination is to be provided at the main steering console to show which mode of steering is in operation at a particular moment.

5.2.3 Functional and performance requirements for heading control unit

- (1) The design of the operational controls of heading control unit is to comply with the principles of ergonomics as specified in 6.1 of IEC60945. The display of the navigation information is to comply with the applicable requirements of IEC62288.
- (2) All operational controls are to be facilitate for normal working and to be easy to identify from the position at which the equipment is normally operated. Controls not required for normal operation are not to be readily accessible. The number and arrangement of operational controls are to be such that simple, safe and easy operation can be achieved.

^① Except for non follow-up mode, other steering modes are optional.

(3) Adequate illumination is to be provided in the control unit to enable identification of controls and facilitate reading of indicators at all times. Means are to be provided for dimming the output of the light source which is capable of interfering with navigation.

(4) Unless features for automatic adjustment are incorporated in the installation, the heading control system is to be provided with adequate controls to adjust its performance to effects due to weather and the ship's steering performance.

(5) Preset heading

Any alteration of the preset heading is not to be possible without intended action of the ship's personnel. Requirements are to be made to preclude unintended alteration of heading such as the confirmation by the steering operator. The heading control system is to be so designed 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 is to effect a similar alteration to port.

(6) When the heading is changed in automatic mode, the ship's turning direction is to be in consistent with the heading change direction as the heading is preset (i.e. if the heading is preset to change towards starboard, the ship's actual heading is also to be changed towards starboard, and vice versa). Other controls are not to cause significant change to ship's heading, except preset heading control.

(7) Rudder angle limitation

Means are to be provided to enable adjustable rudder angle limitation in the automatic mode. Means are also to be available to indicate when the angle of limitation has been commanded or reached. When other means of directional control are used in the heading control unit, the rudder angle limitation may not be provided by the unit or be incorporated with other functions.

(8) Allowable yaw

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

(9) Heading indication accuracy

The deviation between the heading shown by heading indicator of steering gear control system and the heading sensor is not to be more than 0.5 °.

(10) Preset rate of turn (if applicable)

If the heading control unit is provided with the function to control the ship's turning at a preset rate of turn, the accuracy of the rate of turn when the ship is in a stable state is to be of $\pm 10\%$ of its preset value or $3\%/min$, whichever is the greater, under the ship's normal load condition and in a calm sea with sufficient breadth and depth, which will not influence the ship's manoeuvrability.^①

(11) Preset turning radius (if applicable)

If the heading control unit is provided with the function to control the ship's turning with a preset turning radius, the accuracy of the radius when the ship is in a stable state is to be calculated by the data of the above-mentioned (10).^②

(12) Limiting of overshoot

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

(13) Heading stability

Under the conditions of no disturbance, the average value of the difference between the preset and actual headings is within $\pm 1^\circ$ and the maximum single amplitude is within 1.5° .

5.2.4 Functional and performance requirements for follow-up control unit

(1) Steering error

The steering error is not to exceed 1° and not to exceed 0.5° at zero position within the specified steering range in the follow-up mode.

(2) Steering sensitivity

It is not to be more than 1° for follow-up steering.

(3) Rudder angle limitation'

^①Note: There are some cases where it is not possible to turn at the preset rate (turning radius), even if steered at the maximum ruder angle, due to the effect of weather, sea state or ship's maneuverability.

^②Note: It is possible that the ship could not turn at the preset radius even at the maximum rudder angle due to the influences of weather, sea condition or ship's manoeuvrability in certain cases.

±35 °(adjustable)

(4) Insensitivity

Sensitivity adjustment is to be provided and the adjustable range of insensitivity is from the range of 0.5 ° to 2 °. Rudder blades are not to vibrate within the steering range.

5.2.5 Power supply

- (1) The power of steering gear control system is served by own separate circuit supplied from a steering gear power circuit from a point within the steering gear compartment. Or alternatively, this control system may be supplied by a separate circuit directly from the same section of main or emergency switchboard bus-bars at a point on the switchboard adjacent to that supplying the said steering gear power circuit. Short circuit protection is only to be provided for power circuit of above mentioned control system. (See 13.1.8.5(4) of Part Three of CCS Rules)
- (2) The steering control solenoid valve is to be supplied by the corresponding power unit.
- (3) Indication is to be provided for the power supply to the alarm device (unit). It is to be ensured that the alarms as specified in 3.5.2.7 of this Chapter are given in the event of loss of power or failure of the controls (unit) of steering control system.

5.2.6 Independency of system components

- (1) Two independent power and control systems are to be provided for the steering gear control system (except that the steering wheel and steering lever may be shared). The two systems are to be automatically changed over and standby each other. The change-over from one system to the other within 3 seconds is to be achieved in the event of failure in any one of the two systems. The change-over is also to be achieved manually through the selector switch. The system is to be restarted automatically after the restoration of the power supply.
- (2) The two systems are to be separated electrically and mechanically and the failure in one of them will not render the other inoperative except the shared steering wheel /steering lever and steering mode selector switch. If a steering mode selector switch is employed for both steering gear control systems, the connections for the circuits of the control systems are to be separated from each other by an isolating plate or by air gap.
- (3) The rudder angle feed-back units is to be designed as the mechanically parts may be shared and electrically separated in order to comply with the independence requirements.

- (4) Wires, terminals and the components for duplicated steering gear control systems installed in units, control boxes, switchboards or bridge consoles are to be separated as far as practicable. Where physical separation is not practicable, separation may be achieved by means of a fire retardant plate.

5.2.7 Alarms and indication

- (1) The steering gear control system is to comply with the requirements for alarms and monitoring as specified in 13.1.9.1 of Chapter 13 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships.
- (2) In addition to (1) above, the heading control system is to be fitted with off-heading alarm, heading monitor (if applicable), indication of source (if applicable) and sensor status.

5.2.8 Interfaces and others

- (1) The heading control system is to be connected to a heading sensor with appropriate interfaces.
- (2) The heading control system is to be connected to a speed sensor with appropriate interfaces when it is used in a turning radius mode or when any control parameters are automatically adapted to speed.
- (3) If required, appropriate interfaces are to be provided to connect the system with other navigation related systems of the ship.
- (4) The interfaces mentioned above are recommended to adopt the standards of IEC61162 series.
- (5) The display of navigation information is to comply with the applicable requirements of IEC62288.

6 Type approval and unit/batch test

6.1 The steering gear control system is to be type approved by CCS. The type approval certificate is to be issued, maintained, modified, renewed or cancelled according to the requirements of Chapter 3 of PART ONE of Rules for Classification of Sea-going Steel Ships.

6.2 Selection of typical samples and arrangement of test

Types and specifications of test samples are to be technically representative and are to cover the products for which type approval is sought. Products with most steering modes and functions are to be selected to compose the steering gear control system. The test samples are to be taken by CCS surveyor at the manufacturer on site.

6.3 Test organization

The type approval test is to be carried out in a competent test organization acceptable to CCS. The test organization is to be subject to the international/domestic laboratory certification. Some functional tests items may be carried out at the manufacturer under supervision of CCS Surveyor on site if the manufacturer is qualified to carry out the test and examined and approved by CCS surveyor. The ship model used for the functional test of heading control system is to comply with the requirements of Annex A of ISO11674-2006 and confirmed by CCS surveyor.

6.4 Type approval test items and requirements

For type approval test items, see the table below. The electromagnetic compatibility test and ambient conditions test only apply to the main instrument consisting of various steering control units.

6.5 Unit/batch inspection

The unit/batch inspection is to be carried out as required by CCS upon the delivery of products and the product certificate is to be issued.

After type approval, the manufacturer is to implement the control of the manufacturing and test progresses and to carry out the specified routine test for each product and issue the routine test report according to the quality control documentation submitted. CCS surveyor is to carry out the inspection according to the product inspection plan on the basis of the examination of the routine test report. The unit/batch inspection is to include at least the following tests:

- check of information of main components (parts), confirmation of the software version;
- visual examination and examination of internal wiring;
- measurement of insulation resistance;
- withstand voltage test;
- functional verification test.

The test items and number of samples may be added where deemed necessary by the surveyor.

Table of test items

Table 6.5

No.	Test items	Technical requirements and test method
1.	Visual examination, examination of structure and enclosure, conductor and internal wiring, earthing, identification	
2.	Steering position and functional change-over	3.5.2.1 of this Chapter
3.	Steering mode and change-over	3.5.2.2 of this Chapter
4.	Functional test of heading controller	3.5.2.3 of this Chapter, 5.5 of ISO11674
5.	Functional test of follow-up control unit	3.5.2.3 of this Chapter
6.	Functional test of alarms and indication	3.5.2.7 of this Chapter
7.	Examination of interfaces and tests	3.5.2.8 of this Chapter
8.	Withstand voltage test	regulation 2.14 of <Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version)
9.	Measurement of insulation resistance	regulation 2.3 of <Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version)
10.	Extreme power supply condition test	IEC600945 7.1, 5.2.2
	Immunity to power supply short-term variation	IEC600945 7.3, 10.7
	Immunity to power supply failure	IEC600945 7.4, 10.8
11.	Dry test	IEC600945 8.2
12.	Damp heat test (cyclic)	IEC600945 8.3
13.	Low temperature test	IEC600945 8.4
14.	Vibration test	IEC600945 8.7
15.	Protective enclosure test	IEC60533
16.	Salt mist test	IEC600945 8.12
17.	Acoustic noise and alarm signals	IEC600945 11.1
18.	Test of compass safe distance	IEC600945 11.2
19.	Conducted emissions	IEC600945 9.2
20.	Radiated emissions from enclosure port	IEC600945 9.3
21.	Immunity to conducted radio frequency disturbance	IEC600945 10.3
22.	Immunity to radiated radio frequencies	IEC600945 10.4
23.	Immunity to fast transients on electrical lines	IEC600945 10.5
24.	Immunity to surge (impact)	IEC600945 10.6
25.	Immunity to electrostatic discharge	IEC600945 10.9