

# REGULATIONS

## FOR CLASSIFICATION OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS)

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# **REGULATIONS FOR CLASSIFICATION OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS)**

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Regulations for Classification of Maritime Autonomous and Remotely Controlled Surface Ships (MASS) of the Russian Maritime Register of Shipping have been approved in accordance with the established approval procedure and come into force on 1 August 2020.

The present edition of the Regulations has been developed upon the results of the scientific research "Development of the RS draft requirements for autonomous (unmanned) ships, including the requirements for electrical equipment, automation, radio and navigational equipment of such ships".

**REVISION HISTORY<sup>1</sup>**

(purely editorial amendments are not included in the Revision History)

Amended paras/chapters/ sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
<a href="#">Chapter 7.1</a>	Chapter has been amended regarding optional development of the Concept of MASS operation by the shipowner	315-23-1824c of 27.09.2022	27.09.2022
Para 7.2.1.9	Para has been deleted	315-23-1824c of 27.09.2022	27.09.2022
<a href="#">Para 9.2.2.1</a>	Area of requirements application regarding availability of two separate and independent radio communication means has been specified	315-12-1678c of 06.12.2021	01.01.2022
<a href="#">Para 9.2.2.10</a>	Para has been amended regarding deletion of the requirement for recognition of satellite communication provider by the International Maritime Satellite Organization (IMSO), and introduction of the requirement for satellite network availability	315-12-1678c of 06.12.2021	01.01.2022
<a href="#">Appendix A</a>	Section 9 has been deleted	315-23-1824c of 27.09.2022	27.09.2022

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<sup>1</sup> Amendments and additions introduced at re-publication or by new versions based on circular letters or editorial amendments.

## **1 GENERAL**

### **1.1 SCOPE OF APPLICATION**

**1.1.1** Regulations for Classification of Maritime Autonomous and Remotely Controlled Surface Ships (MASS) (hereinafter referred to as the "Regulations") have been developed for defining the instructions on technical supervision during design and construction of MASS.

**1.1.2** The Regulations apply in technical supervision during design and construction of MASS, conversion of ships to MASS, as well as manufacture of materials and products for MASS.

**1.1.3** These Regulations apply in addition to other RS requirements applicable in accordance with the class notation and purpose of the ship.

**1.1.4** The requirements of these Regulations cover the following items, means and systems:

- .1** situational awareness system;
- .2** radiocommunication and data exchange system;
- .3** means of navigation and manoeuvring;
- .4** ship power plant;
- .5** remote control centre (fixed or mobile);
- .6** means of movement delimiting marking (fixed or mobile).

**1.1.5** The requirements of these Regulations may be amended as a result of the experience gained during technical supervision of MASS

### **1.2 DEFINITIONS AND EXPLANATIONS**

**1.2.1** Definitions and explanations relating to general terminology of the RS rules and guidelines are given in 1.1, Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships (hereinafter referred to as the "RS Rules/C") and 1.1, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships (hereinafter referred to as the "RS Rules/TS").

#### **1.2.2 Basic terms, definitions and abbreviations.**

Administration of the remote control centre is an organization that establishes, operates and develops the remote control centre.

Autonomous control is a control mode of a ship, systems and technical means of the ship without human intervention.

Autonomous ship (autonomously controlled ship) is a ship complying with all applicable requirements of the RS rules, international instruments and requirements of Administrations, that uses automation to operate without human intervention during the voyage.

Autonomy is the ability of a ship to perform tasks according to its intended purpose, based on the current condition of the ship and the features of data reading without human intervention.

Delimitation is a method for determination of conditions for safe navigation using land-, air- (orbit-) and sea-based technical facilities applied together or separately.

Element is a constituent part of an item and/or system considered during the analysis as a whole not subject to further subdivision to constituent parts.

Life cycle is a set of interrelated processes of changing the state of an item during its design, construction, operation, repair and utilization.

MASS is a maritime autonomous or remotely controlled surface ship.

Movement delimiting marking (marking) is a set of land-, sea-, air- and orbit-based technical facilities applied together or separately and ensuring safe manoeuvring during the MASS movement along the intended route, entrance to the port, departure from the port, moving in restricted waters, MASS mooring using guidance beams, virtual objects, marks.

Remote control is a control mode of a ship, its systems and technical means from a location other than aboard this ship.

Remotely controlled ship is a ship which is controlled from the remote control centre.

Ship(s) remote control centre (RCC) is a location other than aboard the controlled ship from which monitoring and control of the ship can be performed using the methods ensuring safe navigation.

SPP is a ship power plant.

System is a combination of elements structurally and/or functionally connected to perform the required functions.

### **1.2.3 Risk terms and definitions.**

Event is occurrence or change of a particular set of circumstances.

Failure mode is a combination of possible or observed failures of an element and/or system clustered in a classification group based on one or several common features (causes, generation mechanism, outward appearance and other indications except for the failure effects).

Frequency is a number of events or outcomes per defined unit of time.

Harm is physical injury or damage to people health, property or to the environment.

Hazard is a source of potential harm.

Hazardous event is an event that may cause harm.

Level of risk is a magnitude of a risk expressed in terms of the combination of consequences and their likelihood.

Likelihood is a chance of something happening.

Probability is a measure of the chance of occurrence expressed as a number between 0 and 1, where 0 is impossibility and 1 is absolute certainty.

Risk is a negative effect of uncertainty on objectives assessed as a combination of the probability of hazardous event and its consequences.

Risk acceptance is an informed decision to take a particular risk.

Risk assessment is an overall process of risk identification, risk analysis and risk evaluation.

Risk aversion is attitude to turn away from risk.

Risk avoidance is an informed decision not to be involved in, or to withdraw from, an activity in order not to be exposed to a particular risk.

Risk description is a structured statement of risk usually containing four elements: sources, events, causes and consequences.

Risk evaluation is a process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable.

Risk identification is a process of finding, recognizing and describing of risks.

Risk source is an element which alone or in combination has the intrinsic potential to give rise to risk.

Severity category of failure effects is a classification group of failures by their effect severity characterized by certain, established prior to the analysis, combination of qualitative and/or quantitative components of the estimated (probabilistic) failure or damage caused by a failure.

Severity of failure effects is qualitative or quantitative assessment of probable (observed) damage from failure of element and/or system.

**1.2.4 MASS categories.**

For categorization of the remotely and autonomously controlled surface ships, a complex symbol is introduced that characterizes the capability to control the ship in the open sea and when moving in confined spaces: restricted waters, mooring areas, in ports: <at sea> <in confined spaces>.

When moving at sea: MC, MC<sub>DS</sub>, RC<sub>MC</sub>, RC, AC are used, and when moving in confined spaces: MC, MC<sub>DS</sub>, RC<sub>MC</sub>, RC, AC are used. The explanations for complex symbols are given in [Table 1.2.4](#).

Table 1.2.4

**Complex symbols**

MC	Manual control	person on board
MC <sub>DS</sub>	Manual control with decision support	person on board
RC <sub>MC</sub>	Remote control with manual control override capability	person on board
RC	Remote control	no person on board
AC	Autonomous control	no person on board

Examples of complex symbols of the ship category: AC-MC (AC — autonomous control when moving at sea and MC — manual control when moving in restricted waters and at the entrance to the port) or RC<sub>MC</sub>-MC<sub>DS</sub> (RC<sub>MC</sub> — remote control with manual control override capability when moving at sea and MC<sub>DS</sub> — manual control when moving in restricted waters and at the entrance to the port).

## 2 TECHNICAL SUPERVISION DURING DESIGN

### 2.1 TECHNICAL DOCUMENTATION

**2.1.1** Provisions of Section 3, Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships, Section 2, Part I "General" of the Rules for the Equipment of Sea-Going Ships, as well as Part II "Technical Documentation" of the Rules for Technical Supervision During Construction of Ships and Manufacture of Materials and Products for Ships fully apply to technical documentation for MASS construction and manufacture of materials and products for them.

**2.1.2** In addition to the documentation given in [2.1.1](#), during the design of MASS and systems covered by the requirements of these Regulations, the following documents shall be submitted to the Register depending on the MASS category.

**2.1.2.1** General:

- .1 concept of MASS operation ([Appendix A](#)) including the list of systems;
- .2 MASS operational risk assessment ([Appendix C](#));
- .3 technical specifications for newly designed MASS systems;
- .4 safety program of MASS operation.

**2.1.2.2** Situational awareness system:

- .1 explanations to the concept of MASS operation as regard the situational awareness, environmental perception parameters, including list of systems — sources of this information;
- .2 risk assessment of situational awareness system application;
- .3 structural and functional diagrams of situational awareness system;
- .4 arrangement plan of equipment of situational awareness system;
- .5 description of functioning of situational awareness system during the MASS operational scenarios in accordance with the concept of MASS operation;
- .6 program and procedure of provisional and acceptance tests in respect of situational awareness system during the tests onshore and on board the ship;
- .7 situational awareness system user manual;
- .8 guidelines on the situational awareness system maintenance.

**2.1.2.3** Radiocommunication and data exchange system:

- .1 diagrams of communication systems;
- .2 arrangement plans of communication equipment.

**2.1.2.4** Means of navigation and manoeuvring:

- .1 diagrams of the navigation control systems;
- .2 risk analysis and reliability calculation for the navigation control system;
- .3 fields of vision from the navigation bridge (where applicable);
- .4 layout and connection diagram of the navigation bridge equipment (where applicable);
- .5 program and procedure for mooring and sea trials;
- .6 technical justification for the navigation control system;
- .7 plan of mooring operations and movement in port waters;
- .8 plan of anchor operations and operations for ship's position keeping using dynamic positioning systems.

**2.1.2.5** Ship power plant (SPP):

- .1 automatic power supply system:  
description of elements of the ship's power supply system;  
operating manual for power supply system of the ship containing control procedures (including control logic, functional block diagram, etc.) and description of operation of power supply system in different conditions and modes (at normal operation, failures, start, sea

voyage commencement, anchorage, moving in restricted waters, entering the port, departure from the port, mooring, during cargo and ballast operations, etc.);

procedures and plans for performing by the RCC personnel: monitoring of operating parameters, condition of ship's systems, records of automatic recorders, reports; emergency procedures related to any failure that may occur during the operation and application of automatic power supply system;

program and procedure for verification of automatic power supply system, including inter alia checking of automatic operation of the automatic power supply system for each subsystem under different operating conditions and modes of operation; switching from autonomous to remote control, including checking of autonomy of the systems; failure test modeled in accordance with the risk assessment report;

**.2 SPP artificial intelligence system:**

arrangement of main equipment of SPP artificial intelligence system;

algorithms of SPP artificial intelligence system interaction with the most essential systems providing parameters for monitoring and control thereof;

control procedures (algorithms) (including control logic, functional block diagram, etc.) and description of operation of SPP artificial intelligence system under different conditions and modes including emergency modes;

operating and maintenance instructions for the system including procedures and plans for verification of the SPP artificial intelligence system;

emergency operating procedures.

**2.1.2.6 Remote control centre (RCC) (fixed or mobile):**

**2.1.2.6.1 Situational awareness:**

**.1** design of the RCC situational awareness system equipment including system composition, technical description, structural diagram, general view, operating manual, justification for locations, operating areas, redundancy level provided for all requested areas of RCC operation;

**.2** justification of sufficiency of the received information for MASS operation under all predictable operating conditions in the permitted areas of operation, obtained using methods of mathematical modelling of integral RCC system;

**.3** description of procedures and algorithms for making decisions on the possible mode of autonomy of the ship: autonomous, remote control, manual, decision support for the crew on board the ship, depending on the information received under all predictable operating conditions in all permitted areas of operation;

**.4** justification for the adequacy of the decision on the possible mode of autonomy of the ship: autonomous, remote control, manual control, decision support for the crew on board the ship, depending on the information received under all predictable operating conditions in all permitted areas of operation obtained using methods of mathematical modelling of the integral RCC system.

**2.1.2.6.2 Strategic management of voyage:**

**.1** description of the area of strategic management of the voyage being under the RCC control;

**.2** description of the voyage planning procedure applied in RCC;

**.3** risk analysis in case of loss of communication with MASS, error in delivery of the voyage assignment or misrepresentation thereof, inability to monitor the voyage assignment performance.

**2.1.2.6.3 Remote control of navigation:**

**.1** functional diagram of the navigation control system operated from RCC;

**.2** description of the navigation control system operated from RCC;

**.3** risk analysis and reliability calculation for the navigation control system operated from RCC;

**.4** diagram of fields of vision around MASS from RCC;

.5 arrangement plan of equipment of the navigation control system operated from RCC;

.6 program and procedure of mooring and sea trials in respect of testing the interaction with RCC as regards navigation;

.7 justification of sufficiency of the adopted engineering solutions to ensure continuous navigation control from RCC;

.8 mooring plan under control from RCC;

.9 weighing/anchorage plan under control from RCC.

**2.1.2.6.4 Anti-intrusion protection:**

.1 RCC space(s) arrangement indicating doors (passages) equipped with access system;

.2 instructions on updating the authorized persons list;

.3 RCC rules.

**2.1.2.6.5 Electrical power supply:**

.1 RCC power supply diagram;

.2 power supply connection diagram of RCC equipment.

**2.1.2.7 Means of movement delimiting marking (fixed or mobile):**

**2.1.2.7.1 Navigation delimiting signs:**

.1 control procedure for navigation delimiting signs;

.2 maintenance procedure for means ensuring operability of navigation delimiting signs;

.3 redundancy of means ensuring operability of navigation delimiting signs;

.4 user manual for operator.

**2.1.2.7.2 Marking control:**

.1 risk assessment;

.2 marking control procedure;

.3 maintenance plan for means ensuring operation of marking;

.4 redundancy management of marking means;

.5 user manual for operator.

**2.1.2.7.3 Mooring area:**

.1 control procedure for mooring means and equipment;

.2 arrangement plan of equipment of mooring area;

.3 power supply connection diagrams of mooring area;

.4 connection diagrams of mooring area indication system;

.5 maintenance plan for means and equipment of mooring area;

.6 description of functions of equipment and systems of mooring area.

**2.1.2.8 Cyber security:**

**2.1.2.8.1 Computers and computer-based systems:**

.1 description of software architecture of control system implemented by RCC and the controlled ship:

control procedures (algorithms) (including control logic, functional block diagram, etc.) and description of the RCC systems operation under various conditions and in the various operational modes (start, sea voyage commencement, anchorage, moving in restricted waters, entering the port, departure from the port, mooring, during cargo and ballast operations, etc.);

.2 description of data formats applied by the control system software implemented by RCC and the controlled ship;

.3 description of operating systems and data exchange technical facilities applied by the control system software implemented by RCC and controlled ship;

.4 procedures and plans for performing by RCC and controlled ships of self-diagnostic procedures of parameters and emergency procedures relating to monitoring of transmitted data and in case of any failure that may occur during the operation and use of remote control system.

**2.1.2.8.2 Cyber security on board the ship:**

- .1 cyber risk assessment;
- .2 cyber security management;
- .3 maintenance plan;
- .4 description of data storage redundancy management;
- .5 connection diagrams of equipment and power supply system;
- .6 procedures for cyber security risk identification and management;
- .7 justification for cyber security measures for navigation bridge systems;
- .8 justification for cyber security measures for engines, machinery and power supply control systems;
- .9 justification for cyber security measures for ship access control systems;
- .10 justification for cyber security measures for administrative systems and networks;
- .11 justification for cyber security measures for radio and communication systems;
- .12 documents confirming implementation of measures aimed at ensuring safe software development;
- .13 list of protected information resources;
- .14 access matrix;
- .15 threat model and security model;
- .16 operating documentation on information security system.

**2.1.2.8.3 RCC cyber security:**

- .1 cyber risk assessment;
- .2 cyber security management;
- .3 indication system of ship technical condition;
- .4 maintenance plan;
- .5 RCC functions justification;
- .6 data storage redundancy management;
- .7 power supply connection diagrams;
- .8 procedures for cyber security risk identification and management;
- .9 user manual for RCC operator;
- .10 documents confirming implementation of measures aimed at ensuring safe software development;
- .11 list of protected information resources;
- .12 access matrix;
- .13 threat model and security model;
- .14 operating documentation on information security system.

**2.1.2.8.4 Movement delimiting marking:**

- .1 description of software architecture of movement delimiting marking: control procedures (algorithms) (including control logic, functional block diagram, etc.); description of movement delimiting marking system operation in different conditions and in different operational modes (including emergency modes);
- .2 description of data formats applied by marking system software;
- .3 description of operating systems and data exchange technical facilities applied by marking system software;
- .4 procedures and plans for self-diagnostic procedures for movement delimiting marking parameters and emergency procedures relating to monitoring of transmitted data and in case of any failure that may occur during the operation and use of marking system;
- .5 verification of compliance with the prescribed security requirements for information received from movement delimiting marking and intended for MASS shall verify: availability of information security records; compliance of reported documentation with the requirements of national and international standards, as well as normative documentation of flag State Maritime Administration.

## **2.2 REVIEW OF TECHNICAL DOCUMENTATION**

**2.2.1** MASS technical documentation shall be reviewed by the RS Head Office (hereinafter referred to as the "RHO") or the RS Branch Office upon the RHO authorization based on standard agreement as per form 430.1.4 with Appendix as per form 430.1.4.2 concluded in accordance with a request as per form 430.1.4.1.

**2.2.2** When technical documentation contains solutions not complying with the RS requirements, deviations from these Regulations and the RS rules shall be agreed in accordance with 1.3.4 of the General Regulations for the Classification and Other Activity.

**2.2.3** Upon results of the review of the MASS technical documentation a final conclusion letter shall be made containing all reviewed documents without stamping the documents.

### **3 TECHNICAL SUPERVISION DURING MANUFACTURE OF MATERIALS AND PRODUCTS**

**3.1** Materials and products for MASS constructed under the RS technical supervision are subject to the RS technical supervision during their manufacture with issuance of the appropriate certificates.

**3.2** Organization and carrying out of technical supervision shall comply with the requirements of Parts I "General Regulations for Technical Supervision", III "Technical Supervision during Manufacture of Materials" and IV "Technical Supervision during Manufacture of Products" of the RS Rules/TS.

**3.3** Technical supervision during manufacture of materials and products not included in the Nomenclature of Items of the Register Technical Supervision, but covered by the requirements of these Regulations shall be carried out while rendering the "Approval in Principle" (AIP) service in compliance with 3.6, Part II "Technical Documentation" of the RS Rules/TS.

## **4 TECHNICAL SUPERVISION DURING CONSTRUCTION**

**4.1** The requirements of Part I "General Regulations for Technical Supervision" of the RS Rules/TS and the Guidelines on Technical Supervision of Ships under Construction fully apply to MASS.

**4.2** Preliminary list of items of technical supervision covered by the requirements of these Regulations is developed by the designer and subject to agreement with the RS Branch Office responsible for review of ship design documentation.

**4.3** List of items of technical supervision containing detailed scope and procedure of technical supervision, types of checks, tests and control is developed by the shipyard in compliance with 13.3, Part I "General Regulations for Technical Supervision" of the RS Rules/TS based on the preliminary list given in [4.2](#), and reviewed and agreed by the RS Branch Office responsible for technical supervision during construction.

**4.4** Programs of MASS mooring and sea trials are reviewed by the Register in compliance with the provisions of Part II "Technical Documentation" of the RS Rules/TS and Section 18 of the Guidelines on Technical Supervision of Ships under Construction. The programs shall include tests of items, means and systems given in [1.1.4](#) of these Regulations and provided on board the ship taking into account MASS category.

**4.5** Systems related to systems of high and very high risk level, as well as systems ensuring essential MASS control functions shall be preliminary verified using simulators prior to full-scale tests.

**4.6** After completion of mooring and sea trials, the MASS test report shall be prepared and submitted to the Register. The report shall provide evidence that all earlier planned actions for risk mitigation (safety program) have been implemented, and MASS together with the shore-based and maritime infrastructure ensures a safety level equivalent to or better than that of a conventional ship.

**4.7** Before the commissioning, the designer shall develop a survey plan agreed with RS, covering the total life cycle of MASS, including RCC and supporting infrastructure to determine the content and scope of each survey, as well as survey and testing procedures. The following input data shall be considered:

- compliance with the applicable requirements of the RS rules;
- compliance with the requirements of these Regulations;
- compliance with the requirements of the Guidelines on Technical Supervision of Ships in Service;
- maintenance and repair plan.

**4.8** Scope of surveys after construction shall comply with the approved survey plan to verify that MASS systems comply with the requirements of these Regulations.

## **5 SURVEY OF REMOTE CONTROL CENTRE**

**5.1** For the initial survey, the documents listed in [2.1.2.6](#), as well as procedures and programs of RCC tests shall be submitted to the Register.

**5.2** The scope of survey shall include at least the following:

- verification of RCC compliance with the approved design documentation;
- confirmation, based on the documents issued by competent organizations that fire safety of RCC meets the requirements of national standards;
- confirmation, based on the documents issued by competent organizations, that operators work stations meet the requirements and norms of national standards;
- verification of personnel sufficiency and competence;
- verification of documents on ensuring the safety, security and network management system and implementation efficiency;
- functional tests within the scope of test program.

**5.3** To carry out annual survey for extension of documents confirming compliance with the requirements of these Regulations:

- list of amendments (if any) made to the documentation for initial survey shall be submitted to the Register;

- annual survey for confirmation of compliance shall be carried out 3 months before the date of expiry of the documents confirming the compliance with the requirements of these Regulations;

- scope of survey shall comply with [5.2](#).

**5.4** Survey for renewal of documents upon expiry thereof:

- the documentation in accordance with [2.1.2.6](#) shall be submitted to the Register;
- annual survey for renewal of documents shall be carried out not less than 3 months from the date of expiry of the documents;

- scope of survey shall comply with [5.3](#).

**5.5** The documents confirming RCC compliance with the requirements of these Regulations are valid 12 months from the date of the issuance of the documents.

## **6 DRAWING UP AND ISSUANCE OF DOCUMENTS**

**6.1** Results of technical supervision shall be documented in the reports as per form 6.3.10.

The basic document confirming the compliance of the ship with the RS requirements for the appropriate MASS category on the date of construction or conversion completion is the MASS Statement of Compliance.

**6.2** Statement of Compliance of MASS Remote Control Centre is issued upon confirmation of compliance with the requirements of these Regulations applicable to RCC.

## 7 CONCEPT OF MASS OPERATION

### 7.1 TASKS

The Concept shall specify the conditions and methods of MASS operation, as well as basic design solutions allowing compliance with the requirements of these Regulations.

### 7.2 REQUIREMENTS

**7.2.1** Concept of MASS operation shall include the following basic sections:

- .1** MASS description, name, flag, identifiers;
- .2** MASS main particulars;
- .3** variants of MASS operation: basic and additional;
- .4** conditions of MASS operation:
  - ambient conditions of operation;
  - marine conditions of operation;
  - special conditions of operation;
- .5** MASS manoeuvring characteristics (for assessment of risks and manoeuvring safety) including:
  - general parameters of the ship movement;
  - controllability parameters and inertia and braking characteristics of the ship on even keel, fully loaded in deep and shallow waters (1,5 N/T);
  - ship behavior in full load/ballast, on even keel using ship positioning means;
- .6** control level of MASS systems, including:
  - structure of control systems;
  - means of situational awareness, communication, navigation and manoeuvring;
  - ship power plant (SPP);
  - systems serving the hull, deck machinery, means of damage control;
  - means of environmental protection, means of anti-intrusion protection of the ship, means of cyber security assurance;
- .7** main principles of operation (including control methods, limitations, specific operations) at anchorage and mooring; towing (other than emergency one); at launching/hoisting; during transportation; hull strength, buoyancy and stability control; engines, machinery and electrical systems of fire-fighting means and water control; control of systems of navigational equipment; systems for dangerous goods transportation; recovery of control systems after their disabling;
- .8** main principles of inspection, maintenance and withdrawal.

### 7.3 VERIFICATION METHODS

**7.3.1** The following documents and drawings shall be submitted to RS for the survey: concept of MASS operation ([refer to Appendix A](#));

technical description of the main components of the MASS onboard equipment which ensures its unmanned operation, at least: means of operational situation assessment; means of communication; means of navigation and manoeuvring; SPP additional monitoring devices; means of additional monitoring of the hull; means of additional monitoring of movement, anchor and mooring arrangements; means of damage control (water and fire); means of environmental protection; means of anti-intrusion protection of the ship; means of cyber security assurance.

**7.3.2** Moreover, the compliance of the submitted concept of MASS operation ([refer to Appendix A](#)) with the requirements of the Rules for the Classification and Construction of Sea-Going Ships shall be verified.

## **8 RISK-ORIENTED PROCESS OF MASS APPROVAL**

### **8.1 PURPOSE AND APPLICATION**

This Section contains the description and recommendations on the implementation of the process aimed at objective evidence that the operation of MASS and/or the system within MASS ensures a safety level equivalent to or better than that of a conventional ship designed and operated in accordance with the existing RS rules and regulations. This process is based on the risk assessment being a part of the risk management process, and covers all stages of the MASS life cycle involving RS and requiring RS approval or survey.

The Section contains a description of two interconnected processes:

risk assessment of MASS operation;

risk assessment of operation of systems for MASS.

### **8.2 NORMATIVE REFERENCES**

A list of valid international and Russian standards referenced in these Regulations is given below. The list is divided into groups of standards according to their applicability to description of process of assessment and approval of MASS and systems for MASS at various stages of their life cycle. Full titles of standards are given. Hereinafter, only their alphanumeric characters are specified.

General approach to risk management process:

ISO 31000:2009 "Risk management — Principles and guidelines";

GOST R ISO 31000-2010 "Risk management. Principles and guidelines";

ISO/IEC 27005:2018 "Information technology — Security techniques — Information security risk management";

GOST R ISO/IEC 27005-2010 "Information technology. Security techniques. Information security risk management".

Life cycle processes and stages:

ISO/IEC/IEEE 15288:2015 "Systems and software engineering — System life cycle processes";

GOST R 57193-2016 "Systems and software engineering. System life cycle processes";

ISO/IEC 12207:2008 "Systems and software engineering — Software life cycle processes";

GOST R ISO/IEC 12207-2010 "Information technology. Systems and software engineering. Software life cycle processes";

GOST 34.601-90 "Information technology. Set of standards for automated systems. Automated systems. Stages of development";

GOST R 15.301-2016 "System of product development and launching into manufacture. Products of industrial and technical designation. Procedure of product development and launching into manufacture".

Selection of risk assessment methods:

ISO/IEC 31010:2019 "Risk management — Risk assessment techniques";

GOST R ISO/IEC 31010-2011 "Risk management. Risk assessment methods";

GOST R 51901.1-2002 "Risk management. Risk analysis of technological systems".

Description of risk assessment methods:

IEC 61882:2016 "Hazard and operability studies (HAZOP studies) — Application guide";

GOST R 51901.11-2005 (IEC 61882:2001) "Risk management. Hazard and operability studies. Application guide";

IEC 60812:2018 "Failure modes and effects analysis (FMEA and FMECA)";

GOST R 51901.12-2007 (IEC 60812:2006) "Risk management. Procedure for failure mode and effects analysis";

IEC 61025:2006 "Fault tree analysis (FTA)";  
 GOST R 51901.13-2005 (IEC 61025:1990) "Risk management. Event tree analysis";  
 IEC 62502:2010 "Analysis techniques for dependability — Event tree analysis (ETA) ";  
 IEC TR 63039:2016 "Probabilistic risk analysis of technological systems — Estimation of final event rate at a given initial state".

Terminology related to risk assessment and reliability:

ISO Guide 73:2009 "Risk management — Vocabulary";  
 GOST R 51897-2011/ISO Guidelines 73:2009 "Risk management. Terms and definitions";  
 GOST 27.002-2015 "Dependability in technics. Terms and definitions".

### 8.3 LIFE CYCLE STAGES

Designers of MASS and systems for MASS may be guided by different methodologies, i.e. a complex of rules, principles, ideas, concepts, methods and techniques defining the way of development, creation and application. These methodologies also include stages/steps of the life cycle of the products being created, which are a systematic complex of steps that determine, inter alia, the processes of interested parties' interaction in the results of creation and operation of these products. Taking into account that the standards specifying different development methodologies contain various definitions of stages/steps of product life cycle, the uniform terms for these stages are adopted in these Regulations.

The comparison results and the terms for the life cycle stages accepted in these Regulations are given in [Table 8.3](#).

Table 8.3

**Comparison of stages/steps of work or processes/activities**

ISO/IEC/IEEE 15288:2015 GOST R 57193-2016 (technical processes)	ISO/IEC 12207:2008 GOST R ISO/IEC 12207-2010 (technical processes)	GOST R 34.601-90 (stages of automated systems development)	GOST R 57193-2016 (stages of life cycle of the products)	Names of stages specified in the Regulations
Business or mission analysis, the interested party needs and requirements definition, system requirements definition	Defining of stakeholders' requirements, analysis of system requirements	Establishment of requirements for automated systems, development of a concept of automated systems, terms of reference	Research and design	Concept development
Architecture definition, design definition, system analysis	System architecture design	Conceptual design, technical design		Design

ISO/IEC/IEEE 15288:2015 GOST R 57193-2016 (technical processes)	ISO/IEC 12207:2008 GOST R ISO/IEC 12207-2010 (technical processes)	GOST R 34.601-90 (stages of automated systems development)	GOST R 57193-2016 (stages of life cycle of the products)	Names of stages specified in the Regulations
Implementation, integration	Implementation, integration of system	Detailed (design) documentation	Development, manufacture (production)	Manufacture and commissioning
Verification, transition, validation (appraisal)	Qualification testing of the system, software installation, support of software acceptance	Commissioning	Delivery	
Operation, maintenance	Software functioning, software maintenance	Maintenance of automated systems	Operation	Operation
Disposal and retirement	Software disposal		Liquidation	Retirement

#### **8.4 MASS OPERATION RISK ASSESSMENT**

##### **8.4.1 Development of concept of MASS operation.**

At the stage of development of the concept of MASS operation, the risk assessment of its operation shall be performed by designer.

**8.4.1.1** The concept of MASS operation ([refer to Appendix A](#)) shall define the factors to be considered during design. At least the following shall be referred to these factors:

MASS category (e.g.: purpose, type, main particulars or gross tonnage, new or existing hull type, cargo type);

ship systems or functions (e.g.: type of electrical power plant, equipment functions);

MASS areas of navigation and maintenance (e.g.: operations in the open sea, coastal area, inland waterways, service area in the port and/or during navigation);

limiting conditions of operation (e.g.: seaways, wind, ice situation);

MASS external communications (e.g. with vessel traffic system, forecasting service, rescue and port services, remote control centre);

hazards with such potential sequences as injuries and/or death of passengers and mooring/service crew, environmental impact, damage of MASS or port facilities or damage to business.

**8.4.1.2** Based on the decisions on the degree of MASS autonomy and its purpose, the initial data for risk assessment shall be prepared by the designer. Such data include statistics of the relevant accidents and incidents, as well as the data on system and equipment reliability. These data shall be collected during the whole design period for using the experience gathered in risk assessment. As much as possible data and information shall be collected. Where the data are not sufficient, expert reviews, physical models and numerical simulation may apply. While considering a new problem for solving of which no sufficient experience and statistical data of accidents are available, the data and information of other industry branches may be reviewed and used as the reference.

**8.4.1.3** For obtaining the information on marine casualties and incidents, it is recommended to use well-known databases, the most overall and public database is contained in the IMO maintained Global Integrated Shipping Information System (GISIS). This data base is referred to as the "Marine Casualties and Incidents". Information resource address and access conditions to this and other database are given in [Table 8.4.1.3](#).

Table 8.4.1.3

**Recommended database of marine casualties and incidents**

Database	Information resource address	Access
Marine Casualties and Incidents	<a href="https://gisis.imo.org/Public/Default.aspx">https://gisis.imo.org/Public/Default.aspx</a>	Free
Marine Accident Investigation Branch (MAIB) reports	<a href="https://www.gov.uk/maib-reports">https://www.gov.uk/maib-reports</a>	Free
Marine Accident Reporting Scheme (MARS) reports	<a href="https://www.nautinst.org/resource-library/mars/mars-reports.html">https://www.nautinst.org/resource-library/mars/mars-reports.html</a>	Free
Marine Accident Reports (National Transportation Safety Board (NTSB))	<a href="https://ntsb.gov/investigations/AccidentReports/Pages/marine.aspx">https://ntsb.gov/investigations/AccidentReports/Pages/marine.aspx</a>	Free
Casualty and Events (IHS Markit)	<a href="https://ihsmarkit.com/products/casualty-and-events.html">https://ihsmarkit.com/products/casualty-and-events.html</a>	Pay

Processed and systematical statistical data related to marine casualties for the European waters are freely available at webpage of the European Maritime Safety Agency — EMSA — <http://emsa.europa.eu/implementation-tasks/accident-investigation/>. Statistical data for territorial waters and ships are also provided by other countries, e.g.: Australia, Japan, Norway, Denmark, and Canada.

**8.4.1.4** Prepared initial data shall be thoroughly analyzed. The analysis is aimed at MASS operation risk ranking based on its purpose. The analysis is recommended to be performed through the following steps.

**8.4.1.4.1** Hazardous event identification.

Depending on the prior decision on the preparation of initial data, their scope and depth, one or more methods of identification may be chosen as specified in ISO/IEC 31010:2019 and GOST R ISO/IEC 31010-2011. Anyway, a final list of hazardous events shall be consequently defined containing a description of identification procedure, the events, causes of occurrence, sources of danger, quantitative and/or qualitative likelihood parameters. The following may refer to these events, namely:

collision — an impact or allision with another ship irrespective of the latter movement, anchorage or berthing;

grounding — ground contact, impact or touching of seabed, shore or underwater object (sunken ship, etc.);

run foul — impact with a fixed or float object not fall within the definition of collision or grounding;

fire/explosion — the events where fir/explosion are the initial causes of an incident;

flooding — solid or partial;

capsizing, high-risk list — instability;

damage to the hull due to violation of seaworthiness limitations;

damage to the equipment — a failure of machinery being an initial cause of an incident;

loss of control — inability to control seaway course and speed;

piracy — malicious actions of extraneous forces on illegal seizure, robbery or sinking of a ship;

disappearance — missing by unknown cause.

When the information on the previous marine casualties was used as the initial data, the result of hazardous event identification shall be submitted in tabular form ([refer to Table 8.4.1.4.1](#)):

Table 8.4.1.4.1

**Examples of submitting the results of hazardous event identification**

Period from ... to ... Totally = ... years Number of ships in service throughout the entire period = ...		
Hazardous event	Numbers of event for the period	Frequency of event (for one ship per a year)

Obtained probabilities may apply as initial for the event tree analysis at the next step.

**8.4.1.4.2 Likelihood assessment of hazardous events.**

The task of this step is identification of hazardous event scenarios and quantitative and/or qualitative assessment of likelihood thereof. Scenario means a sequence of events from the initial to the final one characterized by harm caused, taking into account different conditions of the hazardous event occurrence. It is recommended to assess the likelihood by construction of an event tree similar to event tree analysis (ETA) in accordance with IEC 62502:2010 standard. Hazardous events identified with their probability at the first step are accepted as the initial events. Further, the related events, conditions of hazard occurrence, hazardous event results shall be listed in such a way that they form event sequences — scenarios specifying each of them by the probability, likelihood value. The links of these chains may be, for example:

**.1 areas of hazardous event occurrence:**

- inland waters,
- coastal waters,
- open sea,
- channels,
- restricted waters,
- ports;

**.2 stages of ship functioning:**

- berthing (loading/unloading),
- entrance to the port,
- departure from the port,
- anchorage/moorage/weighing,
- sea passage;

**.3 sources of hazards:**

- other ship or object,
- environment,
- equipment failure,
- human errors.

Initial hazardous events that may result (resulted to in the past) may be accepted as the last links of the scenario chains. These terminal events shall define harm that may occur in case of implementation of each of scenarios received. Based on the IMO recommendation, three harm categories are considered with regard to assessment of safety at sea:

- injury or damage to health,
- harm caused by ship damage,
- environmental damage.

Finally, scenarios of hazardous event occurrence shall be formed indicating quantitative and/or qualitative assessment of their likelihood. For this purpose, it is recommended to use IMO event frequency Table ([refer to Table 8.4.1.4.2](#)) where the correlation between the qualitative and quantitative parameters is specified and frequency indices are given.

Table 8.4.1.4.2

**Qualitative and quantitative parameters of event frequency**

Determination of the event frequency	For one ship per a year		Frequency index
	Qualitative parameter	Quantitative parameter	
Once a month on one ship	Often	10	7
Once a year on one ship	Sometimes	1	6
Once a year for the fleet of ten ships or several times throughout the life cycle of one ship	Very likely	0,1	5
Once a year for the fleet of 100 ships	Possibly	$10^{-2}$	4
Once a year for the fleet of 1000 ships or throughout the life cycle of several similar ships	Probably	$10^{-3}$	3
Once for the life cycle (20 years) of a fleet of 400 ships	Not likely	$10^{-4}$	2
Once for the life cycle (20 years) of a fleet of 5000 ships	Most unlikely	$10^{-5}$	1

**8.4.1.4.3 Determination of severity effects of hazardous events.**

For assessment of severity effects of each scenario in accordance with the IMO recommendation, three groups shall be considered: effects for people, ships and environment. Qualitative assessments of the effects and relevant verbal characteristics thereof, as well as values of indices for these groups are given in [Tables 8.4.1.4.3-1 — 8.4.1.4.3-3](#).

Table 8.4.1.4.3-1

**Severity effects parameters for people**

Definition of effect	Qualitative parameter	Equivalent fatalities	Severity index
Single or minor injuries	Minor	0,01	1
Multiple or major injuries	Serious	0,1	2
One fatality or multiple major injuries	Heavy	1	3
Multiple fatalities	Catastrophic	10	4

Table 8.4.1.4.3-2

**Severity effects parameters for ship**

Definition of effect	Qualitative parameter	Equivalent damage	Severity index
Local damage to equipment	Minor	0,01	1
Minor damage to the ship	Serious	0,1	2
Major damage to the ship	Heavy	1	3
Total loss	Catastrophic	10	4

Table 8.4.1.4.3-3

**Severity effects parameters for environment**

Definition of effect	Qualitative parameter	Equivalent oil chemical substances spill	Severity index
Local spill	Minor	< 1 ton	1
Major local spill	Serious	1 – 100 tons	2
Serious major spill	Heavy	100 – 10000 tons	3
Very heavy spill	Catastrophic	> 10000 tons	4

Finally, each of hazardous scenarios specified in [8.4.1.4.2](#) shall be evaluated according to severity effects for people, ships and environment.

**8.4.1.4.4 Risk level assessment.**

At this step, the quantitative and qualitative characteristic of risk level of each hazardous scenario determined by the scenario probability and its effect severity. It is recommended to assess the risk level using the risk index by addition of the frequency index and effect severity for each of three effect groups. The example is given below ([refer to Table 8.4.1.4.4](#)).

Table 8.4.1.4.4

Risk degree parameters (examples)								
Hazardous event	Scenario (number)	Frequency index	Severity index			Risk index		
			Human	Ship	Environment	Human	Ship	Environment
Collision	1	3	1	4	1	4	7	4
	2	4	2	2	1	6	6	5
	...							
	n	7	2	2	1	9	9	8
Fire	1	4	1	4	2	5	8	6
	2	2	1	4	2	3	6	4
	...							
	m	1	2	3	3	3	4	4

**8.4.1.4.5 Risk evaluation.**

It is recommended to perform risk evaluation of all hazardous scenarios by ranking thereof, e.g. in descending order of risk index values or other quantitative/qualitative parameters of risk level. As a result, a list shall be formed where the scenarios, having different hazardous events as the initial ones, are grouped by risk level. It is recommended to form three lists of the ranked scenarios: by severity of consequences for people, ship or environment.

The designer shall substantiate and propose the risk criteria for determination of acceptability thereof as applied to all three ranked lists of scenarios. Resulting from the risk level and risk criteria comparison, the decisions on risk acceptance or risk aversion during further MASS development shall be substantiated for each scenario. For all scenarios, where risk aversion is specified, the risk mitigation actions shall be proposed.

**8.4.1.5 Identification of risk mitigation actions shall finalize risk assessment at the stage of development of the concept of MASS operation. Risk mitigation actions shall be aimed at obtaining one or several of the following results:**

- risk probability mitigation during design, engineering implementation, operation, maintenance, training of specialists;
- risk consequence prevention, for instance, by hazardous event prevention;
- mitigation of risk occurrence conditions;
- mitigation of severity effects of hazardous events.

The proposed risk mitigation actions may be grouped according to the achieved results or stages of MASS life cycle where they shall be implemented. Therewith, possible impact of actions on achievement of more than one outcome and their mutual impact shall be considered. The final list of risk mitigation actions shall be evidenced in the concept of MASS operation.

For this purpose, the designer shall decide on which of the functions associated with risk mitigation actions that traditionally have been performed by crew will be performed either by remote control or automatically. This solution shall also be evidenced in the concept of MASS operation. The concept shall describe all MASS functions that will be either fully or partially automated. Each function shall be additionally divided into tasks and subtasks to

a level that enables a clear distinction between the tasks where a human is in charge of decision making and performing actions, and the tasks where the system is in charge of decision-making. When a human is involved in the implementation of control functions, the location of decision maker shall be clearly described: on board, in RCC, or on board and in RCC (in case of combined control). Risk assessment shall be finalized by the specific solutions for mitigation of risk of MASS operation and determination of degree automation thereof.

Risk analysis results including the description of all steps, methods applied, initial data, solutions adopted, and concept of MASS operation shall be submitted by the designer to the Register for review and subject to updating during the risk assessment process at the next stages of the MASS life cycle.

#### **8.4.2 Design.**

It is customary to divide a design stage into two substages: conceptual (high-level, general) and technical (detailed) design.

**8.4.2.1** The main objectives of conceptual design are development of variants of MASS development, their comparison and selection of the optimum variant according to specified parameters. As a result, a variant balanced by the required functionality, performance characteristics, availability, safety and maintainability is selected. The major design decisions like propulsion arrangement, fire-fighting capabilities and system architecture shall typically be made at this stage. This design serves as a basis for discussion with potential system suppliers, and shall be implemented based on the information received from suppliers regarding specific system capabilities. Therewith, it shall be decided which system is a conventional one and shall be approved by RS according to the existing rules and regulations, and which system is not subject to these rules and regulations and shall be approved by RS following the verification for compliance with these Regulations ([refer to Section 3 – 7](#)). Potential suppliers of conventional systems shall submit the appropriate RS certificates of approval.

To confirm that operation of MASS to be designed ensures a safety level equivalent to or better than that of a conventional ship, the technical background for the conceptual design shall contain (but not limited to) the following three sections.

##### **8.4.2.1.1 Basic safety measures.**

Firstly, this Section shall contain an analysis of the existing rules and requirements for operation of similar purpose ships where nonconformities and discrepancies with the intended operation of MASS to be designed will be identified. On this basis, the alternative solutions shall be outlined, and this results in requirements for systems to be supplied. In some cases, a focussed risk analysis shall be provided in order to clarify that the proposed, alternative solution will result in an equivalent safety level.

Secondly, the minimum risk conditions (MRC) shall be proposed that the ship shall enter when the external conditions go outside the limits and, probably, exit of which, when the conditions allow to operate normally. These conditions shall be detailed and their position shall be determined in the hierarchy of the event tree and/or decision tree. The same MRCs may be structured in different trees for different scenarios. MRCs which serve as the last resort in the event and solution hierarchy shall be clearly indicated. These conditions shall be such that no circumstances may worsen safety level of MASS in question.

Thirdly, the formal and informal requirements regarding competency for the personnel involved with the MASS operation and maintenance shall be described. Competence criteria of the personnel involved in remote control, supervision and control of the MASS systems operation shall be specified.

##### **8.4.2.1.2 Main principles of autonomous/remote control.**

This Section shall contain a description of overall design solutions, requirements and limitations for systems intended for implementing autonomous/remote control functions. For these systems, such redundancy and fault tolerance shall be provided in order to ensure the capability of MASS to enter and maintain in MRC in case of any hazardous scenario.

The boundaries of each system from different suppliers shall be defined. In this regard, in order to specify the required scope of work on the RS approval of systems they shall be categorized into the following categories:

- type approved systems intended used in conventional application;
- type approved systems intended used in new application or serving new purpose;
- conventional systems (without approval) intended used in conventional application;
- conventional systems (without approval) intended used in new application or serving new purpose;
- new systems having an approval for application in MASS;
- newly developed systems for MASS to be designed and having no RS approval.

**8.4.2.1.3 Basic solutions for maintenance during operation.**

This Section shall substantiate reduction in the number of required personnel in the vicinity of the systems and machinery during the introduction of autonomous and remotely controlled systems. Special attention shall be paid to maintenance of systems implementing the remote control functions of the ship. A description containing the procedure how each system will be monitored, diagnosed, maintained and repaired shall be provided. These systems include both software and mechanical subsystems/components. Basic responsibilities of different officials both on board the ship and onshore shall be clearly defined.

**8.4.2.2** The main tasks of technical design are justification and description of the previously selected MASS variant.

At this substage, the final design solutions regarding all MASS systems shall be adopted. For autonomous functions, focus of this substage is to make sure that each system selected for delivery will be able to provide desired functionalities and that interfaces between different systems are sufficiently defined. Combined, the MASS design documentation and documentation for ship systems design shall describe the total infrastructure in such a way that enables to make a decision on safety implement of MASS functions. For this purpose, MASS design documentation shall in addition to the conventional content, also specify special arrangements needed to fulfil requirements for autonomous functionality and associated systems ensuring such functionality.

MASS design documentation shall define infrastructures needed off the ship in order to safely implement autonomous functions. It may be design documentation for RCC and communication systems connecting the ship and RCC. Also, the design documentation shall include other off-ship systems required for ship operation based on its operational concept. Systems of movement delimiting marking, towing and automatic mooring system may be referred to such systems.

Design documentation shall contain a single document on detailed risk analysis of MASS operation. In total, this analysis shall be performed on basis of the concept of MASS operation, decision made during design work, information on ship systems and MASS structure. The purpose is to ensure that MASS and supporting infrastructure as a whole are able to withstand with relevant malfunctions, failures and hazardous situations at sea in safe manner. The risk analysis shall be performed using one or more standard (ISO/IEC 31010:2019, GOSTR 51901.1-2002) risk assessment methods, e.g. FTA — fault tree analysis (IEC 61025:2006, GOST R 51901.13-2005), ETA — event tree analysis (IEC 62502:2010) or FMEA (FMECA) — failure modes and effects analysis (IEC 60812:2018), GOST R 51901.12-2007). Software products applied for quantitative risk assessment shall be agreed with RS and/or have certificates of approval issued by the appropriate regulatory bodies and governmental institutions. All risk mitigation actions proposed at the development stage of the concept of MASS operation shall be reasonably confirmed by this analysis. Newly identified risks shall be accompanied by the justification of actions for mitigation thereof. All risks shall be documented and actions for their mitigation shall be planned, executed and monitored throughout all subsequent life cycle stages. For that, at the design stage the safety

program of MASS operation shall be developed and submitted to the Register in addition to the design documentation and risk analysis.

#### **8.4.3 Manufacture and commissioning.**

At this stage a test program shall be developed containing a description of the procedure for testing MASS functional capabilities prior to its operation.

The program shall contain all required verifications and tests (provisional tests, mooring trials, sea trials, etc.) with indication of the area of their conducting. The purpose of each type of verification shall be defined and the scope and responsibilities of the involved parties shall be specified. Test medium, its capabilities and limitations shall be defined for each test. The program shall take into account that the systems having already obtained the RS type approval, may still require verification in real operational environment. For successful completion of test program it is essential that the autonomous infrastructure is tested for extreme load and its actual performance is verified for compliance with the required reliability and safety parameters.

Individual programs and procedures shall be developed for particular verifications and tests. The procedures shall contain detailed information on the system intended for testing including system type, hardware identification and software versions. Any simulators used in the test setup shall also be described and recorded with type and version. For redundant systems, the tests within verification of each system shall be provided. Therewith, the conclusions and recommendations made earlier at risk assessment shall be verified, in particular, the requirements for fail safe response, the necessity of redundancy or, vice versa, absence of such necessity. The tests shall cover all specified technical system configurations. The tests for acknowledgment of redundancy necessity and tests for fault tolerance shall be performed under as realistic conditions as practicable, e.g. by use of emulators and simulators.

During the appraisals, verifications and tests, all results shall be recorded along with any discrepancies towards the expected results. Protocols and reports on appraisals, verifications and tests shall be submitted to the Register. MASS test program report shall be prepared and submitted to the Register. This report shall provide evidence that all earlier planned actions for risk mitigation (safety program) have been implemented, and MASS together with the shore-based and maritime infrastructure ensures a safety level equivalent to or better than that of a conventional ship.

#### **8.4.4 Operation.**

Data on MASS functioning shall be collected, analyzed and submitted to the Register as agreed with the shipowner and operator of the ship. The data shall include hours of operation, detected failures, entering and leaving MRCs, and other operational data used for condition monitoring of systems and ship in general. The particular data list and access procedure thereto shall be determined for each MASS in coordination with relevant interested parties. The designer responsibility is to provide the possibility of collection, storing, processing and release of information to RS.

Any MASS in service shall be subject to survey for compliance with the applicable RS rules and regulations.

For MASS, the survey scheme shall include verification of technical means of the supporting infrastructure (remote control centre, means of movement delimiting marking, communication means, etc.).

The designer shall develop the procedure of software maintenance and upgrade. The procedure shall contain at least the following information:

- testing methodology for a new software version including simulator based testing;
- instructions for a new software version installation;
- instructions for rollback to previous version.

The designer shall ensure storage of the released software versions with the possibility of rollback to previous version. Prior to making changes, RS shall be notified of the necessity of any changes to the MASS systems by sending to RS the notification of the changes to the design and program documentation, as well as description of modernization process.

## 8.5 RISK ASSESSMENT OF APPLICATION OF SYSTEMS FOR MASS

### 8.5.1 Concept development.

Development of the concept of system for MASS is a formulation of an idea, which shall reflect the requirements of terms of reference, main and the most general proposals for their implementation, comparison of system architecture options, including the modelling results. The results of concept development shall be drawn up as technical background and submitted to RS by the designer independently or as a part of the concept of MASS operation.

For the systems to be applied for MASS, the risk assessment shall be performed by the designer at the stage of development. For complicated systems, breakdown into individual subsystems or functions is permitted. Risk assessment shall be performed for each of them. The assessment results shall be indicated in the technical background to be submitted to RS.

Risk assessment of the system application consists of the following three steps.

#### 8.5.1.1 Qualitative assessment of system failure probability.

Assessment of failure probability shall be defined based on technical complexity level of the system and the complexity level of the applicable data analysis. Qualitative descriptions of these levels are given in Tables [8.5.1.1-1](#) and [8.5.1.1-2](#) accordingly.

Table 8.5.1.1-1

**System complexity levels (SCL)**

SCL	System complexity
0	Simple system (Isolated system)
1	Simple system (Partial integration with other systems, not every system is connected to the network)
2	Complex network (Network connection and full integration (on board only))
3	Multi-agent communication (Remote and shore access, onboard function is based on ground support, continuous and reliable ship-to-shore communication)

Table 8.5.1.1-2

**Data analysis complexity levels (DACL)**

DACL	Data analysis complexity
0	Basic (Parameter monitoring, statistics and trends)
1	Physical simulators and conventional condition monitoring methods with analytical support
2	Data models (Machine learning models and artificial intelligence models with/without physical model)

As a result, the failure probability levels shall be determined by a sum of SCL + DACL. Correspondence of this sum with three failure probability levels — low, moderate and high, with system examples is given in [Table 8.5.1.1-3](#).

Table 8.5.1.1-3

**Probability levels of failure occurrence with system examples**

Failure probability level	SCL + DACL	System example
L (Low)	0, 1	Check of bending moment and hull slamming by means of strain-gauge transducers and accelerometers
M (Moderate)	2, 3	Check of temperature and pressure in the engine cylinder with integral temperature and pressure detectors
H (High)	4, 5	Voyage optimization (periodical use of weather forecast, performance monitoring of relevant onboard systems, data driven fuel consumption model)

**8.5.1.2 Qualitative assessment of system failure effects.**

Possible effects of the system failure shall be assessed based on the identified levels: participation of the system in decision-making and implementation thereof; integration in the onboard system; severity categories of the system failure effects.

The appropriate levels are given in [Tables 8.5.1.2-1 – 8.5.1.2-3](#).

Table 8.5.1.2-1

**Levels of participation in decision-making and implementation thereof (LDM)**

LDM	Data processing	Decision making	Action implementation
0	System and human	Human	Human
1	System and human	Human with system support	Human
2	System	System under human supervision	System under human supervision
3	System	System	System

Table 8.5.1.2-2

**Levels of integration in the onboard system (LIS)**

LIS	Level of integration
1	Detached (separated from other systems or passively connected only for data collection in case of integration with onboard systems. No potential effect on safety and system performance of the integrated system)
2	Partial (one-way transmission to pull-model system. May result in performance reduction, but have no effect on the safety of the integrated system)
3	Fully integrated (two-way communications with onboard systems with the possibility of order transmission to systems for on-line adjustment or optimization. Possible effect on the safety of the integrated system application)

Table 8.5.1.2-3

**Severity categories of the system failure effects (SCSF)**

Category	Failure effect	Examples of the system functioning
1	Failure that may result in reduction of system functioning quality, but pose no hazard to the environment, ship and people's health	Monitoring function for information/administrative tasks
2	Failure that may cause delay of the task executing, reduction of readiness and efficiency of ship application, but pose no hazard to the environment, ship and people's health	Functions of alarm and monitoring Control functions required for ship maintenance in normal operating and manned conditions
3	Failure that may quickly and highly likely result in significant harm for the ship and/or environment, breaking of the performing task, but create a negligible hazard to health or life of people	Control functions for holding of speed and travel direction
4	Failure that may quickly and highly likely result in significant harm for the ship and/or environment, loss of life or heavy injuries of people, breaking of the performed task	Ship safety functions (navigational, fire explosion safety)

Finally, possible effects of the system failure are determined by LDM + LIS + SCSF and are characterized by four levels ([refer to Table 8.5.1.2-4](#)).

Table 8.5.1.2-4

**Severity categories of the system failure effects with system examples**

Effect severity level	LDM + LIS + SCSF	System example
L (Low)	0, 1, 2	Monitoring of ship framing condition (control panel with strain-gauge transducers)
M (Moderate)	3, 4, 5	Consideration of actual weather along the route (recommendations for the route and passive data collection from the relevant systems)
H (High)	6, 7, 8	Control of power and optimization (automatic adjustment of engine performance parameters with specifying the range for better output)
VH (Very High)	9, 10	Remote control of the ship or control of fully automated ship

**8.5.1.3 Assessment of risk level associated with system application.**

Four risk levels of system application: L — low (green), M — moderate (yellow), H — high (orange) and VH — very high (red) shall be specified based on the qualitative levels of failure probability and effect severity of the system failure by means of risk matrix given in [Table 8.5.1.3](#).

Table 8.5.1.3

**Risk level matrix of system application**

Effect severity level	Failure probability level		
	L	M	H
L	L	L	M
M	M	M	H
H	M	H	H
VH	H	VH	VH

Risk analysis results including the description of all steps, initial data and decisions made, and application concept shall be submitted by the designer to the Register for review as a part of the concept and subject to updating during the risk assessment at the next stages of the system life cycle.

**8.5.2 Design.**

At the design stage, a quantitative or qualitative analysis of the system failure criticality shall be carried out depending on the risk level of the system:

VH — in-depth quantitative criticality analysis is mandatory;

H — quantitative criticality analysis is advisable;

M — only qualitative analysis may apply;

L — no analysis is required.

Criticality analysis is aimed at specifying the failure criteria of the system or its components, that severity effects within this analysis are considered as inadmissible and require special measure to be taken for reduction of the probability of such failure and/or possible damage related to its occurrence. At this stage, the designer shall substantiate and propose the risk criteria to define its acceptability. Resulting from comparison of risk level and risk criteria, the decisions on risk acceptance or risk aversion during further development shall be substantiated for each system. It is recommended to perform the criticality analysis using FMECA method — failure mode and effect critical analysis (IEC 60812:2018, GOST R 51901.12-2007).

It is recommended to perform quantitative risk analysis of the system using one or several standard methods (ISO/IEC 31010:2019, GOST R 51901.1-2002), e.g. FTA — failure tree analysis (IEC 61025:2006, GOST R 51901.13-2005), ETA — event tree analysis (IEC 62502:2010). Software products applied for risk quantitative assessment shall be agreed with RS and/or have certificates of approval issued by the appropriate regulatory bodies and governmental institutions. It is also recommended to combine risk assessment with reliability assessment of the system based on the parameters specified in the terms of reference, e.g. failure-free, reparability, and durability. In this case, a reliability program should be used if its development is provided for by the terms of reference or the methodology of development. Calculations for different options of system architecture shall clearly demonstrate the effectiveness of the proposed actions to mitigate the system's risk.

Finally, qualitative and/quantitative risk analysis of the system shall demonstrate how the designed structure of the system supports the required functionality and ensures safety of people on board, ship and environment equivalent (as safe or more safe) to the existing conventional solutions. System risk analysis as part of the design documentation shall be submitted to the Register.

### **8.5.3 Manufacture and commissioning.**

At this stage, the programs and test procedures and all types of tests (provisional tests, acceptance tests, mooring trials, etc.) shall be developed and agreed with RS. Systems previously referred to systems of high and very high risk level, as well as systems responsible for essential MASS functions shall be verified using simulators.

Simulator based testing shall provide objective evidence of suitable functionality (during normal, abnormal and degraded condition) of the specified target control system according to functional and safety requirements defined in these Regulations or originating from the previously performed risk analysis. Such testing shall be definitely performed for the functionality where it is required to verify that the function or whole system will work satisfactorily in a large range of operational scenarios including scenarios of occurrence and sequence of hazardous events. Examples of such functions are:

- voyage and route planning;
- continuous monitoring and situational awareness;
- detection, tracking, classification of ships, navigational objects and dangers;
- determine the distance to the closest point of approach and time to the closest point of approach for ships and other navigational objects;
- determine the hazardous situation, e.g.: crossing of prohibited areas, dense and congested traffic, coastal navigation, weather conditions deterioration, pilot required;
- avoidance of collision or grounding;
- weather routing.

For redundant systems, the tests within verification of each system shall be provided. Therewith, the conclusions and recommendations made earlier at risk assessment shall be verified, in particular, the requirements for fail safe response, necessity of redundancy, absence of such necessity. The tests shall cover all specified technical system configurations. The tests for acknowledgment of redundancy necessity and tests for fault tolerance shall be performed under as realistic conditions as practicable, e.g. by use of emulators of the interfacing systems and simulators of conditions.

Integrated systems with high level of complexity shall be subject to additional verification for the availability of new emergent properties and compliance with the requirements of the functions being the result of integration. Integration of such systems is normally done during commissioning and testing close to project completion. In some cases, this testing may be impossible due to the risk of damage to the system. Therefore, integration testing shall be carefully planned and alternatives, such as simulation, shall also be considered where appropriate. Integrated testing can be done in a simulator environment using models and emulated or hardwired control systems. Scope of testing shall also include critical failure

modes (e.g. short circuit) that are challenging/impossible to perform on real equipment (hardware).

Software tests shall be performed at the earliest stage possible. The objective of the software tests is to ensure that the control system SW is ready and verified as extensively as possible before the commissioning and sea trial period starts. The developer is responsible for logging the versions of uploaded test target SW. The target SW shall not be changed during a test activity unless it is imperative to continue the test activity. The developer is responsible for documentation of changes to SW. Software versions numbers of the emulators and simulators used during testing shall also be documented.

After installation of the system on board the ship, the system shall be subject to mandatory integration testing and network testing towards other systems and components.

During the verifications and tests, all results shall be recorded along with any discrepancies with the expected results. Protocols and reports on verifications and tests shall be submitted to the Register. A report on risk assessment based on the test results shall be prepared and submitted to the Register. This report shall also provide evidence that all earlier planned actions for risk mitigation and system reliability (reliability program) have been implemented, and the system may be applied for MASS. Therewith, a safety level equivalent to or better than that of a conventional ship will be ensured.

#### **8.5.4 Operation.**

Prior to making changes, RS shall be notified of the necessity of any changes to the MASS systems by sending to RS the notification of the changes to the design and program documentation, as well as description of modernization process. The designer shall develop the procedure of software maintenance and upgrade. The procedure shall contain at least the following information:

- testing methodology of a new software version including simulator based testing;
- instructions on how to install the new software version;
- instructions on how to restore the previous software version.

The designer shall ensure storage of the previous software versions with the possibility to rollback to the previous versions. Systems which include machine-learning, artificial intelligence mechanisms can be trained with cumulative data sets obtained from operation, but shall not use the results of training prior to new version deployment. In this case, the system-capabilities in operation shall be updated only at defined intervals after the successful verification of upgrade.

## 9 REQUIREMENTS FOR MASS AND ITS SYSTEMS

### 9.1 SITUATIONAL AWARENESS SYSTEM

#### 9.1.1 Tasks.

**9.1.1.1** Situational awareness system shall receive and process the information on the environmental conditions and MASS condition for making decisions on the ship and ship systems control during:

- movement in the open sea;
- movement in restricted waters, straits;
- anchorage/weighing and at anchorage;
- port entering/departing from a port;
- mooring operations, movement in port waters;
- during cargo handling operations.

**9.1.1.2** Situational awareness system shall consolidate all available sources of information located on board the ship and off the ship (operator-controlled or automated) using on-line and history information.

**9.1.1.3** Depending on the automation level of the ship, situational awareness system is capable of addressing the task of generating command for control response. In this case, it shall be called as the system of situational awareness and decision-making related to ship control.

**9.1.1.4** Situational awareness system shall perform, inter alia, the following tasks:

- ensure MASS operation under all operational conditions provided by the concept of operation thereof ([refer to Appendix A](#));
- ensure timeliness and authenticity of situational information required for correct and timely decision-making related to ship control;
- act in a predictable manner taking into account the safety and reliability level, specified operational requirements and safety requirements for the voyage performed.

#### 9.1.2 Requirements.

**9.1.2.1** Situational awareness system shall response to changing of the environmental parameters and ship conditions within the limits provided by the concept of MASS operation specified in [Appendix A](#) and perform automatic transition to the minimum risk condition in case of overrunning the set parameters and ensure return to normal condition when the operation conditions are re-established.

**9.1.2.2** Situational awareness system shall receive and process at least the following information:

short-term and long-term weather forecasts along the route, including: wind speed and direction, wave height and period (including ripples), current speed and direction, ice conditions (where applicable), data of tropical cyclone or typhoon (maximum wind speed, gust speed, storm wind radius, etc.), data of extratropical cyclone (pressure in the cyclone centre, motion pattern and speed, cold/warm front, etc.), warning of high pressure in the cold front area (a great drop in temperature and storm warning);

actual meteorological information (on board the ship) in real time, including: wind speed and direction, currents, waves (including their period), temperature, humidity, pressure, visibility;

tidal changes and ecological situation in the voyage area (based on messages);

electronic charts and their updating;

keel clearance of the ship;

MASS position, speed and routing considering heel and trim angles, draught, rolling and pitching motions;

parameters of ship systems ensuring MASS movement and manoeuvring;

hull and cargo condition;

MASS communication and alarm systems;

information on surrounding ships;

radar, video, acoustic data around the ship collected and processed in real time (including lights and shapes, sound signals according to the International Regulations for Preventing Collisions at Sea (COLREG-72);

position, size and distance to fixed unidentified marine objects above the water surface.

**9.1.2.3** Information acquired and processed by the situational awareness system at any operational scenario shall be transmitted to the navigation control system in real time and, if necessary, to RCC.

**9.1.2.4** Equipment and components of situational awareness system shall be adequately safe for minimizing the failure probability. Equipment of situational awareness system shall be completed and configured to avoid its perceptive capability or, in case of a single failure of equipment, this capability shall be restored in the shortest time possible for the further MASS operation.

**9.1.2.5** Equipment of situational awareness system shall have self-diagnostic and alarm functions to ensure continuous monitoring during the normal operation of equipment. In case of equipment failure detection, the possibility of its recording and transmission of alarm message and failure message to navigation control system and RCC shall be provided.

**9.1.2.6** When the redundancy function is provided for the equipment of situational awareness system, its switching device shall have self-diagnostic and alarm functions.

**9.1.2.7** In case of failure of MASS situational awareness system leading to inability to perceive the situation during the navigation, the navigation control system shall perform the assessment of necessity of transition to the minimum risk condition, and the relevant alarm information shall be transmitted to RCC or other services ensuring safety of navigation.

**9.1.2.8** MASS situational awareness system shall receive information from at least the following equipment installed on board:

at least two ship radars with automatic radar plotting aids (ARPA) and function of detection of low-size floating targets (4 radars are recommended: 2 X-band and 2 S-band);

at least two sets of ship automatic identification system (AIS);

at least three different ship positioning systems (with satellite time synchronization function) equipment;

systems of server storage and processing of navigation data with redundancy functions, with the ability of connection of electronic chart display and information systems to them;

at least two electronic chart display and information system (ECDIS);

at least two gyrocompasses;

at least two echo sounders;

at least two logs (water speed, bottom speed);

inertia navigation system;

infrared (IR) camera of all-round vision system capable of operating in adverse meteorological conditions;

TV cameras for all-round vision system capable for operating in adverse meteorological conditions and different all-day lighting intensity conditions;

at least two electronic inclinometers;

at least two wind gauges indicating wind direction and speed;

at least two visibility detectors;

equipment for object detection at close distance to the ship side for highly precise mooring;

system for external acoustic signal receiving and recording;

systems of receiving navigational, meteorological information and information for safe navigation through the ship route based on NAVTEX, NAVDAT, VHF (including tidal changes and environmental situation in the port);

systems of short-term and long-term forecasts of weather conditions, current meteorological information in real time;

systems of ship system parameters ensuring MASS movement and controllability, conditions of hull and cargo, MASS communications and alarm systems.

**9.1.2.9** Conventional systems being the data resources of MASS situational awareness system shall meet the applicable RS requirements specified in the Rules for the Equipment of Sea-Going Ships.

**9.1.2.10** Range of measurement, accuracy and time delay of equipment for object detection at close distance shall meet the requirements for rapid decision-making during mooring operations and movement in port waters.

**9.1.2.11** All equipment of the situational awareness system shall collect real-time data in accordance with the requirement for timely decision making.

**9.1.2.12** MASS situational awareness system shall be fitted with sufficient number of sensors and systems for defining, displaying and registration of current time, position relative to the Earth, orientation and rate of changing of parameters sufficient for ensuring safety of navigation.

**9.1.2.13** Ship positioning systems shall ensure the absolute precision of positioning finding with 95 % accuracy:

during navigation in the open sea — 100 m;

automatic collision avoidance manoeuvre and navigation at approaching to ports and in coastal waters — 10 m;

manoeuvring in the port — 1 m;

automatic mooring — 0,1 m;

**9.1.2.14** Operating parameters of inertia navigation systems of MASS positioning shall be sufficient for safe navigation in ocean spaces for a time required for performance restoration of radio navigational systems or any other measures for MASS safe navigation.

**9.1.2.15** Inertia navigational system shall ensure continuous generating information related to MASS course, coordinates, travelling speed and angular orientation.

**9.1.2.16** To ensure redundancy of information on MASS position indication, radio navigation land-based systems may apply.

**9.1.2.17** Information on current weather conditions collected by situational awareness system shall be evaluated and compared with weather forecasts received from ashore centre and other ships. Integrated data shall form reliable information on the actual and prospective weather conditions through the ship's route. The route shall be optimized considering the weather conditions, given parameters and stability and manoeuvring conditions.

**9.1.2.18** Situational awareness system may include situation clarification system based on radio positioning ensuring sufficient level of spatial resolution for radio vision mode implementation.

### **9.1.3 Verification methods.**

**9.1.3.1** For survey, the documents according to [2.1.2.2](#) shall be submitted to the Register.

**9.1.3.2** Survey during the factory, mooring and sea trials shall be carried out in accordance with the approved program and procedure of testing in full extent and shall be based on the comprehensive verification of MASS situational awareness system using methods specified in [Appendix B](#).

## **9.2 MEANS OF RADIO COMMUNICATION AND DATA EXCHANGE**

### **9.2.1 Tasks.**

**9.2.1.1** Composition and functionality of means of radio communication and data exchange shall provide radio communication and data exchange with other ships, RCC, shore-based services, VTS, search and rescue centre, the shipowner and operator, both directly and via RCC throughout the voyage with the quality ensuring its safety and efficiency.

**9.2.1.2** In the autonomous mode, means of radio communication and data exchange shall perform the following tasks:

- transmission of data (if necessary or on request) to RCC related to the environmental conditions;
- transmission of data from other ships (where applicable);
- mutual exchange of information flow for correcting the ship's route in general;
- mutual exchange of information flow for correcting the movement parameters on certain sections of the route;
- transmission of alarm messages when the control system registered that the ship safety failed to be maintained at the proper level;
- receipt from RCC of instructions for ship systems operation in case of abnormal situations;
- transmission of orders for activation and deactivation of autonomous control mode (transfer to remote control mode);
- transmission of information for condition control of technical means, cargo and environmental situation;
- receipt of charts and corrections of electronic chart display and information system;
- transmission of data on parameters of movement, power plant condition, control system, communication to other ships;
- transmission of data stored on the autonomous ship server to RCC.

**9.2.1.3** In the remote control mode, the means of radio communication and data exchange shall perform the following tasks:

- transmission of real-time information on the environmental conditions to RCC;
- transmission of data to other ships;
- mutual exchange of information flows for guaranteed delivery of control orders to the ship's movement and manoeuvring control systems on the basis of data on navigation situation and MASS movement based on optical, radar and satellite observations;
- mutual exchange of information flows for guaranteed delivery of remote control orders to shipboard equipment and deck machinery, main and auxiliary power plant, electrical power plant according to the data on condition monitoring of the ship technical means;
- receipt and transmission of remote control orders for changing the MASS control mode;
- transmission of information on condition control of technical means, cargo and environmental situation;
- receipt of charts and corrections for Electronic Chart Display and Information System;
- transmission of data stored on the MASS server to RCC.

**9.2.1.4** For ensuring safety of navigation, MASS radio communication and data exchange systems shall be capable of recognition and establishing voice communication, respond to interrogation from other ships or ashore services, as well as carry out the reception and transmission of:

- distress signals in "ship-to-shore" and "ship-to-ship" directions;
- search and rescue coordination messages;
- signal for position-finding;
- information for the safety at sea.

**9.2.1.5** MASS radio communication and data exchange systems shall ensure the continuity of data exchange during the ship passage between conditional navigation areas by automatic selection of communications channel based on the conditions and type of the information transmitted. Herewith, they shall be able to provide maritime services in the context of electronic navigation (e-navigation). Examples of communication technologies, both existing (E) and prospective (P) for the selection of data transmission channels depending on the area of navigation, are given in Tables [9.2.1.5-1](#) and [9.2.1.5-2](#). Technologies preferable for application in the interests of e-navigation according to the Maritime Radio Communications Plan of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) are highlighted in yellow in Tables [9.2.1.5-1](#) and [9.2.1.5-2](#).

Table 9.2.1.5-1

**Existing (E) and prospective (P) communication technologies for ship-to-shore communication**

Areas of e-navigation	GMDSS areas	Wi-Fi	WiMax	GPRS CDMA 3G,4G LTE	AIS	VDE	Digit. VHF voice data	Radar with data transmission	Geostationary satellite communication	MEO/LEO commercial satellite communication	MF/HF communication (incl. NAVTEX, DGNSS)	HF digital services	MF/HF IBM services (incl. NAVDAT)
1 – Port	A1	P	P	E	E	P	P		E	E	E		P
2 – Approaches to the port	A1		P	E	E	P	P	P	E	E	E		P
3A – Coastal area with mobile communications (~5 miles)	A1		P	E	E	P	P	P	E	E	E	E	P
3B – Coastal area with VHF communications (~25 miles)	A1		P		E	P	P	P	E	E	E	E	P
4 – Coastal area (~100 miles)	A2								E	E	E	E	P
5 – Open sea	A3								E	E	E	E	P
6 – Polar area	A4									E	E	E	P

Table 9.2.1.5-2

**Existing (E) and prospective (P) communication technologies for ship-to-ship communication**

Areas of e-navigation	GMDSS areas	Wi-Fi	WiMax	GPRS CDMA 3G,4G LTE	AIS	VDE	Digit. VHF voice data	Radar with data transmission	Geostationary satellite communication	MEO/LEO commercial satellite communication	MF/HF communication (incl. NAVTEX, DGNSS)	HF digital services	MF/HF IBM services (incl. NAVDAT)
1 – Port	A1	P	P	E	E	P	P	P	E	E	E		P
2 – Approaches to the port	A1		P	E	E	P	P	P	E	E	E		P
3A – Coastal area with mobile communications (~5 miles)	A1			E	E	P	P	P	E	E	E	E	P
3B – Coastal area with VHF communications (~25 miles)	A1				E	P	P	P	E	E	E	E	P
4 – Coastal area (~100 miles)	A2				E	P	P	P	E	E	E	E	P
5 – Open sea	A3				E	P	P	P	E	E	E	E	P
6 – Polar area	A4				E	P	P	P		E	E	E	P

**9.2.2 Requirements.**

**9.2.2.1** Remotely controlled ships shall have at least two separate and independent radio communication means, each using different technologies.

**9.2.2.2** Various frequency ranges shall be used for MASS control for minimization of signal distortion due to atmospheric forcing.

**9.2.2.3** Radio communication equipment shall be designed for operating with different communication quality levels and shall be resistant to degradation of signal quality level.

**9.2.2.4** Any interference to communication channel shall not result in occurrence of unauthorized actions, in case of appeared ambiguities the possibility of repeated request or backing-up shall be provided.

**9.2.2.5** Radio communication means shall be resistant to malfunction and capable to automatic reconfiguration in case of emergency situations, network degradation or outage of equipment in compliance with safety requirements.

**9.2.2.6** At each sea route stage, voice communications and data exchange shall be performed by means of at least two devices with pass band and speed compliant with autonomous or remote control, as well as the possibility of distress signal transmission from ship to shore shall be provided.

**9.2.2.7** Capacity and information delay in the communication network shall be sufficient for traffic and shall correspond to the extent of data transmitted by autonomous systems.

**9.2.2.8** Radio communication equipment shall be design considering detached reception and transmission of data via different communication channels.

**9.2.2.9** In case insufficient capacity of communication channel between MASS and RCC, types of data shall be transmitted in the order ensuring safety of navigation (top priority in the first instance):

- .1 emergency control;
- .2 remote control orders including data for basic ship functions;
- .3 situational awareness data for remote control of key ship functions;
- .4 monitoring data;
- .5 service data.

**9.2.2.10** Communication equipment shall meet the applicable requirements for operational parameters accepted by IMO. VSAT station shall meet the requirements for navigational area conditions and comply with the recognized international or national standards. Satellite network availability shall be at least 99,9 % (equivalent to 8,8 h of total downtime per year).

**9.2.2.11** Direct visibility communication system shall be based on AIS, digital systems with at least two kilometer range capacity.

**9.2.2.12** Wireless data transmission shall use a recognized international wireless communication system that includes the following functions:

- .1 message integrity: prevention, detection, diagnostics and rectification of errors for the received message not to be damaged or changed as compared with the transmitted one;
- .2 configuration and authentication of the device: enable connection of only those devices that included in the system draft;
- .3 message encryption: protection of confidentiality and/or criticality of data content;
- .4 safety management: protection of network assets, prevention of unauthorized access to network assets.

**9.2.2.13** Network appliances shall automatically start with power supply on and restart after power loss.

**9.2.2.14** For communication networks, in order to maintain the correct level of accessibility in the event of a failure, redundancy shall be provided for the transmission of emergency data. In case of failure, automatic transition between the main and reserve systems with automatic alarm shall be provided.

**9.2.2.15** Radio communication equipment shall ensure continuous twenty-four-hour functioning throughout the voyage.

**9.2.2.16** Information on condition of MASS radio communication equipment transmitted to RCC.

**9.2.2.17** Radio communication equipment shall be supplied from the main and emergency source of electrical power. Communication equipment shall be fitted with an individual backup power source enabling to supply power for 6 h.

**9.2.2.18** Radio communication equipment shall be arranged such that its functioning or technical condition have no adverse effect on normal operation or result in outage of radio navigational equipment or other equipment. Radio equipment shall be arranged in compliance with the requirements of its technical documentation and be available for survey, maintenance and repair.

**9.2.2.19** Where control station is available on board the ship, communication equipment shall enable voice communication between RCC and control station. At the same time, it is capable for communicating between control station and adjacent shore services, VTS centre.

**9.2.2.20** During design and operation, interaction with other MASS and ordinary ships shall be taken into consideration. Communication channels for MASS control and monitoring shall not cause interference to other ships communication.

**9.2.2.21** Electromagnetic compatibility of equipment shall comply with the requirements of regulation V/17 of the international convention SOLAS-74, as amended.

**9.2.2.22** Communication equipment shall meet the requirements for operational parameters accepted by IMO.

**9.2.2.23** Communication equipment shall be subject to mandatory RS approval.

### **9.2.3 Verification methods.**

**9.2.3.1** For survey, the documents according to [2.1.2.3](#) shall be submitted to the Register.

**9.2.3.2** Survey during factory, mooring and sea trials shall be carried out in accordance with the approved test program and procedure.

## **9.3 MEANS OF NAVIGATION AND MANOEUVRING**

### **9.3.1 Tasks.**

**9.3.1.1** Ensure safe MASS navigation during all operational scenarios, including:  
autonomous control;  
remote control from RCC;  
human control using ship means at entering the port/departing from the port and mooring, accidents at sea.

**9.3.1.2** Ensure safe MASS mooring, as well as conducting anchor operations and positioning.

### **9.3.2 Requirements.**

**9.3.2.1** Control system of means of navigation and manoeuvring shall perform the following functions:

plotting the ship's route in accordance with the voyage assignment (taking into account the ship's draught and cargo condition), capabilities of autonomous and remote control of the ship with observance of regulations concerning safety of navigation and risk assessment;

performing complex analysis and making decision on navigation and manoeuvring using the information on target situation, own ship, power plant condition, control system of movement and manoeuvring, mooring system, anchor arrangements in accordance with voyage assignment;

at en-route movement, perform manoeuvring to prevent approaching other ships in compliance with COLREG-72;

receipt of operating instructions for ship systems from RCC;

performing entering the port and departing from the port, mooring operations and ship positioning during cargo handling operations by means of ship means (where available).

**9.3.2.2** As a rule, navigation control system includes autonomous mode, modes of control of the ship from RCC and from navigation bridge (if any) and performs switching in accordance with the following principles:

MASS may be so designed that mooring operations and movement in port waters, as well as entrance to the port and departing from the port are performed autonomously or by remote control or using both;

MASS shall be capable of autonomous navigating at sea. Where necessary, RCC may assume control of the ship. During the remote operation, when the communication does not meet the requirements, the ship shall automatically switch to autonomous navigation;

when MASS is capable of navigation control, it may assume control subject to the approval of RCC. On completion of the approved control cycle, the control function shall return to RCC.

**9.3.2.3** For safe control and observation of COLREG-72 requirements, the actual situation in MASS area of navigation shall be continuously monitored.

**9.3.2.4** All data related to traffic shall be consolidated, analyzed and possible event scenarios shall be calculated for proper decision-making related to target divergence.

**9.3.2.5** Navigation control system shall include functions of route planning and optimization, control of the course and speed of the ship, prevention of navigation hazards, automatic divergence with identified hazardous floating targets, control of anchorage and mooring, position-keeping.

**9.3.2.6** Every MASS shall be fitted with at least two sets of navigation control system, each of them may be in a hot standby condition. Navigation control system shall be designed and constructed so that it is capable of performing autonomous navigation and switching to remote control from RCC in case of failure.

**9.3.2.7** Navigation control system shall be connected to situational awareness system, communication and alarm system, SPP, anchor, mooring and other arrangements by means of redundant network.

**9.3.2.8** Standby system and equipment responsible for navigation and manoeuvring shall be provided with independent interfaces for control implementation.

**9.3.2.9** In case of failure of connected executive subsystem or information source, the navigation control system shall be capable of analyzing the situation to determine the control strategy.

**9.3.2.10** Navigation control system shall be capable of self-diagnostics and receiving the information on failures of connected systems.

**9.3.2.11** Automatic collision avoidance system forming part of navigation control system shall perform the analysis and calculations for collision avoidance based on the information on particular situation.

**9.3.2.12** Navigation control system shall be able to receive the optimum route speed from RCC and ensure autonomous navigation. The possibility of automatic reception of weather information for autonomous plotting and route optimization on board the MASS shall also be implemented.

**9.3.2.13** Navigation control system shall be able to completely monitor the propulsion, steering and auxiliary systems in all possible modes of their operation. The RCC personnel shall control the parameters and, if necessary, intervene in the MASS technological processes.

**9.3.2.14** Automation system shall be arranged such that the responsible personnel is given a notification or warning of the situation in due time before it carries out an order. It shall be possible to manually intervene in the control of propulsion units and thrusters from RCC.

**9.3.2.15** Navigation control system in the calculations and during manoeuvre performance shall:

take into account the effects of MASS own weight and size characteristics, hull thrust force, trim and heel angles, speed, under-keel clearance and stopping distances;

monitor the ship's course, rudder angle, propeller revolutions, propeller pitch (if necessary), thrust operational mode (if necessary);

monitor and take into account the effects of waves, wind and current on the ship.

**9.3.2.16** If it is necessary to perform control from the ship's board during the pilotage, entering the port or departing from the port, as well as during mooring operations and movement in port waters, MASS shall be provided with simplified navigation system located on the navigation bridge or a manual control mode forming part of autonomous navigation system shall be implemented.

**9.3.2.17** Information on the MASS condition, ship machinery and movement parameters shall be displayed on the simplified navigation system, including information on the course, rudder angle, engine operation modes, navigational chart, radar data, etc.

**9.3.2.18** The possibility of manual control of SPP and manoeuvring system with simplified navigation system shall be provided. The possibility of such control may be provided only if confirmed by RCC or by other reliable means.

**9.3.2.19** Navigation bridge visibility shall comply with the requirements of regulation V/22 of SOLAS-74 or be provided with equivalent means.

**9.3.2.20** Navigation bridge shall be equipped with VHF apparatus for voice communications with other ships. Navigation bridge shall be provided with relevant communication terminals to ensure voice communication with RCC.

**9.3.2.21** Navigation bridge shall be provided with necessary personal life-saving appliances, including lifejackets, lifebuoys, etc.

**9.3.2.22** When the ship is equipped with simplified navigation system, the appropriate means of crew embarkation and disembarkation shall be provided which shall be capable of being remotely controlled from RCC or directly controlled by the simplified navigation system.

**9.3.2.23** MASS shall be fitted with backup facilities for storing the information on the ship condition and operational parameters, its equipment and systems. The capacity of each storage facility shall at least provide the possibility of keeping the data received during one voyage, but not less than 30 days. The possibility of transmitting the stored data to RCC shall be provided.

**9.3.2.24** Communications between the navigation control system and the RCC operator shall be continuously maintained.

**9.3.2.25** When the navigation control system is used as a decision support system for the RCC operator (navigator), the following shall be performed:

all actions taken by the operator in the control of propulsion and steering equipment including handling of abnormal situations shall be verified by a decision support system;

decision support system shall issue warnings in case the operator chooses actions which may lead to undesirable effects.

### **9.3.3 Verification methods.**

**9.3.3.1** For survey, the documents according to [2.1.2.4](#), as well as protocols and reports of all types of tests shall be submitted to the Register.

**9.3.3.2** Survey during shore-based tests and tests on board the MASS shall be carried out during and in accordance with the approved program and procedure for acceptance tests in full extent and shall be based on the comprehensive verification of MASS navigation and manoeuvring systems using methods specified in [Appendix B](#).

## **9.4 SHIP POWER PLANT (SPP)**

**9.4.1** The provisions of this Chapter shall apply to SPP:

automatic power supply system;

automation and control systems.

**9.4.2** Level of safety, reliability and automation degree of ship power plant shall be at least equal to the level of safety, reliability and automation degree of the ship with crew.

**9.4.3** Unless otherwise specified in this Chapter, the requirements of the Rules for the Classification and Construction of Sea-Going Ships should be followed.

**9.4.4** The following possibility of SPP control shall be provided:

from local control stations (where applicable);

ship remote control station;

by means of ship's artificial intelligence system;

external remote control centre.

**9.4.5** Ship power plant shall be fitted with the necessary means enabling to:  
perform autonomous operation in compliance with MASS manoeuvring needs, thereby ensuring easy control and operation, as well as tests and checks, maintenance and repair of machinery;

ensure transmission of operating parameters of essential systems and equipment to navigation system and RCC;

specify control authority for different operational modes of essential systems and equipment.

**9.4.6 Automatic power supply system.**

**9.4.6.1** Tasks.

**9.4.6.1.1** Ensuring continuous and safe power supply of MASS systems for safe navigation.

**9.4.6.1.2** Automatic power supply control system is a control system that can automatically receive information related to power sources, perform data conversion and storage, real-time monitoring and safety assessment, analyze and detect deviations/failures, generate control orders and send them to the appropriate machinery for automatic control ensuring safe power supply to MASS.

**9.4.6.1.3** Unless otherwise specified in this Chapter, the requirements of the Rules for the Classification and Construction of Sea-Going Ships should be followed.

**9.4.6.2** Requirements.

**9.4.6.2.1** Automatic power supply system shall automatically provide continuous and safe power supply to the ship's equipment which is necessary for MASS operation under the operating conditions provided for in the concept of MASS operation ([refer to Appendix A](#)).

**9.4.6.2.2** Automatic power supply system shall have functions of autonomous and remote control from RCC, therewith:

parameters of the equipment of automatic power supply system supporting safety of navigation and the most essential MASS systems specified in [Appendix A](#) shall be monitored from RCC. Frequency of monitoring performed by RCC shall be determined in accordance with the level of essentiality of the equipment concern;

remote control has a higher priority as compared to the priority of autonomous control.

**9.4.6.2.3** Automatic power supply system shall include, with necessary redundancy, the following equipment:

prime movers with starting system;

reduction gears (where required);

generators;

transformers;

frequency converters;

power distribution panel;

uninterruptable power supplies;

cables;

automatic control systems;

auxiliary systems serving the above mentioned equipment.

**9.4.6.2.4** Automatic power supply system shall be fitted with:

power backup system for the case of failure resulting in MASS blackout;

automatic start system of emergency power supply facilities supplying emergency consumers ensuring safe navigation, as well as supply of equipment for resumption of normal power supply of all systems in case of failure condition of machinery installation;

system of automatic charging if backup power sources after resumption of normal power supply;

individual control system of prime movers that informs RCC and navigation system of rotation speed (including the limited rpm range) and output capacity, parameters of auxiliary (fuel, oil, cooling, air supply, compressed air) systems.

**9.4.6.2.5** Automatic power supply system shall have sufficient capacity to satisfy the needs of power supply under normal operating conditions and emergency conditions of partial failure of equipment.

**9.4.6.2.6** Automatic power supply system shall have functions of self-diagnostics and control of switching, sequence starting and standby feed of essential equipment.

**9.4.6.3** Verification methods.

**9.4.6.3.1** Prior to survey, the documents according to [2.1.2.5.1](#) shall be submitted to the Register, as well as test protocols of automatic power supply system with the analysis of effect on the redundancy of electrical power supply system and ship system in case of a single failure.

**9.4.6.3.2** Tests shall be carried out in accordance with the approved test program and procedure and shall be based on the comprehensive verification of automatic power supply system using methods specified in [Appendix B](#).

**9.4.7 SPP artificial intelligence system.**

**9.4.7.1** Tasks.

**9.4.7.1.1** MASS shall have artificial intelligence system that monitors the condition and control of engines and their systems, auxiliary machinery, power supply systems in accordance with their maintenance and inspection schedule, as well as taking into account the ship's voyage assignment (route/anchorage duration).

**9.4.7.1.2** Safety of control by means of SPP artificial intelligence system shall be higher than safety of ships with manned engine room.

**9.4.7.2** Requirements.

**9.4.7.2.1** To ensure SPP operation, control by means of ship's artificial intelligence system and from RCC shall be provided:

under normal operating conditions, the authority of RCC has the highest level, and the authority of artificial intelligence system is under its control;

under normal operating conditions, RCC may delegate control to SPP artificial intelligence system having therewith the means of efficient remote control of the main equipment from RCC in case of the artificial intelligence system failure;

in case of degradation of communication, control is carried out by means of SPP artificial intelligence system. Where robust communication is available, RCC control has primacy of control by means of SPP artificial intelligence system.

**9.4.7.2.2** SPP artificial intelligence system shall receive data from alarm system of the most essential systems and devices and, in parallel, receive information on the parameters of SPP main systems and devices and, in case of failure or outage of any part thereof, including failure of electrical power supply, shall perform the following:

sending alarm signals to RCC;

timely activation of backup devices for resumption of normal operational mode;

transition to remote control from RCC, therewith, transfer of control shall have no significant impact on SPP operating conditions.

**9.4.7.2.3** Own components of SPP artificial intelligence system (including sensors, controls, cables, etc.) and power sources (including electric power, source of gas in pneumatic system, safety valves, filters and dehumidifier, hydraulic pumps of hydraulic supply system, solenoid valves, etc.) shall be designed with redundancy, and single failure shall not result in the failure of system in general.

**9.4.7.2.4** SPP artificial intelligence system shall receive information on operating parameters of the following main systems of the plant and its devices: fuel system, oil system, cooling system, compressed air system, hydraulic air system, air supply system, feed water system, scavenging and condensing system, ventilation system, ballast system, fire extinguishing system, draining system, where required: cargo system, stripping system and cooling system, cargo heating, ventilation system and inert gas system, etc. (the list is specified when forming [Appendix A](#));

**9.4.7.2.5** SPP artificial intelligence system shall be able to:

- perform priority blocking of control actions in emergency situations to avoid collision; independently or from RCC reactivate own possibilities to return the system in operable condition after activating its means of protection or blocking;
- determine the self-diagnostic time of SPP artificial intelligence system and the scope of checks of monitoring, alarm, control systems and safety system taking into account the system maintenance plan;
- intellectually block senseless signals during repeated actuation and send to RCC common alarm signal and/or indication thereof on the most important systems of the engine room;
- perform correction of actuating parameters setpoint values strictly in accordance with access authority.

**9.4.7.2.6** SPP artificial intelligence system shall have a function of automatic registration of SPP actions and feedback, including registration of:

- key parameters of SPP operation;
- control actions and response of the main plant systems;
- actuation of engine room alarm and safety measures taken;
- various emergency operations;
- records of maintenance and repair.

**9.4.7.2.7** SPP artificial intelligence system shall have a function of automatic recording, automatic output of different records and reports in compliance with the reporting procedures and plans of reporting to RCC, including: various reports and test results related to sea tests and checks; various instructions from navigation control system and RCC; records stipulated by the shipping company requirements, etc.

**9.4.7.3** Verification methods.

**9.4.7.3.1** For verification of SPP artificial intelligence system, the documents according to [2.1.2.5.2](#) shall be submitted.

**9.4.7.3.2** The effectiveness of the algorithms of the SPP artificial intelligence system functionality and automatic registration and reporting shall be verified as a result of bench tests prior to installation on board the ship.

**9.4.7.3.3** The effectiveness of communications between the SPP artificial intelligence system, ship's autonomous navigation control system and RCC shall be verified during MASS mooring and sea trials.

**9.4.7.3.4** The effectiveness of control performed by SPP artificial intelligence system, remote control from the remote control centre, emergency control and control function by means of local control stations on board the ship shall be verified during MASS mooring and sea trials.

**9.4.7.3.5** The effectiveness of condition control and performance monitoring, automatic registration and reporting of the SPP artificial intelligence system shall be verified on board the ship.

**9.4.7.3.6** The effectiveness of maintenance of the SPP artificial intelligence system shall be evaluated based on machinery condition at the first annual survey after MASS commissioning. Upon satisfactory assessment, it is allowed to continue ship operation.

## **10 REMOTE CONTROL CENTRE (FIXED OR MOBILE)**

Remote control centre (RCC) shall perform tasks on MASS safe operation in different operational modes in the permitted areas of navigation.

RCC is an integrated system containing:

RCC equipment;

sea areas being under the RCC control:

area of remote and autonomous control where communications and navigating conditions allow to perform MASS remote control;

area of autonomous control where communications and navigating conditions allow to perform MASS autonomous control;

RCC personnel;

MASS controlled;

movement delimiting marking;

additional RCC (subordinated, stand-by, mobile, etc.);

RCC safety systems protecting against natural phenomenon (electric safety, seismic hazards, flooding, etc.);

RCC fire safety systems;

RCC cyber security systems.

### **10.1 SITUATIONAL AWARENESS**

#### **10.1.1 Tasks.**

**10.1.1.1** Ensure receipt of information for decision making during MASS navigation, entering ports and departing from ports, movement in port waters and during other manoeuvring by means of:

.1 receipt of information from MASS in the extent limited by communication conditions between MASS and RCC;

.2 receipt of information from own sources within the fields of vision of their sources;

.3 receipt of information from other sources.

**10.1.1.2** RCC situational awareness system shall ensure:

.1 sufficiency of information for MASS operation under all predictable operating conditions;

.2 adequate decision making on the possible mode of autonomy of MASS: autonomous, remote control, manual, decision support for the crew on board the ship, depending on the information received.

#### **10.1.2 Requirements.**

**10.1.2.1** Situational awareness data content of RCC shall include:

MASS location area;

navigational and hydrometeorological conditions in the area of MASS location and adjacent areas, including navigational warnings;

navigating conditions in the area of MASS location and adjacent areas;

monitoring data of movement delimiting marking in the area of MASS location and adjacent areas (where applicable);

data of video monitoring from the ship (where applicable), data of video monitoring from berths (where applicable);

data received from controlled MASS limited by communication conditions with the area of MASS location.

**10.1.2.2** The requirements for the equipment of situational awareness system (radar systems, AIS equipment, television surveillance systems, VHF radio direction-finders, meteorological and hydrological instruments) shall be established at least equal to the similar

VTS equipment of high category in case it is not contravene the requirements of these Regulations.

**10.1.2.3** Location of the RCC own situational awareness means shall be established by calculations in compliance with the requirements of [10.7](#).

Location of the RCC own situational awareness means shall be confirmed by methods of mathematical modelling of operation of the RCC situational awareness means forming part of integral RCC system.

**10.1.2.4** Operating area of the RCC own situational awareness means is water area where the functioning of own situational awareness means is provided with intended efficiency. For each type of the RCC own situational awareness means a separate operating area is established by means of calculations in accordance with the requirements of [10.7](#).

Calculation data shall be confirmed by methods of mathematical modelling of operation of the RCC situational awareness means forming part of integral RCC system.

**10.1.2.5** The redundancy level of RCC situational awareness equipment shall be established in accordance of VTS of high category.

Ensuring redundancy level of the RCC situational awareness equipment shall be confirmed by methods of mathematical modelling of operation of the RCC situational awareness means forming part of integral RCC system.

**10.1.2.6** The RCC administration shall develop a description of procedures and algorithms for making decisions on the possible mode autonomy of MASS: autonomous, remote control, manual, decision support for the crew on board the ship, depending on the information received under all predictable operating conditions in all permitted areas of operation.

**10.1.3 Verification methods.**

**10.1.3.1** Prior to survey of RCC in respect of the requirements for the situational awareness system, the documents according to [2.1.2.6.1](#) shall be submitted.

## **10.2 STRATEGIC VOYAGE MANAGEMENT**

**10.2.1 Tasks.**

**10.2.1.1** Strategic management of MASS voyage shall be performed from RCC and shall be implemented by sending to the ship a voyage assignment for autonomous control system.

**10.2.1.2** Area of strategic voyage management is an area with officially announced boundaries approved during the RCC survey.

**10.2.2 Requirements.**

**10.2.2.1** MASS voyage planning shall be performed from RCC taking into account safe navigation of the ship in the areas of strategic voyage management, as well as possible loss of communication with the ship, weather conditions, restrictions of navigation conditions and possible abnormal situations.

**10.2.2.2** Strategic management of MASS voyage shall be implemented by sending to the ship a voyage assignment for autonomous control system that ensures its receipt, processing and execution within the time limit prescribed by the voyage assignment.

**10.2.2.3** Where no voyage assignment is available, MASS may be remotely controlled from RCC, and in case of loss of communication with RCC, the ship shall be stopped and kept by its own positioning means at the point of communication failure or automatically moved to the point of re-establishment of communication, if such task is indicated in the voyage assignment.

**10.2.2.4** In case the voyage assignment is loaded in the MASS control system, task [10.2.2.2](#) shall be implemented, and in case of loss of communication with RCC, MASS shall continue implementation of the voyage assignment.

**10.2.2.5** While implementing strategic voyage management, RCC shall provide continuous monitoring of the voyage assignment performance and, if necessary, in case of communication availability, RCC shall intervene MASS control to ensure safety of navigation, safe MASS operation and environmental pollution prevention.

**10.2.3 Verification methods.**

**10.2.3.1** Prior to survey, the documents according to [2.1.2.6.2](#) shall be submitted to the Register.

**10.2.3.2** MASS strategic management system shall be subjected to testing and survey in accordance with the approved testing procedures to verify the functioning and efficiency of the system by performing test procedures according to the scenarios ensuring that all its capabilities are checked in compliance with the requirements specified in [10.2.2](#).

## **10.3 REMOTE CONTROL OF NAVIGATION**

**10.3.1 Tasks.**

**10.3.1.1** RCC shall perform tasks on safe MASS operation in the areas of voyage remote control.

Voyage remote control area of the remote control centre is an area with officially announced boundaries approved during the RCC survey, where the communication conditions between RCC and MASS, availability of movement delimiting marking and navigation conditions allow RCC to monitor MASS operation when MASS is in the remote control mode.

**10.3.2 Requirements.**

RCC shall perform at least the following functions at the stage of navigation control:

- .1 development of voyage schedules and approval of scheduled routes;
- .2 continuous monitoring and displaying of MASS conditions and operations, as well as video displaying of actual situation, where required;
- .3 safety monitoring of MASS and its systems, development of maintenance recommendations based on the assessment of the ship condition aimed at preparing it for continued operation;
- .4 cancellation of autonomous mode of navigation and switching to remote control mode of MASS and its systems, if necessary;
- .5 support of voice communication with pilot, cargo terminals, auxiliary tugs, surrounding ships, shipowners and operators, vessel traffic service, etc.;
- .6 sending of additional information that shall be automatically registered by autonomous ship navigation system, including meteorological and marine situation, information on safety at sea, orders of vessel traffic service, etc.;
- .7 recording and reproduction of information on decisions, orders and MASS actions for the selected period;
- .8 monitoring of MASS loading and unloading operations.

**10.3.3 Verification methods.**

**10.3.3.1** The documents according to [2.1.2.6.3](#), as well as protocols and reports for all types of tests shall be submitted to the Register.

**10.3.3.2** Survey of remote navigation control system performed by RCC shall be carried out in accordance with the approved test program and procedure in full and shall be based on the comprehensive verification of control system at the first stage by means of virtual platform for navigation situation modelling, and by control of existing MASS at the second stage.

## **10.4 ANTI-INTRUSION PROTECTION OF REMOTE CONTROL CENTRE**

### **10.4.1 Tasks.**

The purpose of this Chapter is to define the requirements for the design, installation, maintenance and operation of intrusion prevention systems of remote control centre.

### **10.4.2 Requirements.**

**10.4.2.1** RCC space shall be arranged such that to prevent unauthorized access and ensure the authorized one.

**10.4.2.2** RCC shall be fitted with safety systems, which ensure monitoring, detection, alarm, response and storage of data on unauthorized and authorized access. Safety systems shall perform the following tasks:

- storage and updating the authorized persons' data;
- access of the authorized persons;
- granting the possibility of bringing in/out of equipment in compliance with the RCC requirements;
- access of unauthorized persons to the centre in compliance with the RCC requirements;
- denial of access for unauthorized persons;
- detection, alarm, response, event data storage, including but not limited to, logging of authorized access and attempts of unauthorized intrusion.

**10.4.2.3** RCC safety systems may be implemented on the basis of wired or wireless telecommunications isolated from systems intended for MASS control.

**10.4.2.4** RCC safety systems shall have communications with the RCC operator and their control shall be provided from the RCC territory.

### **10.4.3 Verification methods.**

**10.4.3.1** The documents according to [2.1.2.6.4](#) shall be submitted to the Register.

**10.4.3.2** The following verifications shall be performed upon the RS request to verify compliance with the established requirements:

- verification of communication between the RCC operator and the RCC safety system;
- verification of the RCC safety system by performing authorized access and unauthorized attempt of intrusion to the main of standby remote control centre.

## **10.5 ELECTRICAL POWER SUPPLY OF REMOTE CONTROL CENTRE**

### **10.5.1 Tasks.**

**10.5.1.1** The purpose of this Chapter is to define the requirements for the RCC power supply.

### **10.5.2 Requirements.**

**10.5.2.1** RCC shall have uninterruptible power supply and at least one emergency power source.

**10.5.2.2** To maintain continuous RCC operation, separate equipment may have own uninterruptible power supply that shall ensure continuous operation of RCC equipment during the period of changeover from one electrical power source to another or the period required for transfer of control from one RCC to another.

**10.5.2.3** Operating power supply of RCC from the standby power source is permitted for the duration of preventive maintenance.

**10.5.2.4** Climatic conditions in RCC including temperature, humidity, ventilation, etc. shall meet the requirements for office, server rooms and shall be supplied (with 25 % power reserve) by the RCC power supply systems in all operational modes and during the failures of power supply systems.

**10.5.2.5** RCC lighting shall be provided in all operational modes and during the failures of power supply systems. Therewith, the use of an individual uninterruptible power supply

shall be permitted for illumination of main areas of operator's workplace while switching from one power source to another.

**10.5.2.6** RCC shall be fitted with fire alarm system with redundant power supply system.

**10.5.3 Verification methods.**

**10.5.3.1** The documents according to [2.1.2.6.5](#) shall be submitted to the Register.

**10.5.3.2** The maintenance and verification of electrical power supply shall be performed on a regular basis. At least the following shall be verified:

continuity of operation of RCC equipment at switching of electrical power supply from one source to another;

switching time;

condition and shelf life of uninterruptible power supply batteries.

## **10.6 REQUIREMENTS FOR PERSONNEL**

### **10.6.1 Tasks.**

RCC personnel shall ensure safe monitoring and control of MASS in various operational modes, as well as compliance with the requirements of RCC operating procedures, environmental protection during performance of the ship control functions, exchange of information with other services.

### **10.6.2 Requirements.**

**10.6.2.1** RCC shall be manned according to the manning table and the number of controlled ships. The number of personnel shall be sufficient to ensure:

safe monitoring, control and management of that number of ships which is under the RCC control;

environmental protection;

compliance with the requirements for duration of the RCC personnel working time.

**10.6.2.2** Continuous round-the-clock operation of RCC is ensured by means of shift-based work of the RCC personnel. The composition, organization of shift work and shift schedule shall be established by the RCC administration and shall ensure proper performance of the RCC specified functions. In the space where the places of duties of the RCC officers are located, at least two persons including the RCC operator (watch officer) shall be available around the clock and at the same time.

RCC administration shall develop job descriptions for the personnel containing references to normative documents, guidelines, operating procedures and additional instructions, the RCC personnel shall be guided in performance of their duties.

On the basis of the Merchant Shipping Code of the Russian Federation, the RCC administration shall develop regulations on sharing responsibilities during MASS operation in various operational modes between the RCC personnel (personnel of auxiliary (mobile) RCC) and the ship's crew, if any on board the ship, complying with the requirements of these Regulations.

**10.6.2.3** At least the following capacities shall be provided in the RCC manning table:

RCC officers:

master (similar to the master of the ship with a crew);

operator (watch officer) (not lower than a chief mate — qualification "management level");

mechanical engineer (similar to a chief engineer (electro-mechanical engineer) — qualification "management level");

operator (watch officer) (not lower than second engineer — qualification "management level");

communications engineer (similar to the electronic engineer — qualification "management level");

doctor (in case of RCC isolated location, if necessary);

supporting personnel ensuring operation of RCC and its equipment.

**10.6.2.4** Minimum requirements for the RCC officers' qualification.

**10.6.2.4.1** All officers shall have valid certificates of service of relevant qualification issued on the basis of special higher maritime education.

**10.6.2.4.2** Certification of officers shall comply with the requirements for the similar capacities of the ship's crew, as well as:

master and operators (watch officers) shall undergo probation in pilot service for all areas where remote control is possible for the particular RCC and shall have a valid certificate of completed probation; shall have a valid pilot certificate issued by the seaport captain and verifying sea pilot qualification, his rights to perform pilotage of particular ship size and purpose in the particular pilotage areas where remote control of navigation is permitted for this RCC, where pilotage is provided for these areas;

master and operators (watch officers) shall undergo simulator-based training on MASS remote control in the operating area of this RCC for all types of ships the particular RCC may control, and shall have a valid certificate of completed training (not exceeding 5 years) in the operating RCC or on simulator;

master and operators (watch officers) shall undergo simulator-based training on MASS control for all ship types the particular RCC may control, and shall have a valid certificate of completed training (not exceeding 5 years) in the operating RCC or on simulator;

master and operators (watch officers) shall be aware of:

geographical, navigational, meteorological and hydrological peculiarities of RCC operating area where RCC may perform remote control of navigation;

main parameters of ship flow, peculiarities of sea ports and terminals operation in the RCC coverage where RCC may perform remote control of navigation;

location and characteristics of clear ways, recommended ways, ship traffic separation schemes, areas prohibited for navigation and anchorage, navigational and other test ranges in the area of RCC operation, where RCC may perform remote control of navigation, and in the adjacent water area;

location of navigational hazards, underwater cables guards with warning signs, places of installation and characteristics of ashore and floating means of navigation in the RCC operating area where RCC may perform remote control of navigation;

location and characteristics of berths, areas and places of anchorage, areas of road loading and bunkering, pilot boarding and debarkation points in the area of RCC operation where RCC may perform remote control of navigation;

RCC tasks and functions, procedure and peculiarities of their performance;

main technical and operating characteristics, possibilities and limitations of the RCC technical means, methods and rules of their use by the RCC operators;

arrangement of RCC communications with ships, other objects, allied services, the procedure of receipt therefrom navigation, meteorological and other necessary information required for the RCC operation;

procedure of transmission of information, recommendations, warnings and instruction during the interaction with ships in the RCC operating area;

provisions of normative and governing documents regulating organization of shipping in the RCC operating area, activities of RCC and its operators;

peculiarities of activity arrangement of port state control authorities, pilot, tug services of the ports in the RCC operating areas where RCC may perform remote control of navigation;

organization and procedure of RCC interaction with allied ashore services in the routine and emergency situations;

methods and rules for transfer of ship control modes: monitoring, decision support, remote control and autonomous control;

RCC master and operators (watch officers) shall have at least 24 months of service experience in the capacity of master, chief mate or watch officer of the sea-going ship of gross tonnage above 500;

electro-mechanical engineer and mechanical engineer shall undergo simulator-based training on monitoring and control of MASS systems operating in remote control mode and autonomous mode for all types of ships being under the RCC control, and shall have a valid certificate of completed training (not exceeding 5 years);

in case MASS refers to oil tankers, chemical tankers, gas carriers and engaged in transportation of dangerous goods, electro-mechanical engineer and mechanical engineer shall undergo simulator-based training on monitoring and control of MASS systems operating in remote control mode and autonomous mode for all types of ships being under the RCC control, and shall have a valid certificate of completed training (not exceeding 5 years);

communication engineer shall undergo simulator-based training on communications management in the permitted areas of RCC operation for all permitted types of MASS and permitted areas of RCC operation being under the RCC control and shall have a valid certificate of completed training (not exceeding 5 years).

### **10.6.3 Verification methods.**

**10.6.3.1** The following documents shall be submitted to RS for the survey:

manning table, including shift composition, organization of shift work and shift schedule;

list of MASS under the RCC monitoring and control;

list of areas and possible modes of the RCC operation therein (monitoring, decision support, remote control, autonomous control);

job descriptions of officers;

regulations on sharing responsibilities during MASS operation in various modes;

documents verifying qualification of officers, including valid pilot certificates for the areas where remote control of ships is possible and valid certificates of completed simulator-based training on remote and autonomous operation with the list of areas and ships;

medical commission certificates of officers health compliance with the requirements for certification of masters and watch officers in accordance with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW Convention 78/95);

labor agreements of officers with RCC for performance of their duties;

operating procedures developed by the RCC administration.

**10.6.3.2** The following shall be verified during the RCC survey:

compliance of the submitted documents with these requirements, including:

the number of personnel in shifts is sufficient to ensure control of all MASS at any time;

the personnel in shifts is fully qualified for operation in the specified areas of navigation under remote control;

random verification of knowledge and practical skills of the RCC officers as regards job descriptions and operating procedures;

organization of supervision over the RCC officers during several MASS control operations: in the modes of monitoring, decision support, remote control and autonomous control.

**10.6.3.3** Based on verification results, the identified nonconformities to the established requirements, remarks and recommendations shall be recorded in the survey report.

## **10.7 DESIGN PRINCIPLES OF REMOTE CONTROL CENTRE**

### **10.7.1 Tasks.**

**10.7.1.1** RCC task is to perform safe MASS operation in the various modes of remote control and autonomous operation; ensure safety of life at sea, protection of marine environment, coastal areas, places of operation and installation of offshore installations against possible adverse effect of autonomous (remotely controlled) navigation.

**10.7.1.2** Tasks of RCC design are to form an integral system containing the RCC items: permissible RCC areas, controlled equipment, personnel, controlled ships, controlled

movement delimiting marking, subordinated (mobile) RCC, safety systems, fire safety systems, cyber security systems complying with all the requirements for autonomous (remotely controlled) navigation.

**10.7.1.3** RCC (including subordinated (mobile) RCC) shall have a valid statement of compliance issued by RS.

**10.7.2 Requirements.**

**10.7.2.1** The procedure for RCC design shall consist of the stages mentioned below.

**10.7.2.2** Development of the RCC project including justifications for:

areas of RCC operation with various operational modes (permitted areas of strategic voyage management, voyage remote control); the possibility of MASS operation in these areas while performing all permitted manoeuvres in all permitted control modes (monitoring, decision support, remote control, autonomous operation);

location and composition, characteristics of equipment of the RCC situational awareness system;

location and composition, characteristics of the RCC communication equipment;

location, composition, characteristics of the movement delimiting marking;

location, characteristics of standby/mobile RCC, including ensuring of communication between the standby RCC and main RCC, standby RCC and MASS.

**10.7.2.3** Development by the RCC administration of the following procedures complying with the requirements of these Regulations:

operating procedures for operation in the permitted areas of the RCC operation, including the procedure of MASS control transfer between the ship's crew (if any), RCC personnel, personnel of auxiliary (standby) RCC in all possible operating situation;

procedures for operation in emergency situations;

procedures for maintenance of equipment and systems;

procedures for cyber security risk identification and control;

procedures for RCC safety.

**10.7.2.3.1** Working acceptance of completed facilities.

**10.7.2.3.2** Acceptance-delivery tests of the RCC processing equipment.

**10.7.2.3.3** Initial survey of RCC as an integral system.

**10.7.2.3.4** Notifying the interested parties of RCC functioning, its operational modes and areas of operation thereof.

**10.7.2.4** Calculations on the RCC project justification shall be made using mathematical modelling of operation of integral RCC system that includes the following:

RCC controlled equipment;

permitted operating areas of different RCC modes;

area of remote control of navigation where communications and navigating conditions allow to perform MASS remote control;

area of strategic voyage management where communications, availability of movement delimiting marking and navigating conditions allow to perform MASS operation control in the modes of monitoring, decision support, autonomous operation;

variants of standard actions of the personnel (specified in the procedures developed by the RCC administration), including the actions in emergency situations and actions for elimination of pollution from ships;

controlled MASS during manoeuvring as stipulated in the regulations developed by the RCC administration;

movement delimiting marking;

subordinated (stand-by, mobile) RCC;

RCC safety systems;

RCC fire safety systems;

RCC cyber security systems.

**10.7.3 Verification methods.**

**10.7.3.1** The following documents shall be submitted to the Register:

RCC project including documents according to [2.1.2.6](#);

procedures complying with the requirements of these Regulations:

operating procedures for operation in the permitted areas of the RCC functioning, including the procedure of MASS control transfer between the ship's crew (where available), RCC personnel, personnel of auxiliary (standby) RCC in all possible operating situation;

procedures for operation in emergency situations;

procedures for maintenance of equipment and systems;

procedures for cyber security risk identification and control;

procedures for RCC security;

data of latest survey of RCC and its objects.

**10.7.3.2** The concept of the RCC structure shall be verified during the survey.

## **11 MEANS OF MOVEMENT DELIMITING MARKING (FIXED OR MOBILE)**

### **11.1 ESTABLISHMENT OF LIMITATIONS AND SITUATIONAL ABILITIES. NAVIGATION DELIMITING SIGNS**

#### **11.1.1 Tasks.**

**11.1.1.1** Ensuring the detection and navigational use of means of navigational equipment at the distances far in excess of the capabilities of visual and radar equipment.

**11.1.1.2** Ensuring the possibility to use "virtual" and "synthetic" means of navigational equipment.

**11.1.1.3** Ensuring control of MASS route observance.

#### **11.1.2 Requirements.**

**11.1.2.1** Navigation delimiting signs shall not interfere with navigation of conventional ship types and systems in operation.

**11.1.2.2** Virtual, synthetic and actual means of AIS navigational equipment shall be maintained.

**11.1.2.3** Functioning of means of navigational marking for MASS shall not effect AIS operation in case of any technology application.

**11.1.2.4** The possibility of developing local MASS movement marking by means of computing tools of ship navigation system shall be provided.

**11.1.2.5** Virtual and synthetic means of navigational equipment with Iridium, GSM, VSAT, VDES technology may apply.

**11.1.2.6** Horizontal plane route trajectory with a function of MASS movement control shall be supported for waypoints passing or arrival to target point in the prescribed time.

#### **11.1.3 Verification methods.**

**11.1.3.1** The documents according to [2.1.2.7.1](#) shall be submitted to the Register.

### **11.2 CONTROL OF MOVEMENT DELIMITING MARKING**

#### **11.2.1 Tasks.**

**11.2.1.1** Ensuring autonomous, safe navigation by providing the navigation system with optimum traffic routes, with the possibility of correction taking into account the received and processed situational data.

**11.2.1.2** Ensuring safety of MASS operation by improving accuracy of navigation.

**11.2.1.3** Improving efficiency and traffic capacity of water area for MASS operation both on local routes and during the voyage, mooring and unmooring by increasing the route number in the target water area.

**11.2.1.4** Achieving the possibility of creating the structure of dynamic and scalable routes, as well as recommended MASS movement trajectories depending on the target environmental situation. Therewith, the interests of conventional ships involved in formation of navigation situation shall be taken into account.

**11.2.1.5** Reducing voyage time and economic costs for MASS operation through optimization of movement trajectories.

**11.2.1.6** Assistance and support in decision making by visualizing the navigation situation and reducing the RCC operator's burden.

#### **11.2.2 Requirements.**

**11.2.2.1** Formation of movement delimiting marking (hereinafter referred to as the "marking") shall be performed with due regard of MASS operational and manoeuvring characteristics.

**11.2.2.2** Marking control system shall consider standard trajectories of approaching to port, departing from port.

**11.2.2.3** Marking control system shall consider the applicable regulations of COLREG-72.

**11.2.2.4** Marking control system shall consider horizontal profile of MASS movement trajectory using factual and estimated navigation data.

**11.2.2.5** Marking control system shall forecast at least the following parameters for each route point of the current MASS voyage plan:

estimated time of arrival to waypoint;

estimated time of voyage completion;

estimated covered distance;

required temporary waypoints of the route.

**11.2.2.6** All predicted and actual information of marking control system shall be displayed in the RCC.

**11.2.2.7** Marking control system shall ensure MASS navigation together with navigation control system for execution of voyage schedule.

**11.2.2.8** Formation of marking shall be performed taking into account the applicable requirements of regulation V/34 of SOLAS-74 and Part 2, Section A-VIII/2 of the Seafarers' Training, Certification and Watchkeeping Code (STCW Code), as well as IMO resolution A.893(21).

**11.2.3 Verification methods.**

**11.2.3.1** The documents according to [2.1.2.7.2](#) shall be submitted to the Register.

### **11.3 MOORING AREA (SPECIAL MOORING DOCKS)**

**11.3.1 Tasks.**

**11.3.1.1** Ensuring control and safety of MASS mooring by means of preventing and avoiding of emergency situation in case of ship approaching the berth at rather high speed or at high angle.

**11.3.2 Requirements.**

**11.3.2.1** Legal aspects of mandatory pilotage of ships established in some ports shall be considered.

**11.3.2.2** Reliable means shall be provided for ship positioning at the berth.

**11.3.2.3** Mooring area shall control ship movement at the berth and ensure efficiency of loading-unloading operations.

**11.3.2.4** In manoeuvring, mooring and positioning modes, the place and means of mooring shall enable to control MASS in any direction, set longitudinal and transverse motions, speed of ship motion and swinging.

**11.3.2.5** Means and equipment of the mooring area shall perform calculations of propulsion power to be applied by each thruster replacing the conventional control methods of each thruster.

**11.3.2.6** In manoeuvring, mooring and positioning modes, the directions and propulsive force using all propulsion systems and thrusters shall be specified.

**11.3.3 Verification methods.**

**11.3.3.1** The documents according to [2.1.2.7.3](#) shall be submitted to the Register.

**11.3.3.2** Maintenance procedures shall be established for the mooring area, its systems and equipment. Maintenance and tests shall be carried out on a regular basis.

### **11.4 ANTI-INTRUSION PROTECTION**

**11.4.1 Tasks.**

**11.4.1.1** Safety of means of movement delimiting marking from illegal actions shall be ensured.

**11.4.1.2** Timely notification of illegal actions related to means of marking shall be ensured.

**11.4.2 Requirements.**

**11.4.2.1** The requirements for anti-intrusion protection of real means of marking shall be not lower than those adopted for existing means of navigation equipped with radio communication means, e.g. AIS.

**11.4.2.2** The requirements for protection of synthetic and virtual means of marking refer to cyber security matters of MASS and their systems.

**11.4.3 Verification methods.**

**11.4.3.1** No additional documents are required to be submitted, except for the documents provided for the existing means of navigation.

## 12 CYBER SECURITY OF DISTRIBUTED INFORMATION NETWORK

### 12.1 COMPUTER AND COMPUTER-BASED SYSTEMS

#### 12.1.1 Tasks.

**12.1.1.1** Ensuring security of information to be applied for MASS operation by means of: use of information security approaches aimed at safe SW development; ensuring confidentiality, integrity and accessibility of information at the stage of vessel traffic system operation.

**12.1.1.2** Ensuring safe resumption of computer-based system operation after disabling or cyberattack.

#### 12.1.2 Requirements.

**12.1.2.1** SW development for MASS shall be followed by a set of actions aimed at ensuring safe development, in particular:

during SW requirements analysis;

SW architecture design;

SW development and integration;

SW testing;

SW installation and its acceptance support;

solving SW problems during the operation;

development SW documentation, as well as performance of its configuration (changing the program structure);

control of SW development environment infrastructure;

personnel management.

**12.1.2.2** Ensuring confidentiality, integrity and accessibility of information at the stage of MASS operation shall be provided by the following protection measures:

development of a list of protected information resources;

development of access matrix related to protected information resources;

modelling of information security threats;

development of information security measures (including, inter alia, application of technical security means ensuring identification and authentication functions, access control, event registration, integrity control, trusted upload, antivirus protection, intrusion detection, firewalling, emergency destruction of protected information).

#### 12.1.3 Verification methods.

**12.1.3.1** The documents according to [2.1.2.8.1](#) shall be submitted to the Register.

**12.1.3.2** Verification of compliance with the specified requirements for security of information used on MASS shall be documented — the following shall be verified: availability of information security records; compliance of reported documentation with the requirements of national and international standards, as well as normative documentation of flag State Maritime Administration.

**12.1.3.3** The principles of operation are verified using logical analysis or hardware/software verification that simulates external cyber attacks.

### 12.2 ON BOARD MASS

#### 12.2.1 Tasks.

**12.2.1.1** Performing a set of actions aimed at safe SW development for MASS control systems.

**12.2.1.2** Maintaining confidentiality, integrity and accessibility of information at all levels of interaction during MASS operation (from top management of the shipping company to the ship and its systems and subsystems).

**12.2.1.3** Ensuring reliable MASS monitoring and control.

**12.2.1.4** Ensuring safety of people on board the ship, ship's equipment and the environmental protection during autonomous and remote navigation.

**12.2.1.5** Performing a set of actions aimed at prevention of immediate threats to security of information used for MASS operation, including:

ensuring safe and secure exchange of autonomous and remotely controlled ships with RCC and other participants of navigation;

ensuring the necessary, sufficient and excessive level of MASS cyber security;

development of plans of MASS systems and equipment resumption after cyberattacks or other critical situations affecting cybersecurity and maintenance of continuous system operation;

prevention of leakage, misrepresentation of information related to MASS operation;

prevention of unauthorized actions on destruction, misrepresentation, blocking of information and prevention of unauthorized access to MASS control systems.

**12.2.2 Requirements.**

**12.2.2.1** MASS computers and computer-based systems shall comply with the applicable requirements of Section 7, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships.

During design of MASS information network, the following shall be taken into consideration:

the requirements of IMO resolution MSC.428(98) "Maritime Cyber Risk Management in Safety Management Systems";

provisions of the IMO Circular MSC-FAL.1/Circ.3 "Guidelines on Maritime Cyber Risk Management";

the requirements of the International Chamber of Shipping "Guidelines on Cyber Security Onboard Ships";

the requirements for components of embedded devices of cyber security management systems (CSMS) that make up industrial automation and control systems (IEC 62443 series of standards);

the requirements for cyber security for industrial automation and control systems (IEC 62443-4-1 standard);

plans and procedures of shipping company on risk management regulated by the International Safety Management Code (ISM Code — International Management Code for the Safe Operation of Ships and for Pollution Prevention) and the International Ship and Port Facility Security Code (ISPS Code);

information separation between complicated and essential systems.

**12.2.2.2** Measures shall be taken on multilevel security of essential systems of the information network, as well as by means of personnel both on board the ship and in the RCC, on security of the particular procedures and technologies intended for:

enhancement of efficiency of information network cyber threats detection;

increase of means and resources required for cyber security upgrade of MASS information network systems.

**12.2.2.3** Ensuring cyber security on board MASS may include:

physical security of the ship in accordance with developed security plan;

information network protection;

implementation of actions and procedures on intrusion detection to the information network and its subsystems;

periodical scanning of the information network for detection of cyber threats and vulnerabilities;

SW verification for detection of vulnerabilities and undeclared functions;

personnel training both on board the ship and in the remote control centre.

**12.2.2.4** Plan of actions for prevention of cyber threats and minimization of effects of cyber security violation shall be developed, as well as the following systems and arrangements:

- automatic identification system;
- electronic chart and information systems;
- voyage data recorder;
- position, heading, speed and universal time coordinated (UTC) sources;
- emergency position-indicating devices (radio beacons, etc.).

**12.2.2.5** Policy and procedures of cyber security assurance on board the ship shall be considered in view of general approach to risk assessment and management specified in [Appendix C](#).

**12.2.2.6** Cyber security measures on board the ship shall be determined upon the risk assessment results and within planning the activities on security enhancement.

**12.2.2.6.1** Basic cyber security measures shall comply with ISO 27032 standard, they are given in [Table 12.2.2.6.2-1](#).

**12.2.2.6.2** Arrangements complying with the national standards are given in [Table 12.2.2.6.2-2](#).

Table 12.2.2.6.2-1

**Main cyber security measures in accordance with ISO 27032**

Security category	Safety measure
Security of applications and user notification on security policy	User notification on security policy
	Protection of Web application sessions
	Control of input data correctness
	Script security
	Code audit and software independent testing
	Provider identification for the users
Server security	Safe server configuration
	Installation of security updating system
	System log control
	Malware protection
	Regular scanning of systems for the malware identification
	Regular scanning of software vulnerabilities
	Tampering attempt detection
End user security	Use of recommended operating systems
	Use of recommended software versions
	Use of antivirus software
	Use of personal network firewalls and intrusion detection systems
	Use of automatic updates of the trusted programs
Cyber attack protection by social engineering methods	Development and implementation of security policies
	Information categorization and classification
	User training and awareness-raising
	Personnel testing
	Use of technical control means
Readiness raise	Use of traps in "empty" network
	Malicious traffic re-direction
	Back-tracing

Table 12.2.2.6.2-2

**National standards applicable to information security**

GOST identification	Title
Information security management systems	
GOST R ISO/IEC 27000-2012	Information technology. Security techniques. Information security management systems. Overview and vocabulary
GOST R ISO/IEC 27001-2006	Information technology. Security techniques. Information security management systems. Requirements
GOST R ISO/IEC 27002-2012	Information technology. Security techniques. Code of practice for information security management
GOST R ISO/IEC 27003-2012	Information technology. Security techniques. Information security management systems implementation guidance
Risk management	
GOST R ISO/IEC 27005-2010	Information technology. Security techniques. Information security risk management
Safety assessment	
GOST R ISO/IEC 15408	Information technology. Security techniques. Evaluation criteria for IT security
GOST R ISO/IEC 18045-2013	Information technology. Security techniques. Methodology for IT security evaluation
GOST R ISO/IEC TO 19791-2008	Information technology. Security techniques. Security assessment of operational systems
Security guarantees	
GOST R ISO/IEC 15026	Information technology. Systems and software engineering
Systems and software assurance	
GOST R ISO/IEC TO 27033-1-2011	Information technology. Security techniques. Network security. Part 1. Overview and concepts
Systems security engineering	
GOST R ISO/IEC 21827-2010	Information technology. Security techniques. Systems security engineering. Capability maturity model
GOST R 56939-2016	Information protection. Secure software development. General requirements

**12.2.2.7** Limitation and continuous control of networking ports, protocols and services shall be provided. Ports shall be secured against cyber attacks, and the unused ones shall be closed to prevent unauthorized access to the systems.

**12.2.2.8** All network appliances shall be configured by means of firewalls, gateways, routers to ensure the possibility of cyber threat prevention.

**12.2.2.9** Spaces containing essential elements and equipment shall be reliably closed against an unauthorized access.

**12.2.2.10** Restricted control of user access to systems and network shall be provided.

**12.2.2.11** Measures shall be taken for backing up of information snapshots and essential files.

**12.2.2.12** It is necessary to verify operability of SW intended for resumption of information network functioning.

**12.2.2.13** It is necessary to ensure continuous control of data flow of information network and subsystems for establishing threshold values and cyber threat detection.

**12.2.2.14** Cyber security arrangements shall comply with the applicable RS cyber security and safety assessment requirements.

**12.2.2.15** While establishing communications with RCC, the possibility of preventing an unauthorized connection and unauthorized access to ship systems shall be provided.

**12.2.2.16** For network management the following shall be provided:  
limitation of number of persons authorized to perform changes in systems and new SW installation;

limitation and automatic encryption of wireless access to MASS networks;  
regularly updated SW intended for detection, identification and elimination of malicious software in MASS onboard systems;

information network function redundancy for MASS control;  
network protection, in particular wireless one, using secure protocols, and Internet connection shall be secured by a gateway ensuring decoupling between the Internet access and MASS internal network;

obligatory documenting of all information related to risks and MASS cyber security threats.

**12.2.2.17** Data servers used for data receipt and storage shall be backed up and located in different places (to be at least divided by "A-60" class fire-fighting bulkhead) and shall be dynamically updated. Failure of one server shall have no effect on MASS operation.

**12.2.2.18** Precise diagram of MASS information network and communication equipment shall be developed and regularly updated. The diagram shall describe network architecture and contain a list of the identified equipment (determined by a model number) and SW (determined by a version number).

**12.2.2.19** User access management shall be based on the secure authentication protocol containing the best practices, such as prevention of shared or anonymous accounts, as well as regular password updating with the required high degree of complexity.

**12.2.2.20** In emergency, the contingency plan shall be established for operation of MASS and its system in the reduced capacity mode.

**12.2.2.21** SW shall be regularly updated in compliance with updating policy. This policy shall include:

list of components (machines and SW) to be updated;

duties of different participants of updating process;

means used for updating;

check of updates prior to installation;

previous configuration recovery procedure in case of system upgrade failure.

**12.2.2.22** SW installation and upgrade shall be performed only from the server of control system software manufacturer (supplier).

**12.2.2.23** Main information and SW backup means shall be available to ensure recovery.

**12.2.2.24** During the SW requirements analysis, the requirements for ensuring of information security considering the requirements of flag State Maritime Administration shall be specified.

**12.2.2.25** During SW architecture design it is necessary to:

develop a model of information security threats;

clarify the SW architecture taking into account the list of actual threats;

prepare proposals on manageability of detected potential threats.

**12.2.2.26** During SW development and integration it is necessary to:

use identified tool for SW development;

determine and accept the formatting procedure of source code of the program;

perform statistic analysis of the source code of the program;

make an expert examination of the source code of the program.

**12.2.2.27** During the testing in the presence of the RS surveyor, the following shall be performed:

- function testing of the program;
- anti-intrusion testing.

**12.2.2.28** During the program installation and support of SW acceptance it is necessary to: ensure SW protection against the threats related to violation of integrity during its delivery to the customer;

- deliver operating documentation to the customer.

**12.2.2.29** While solving SW problems during the operation it is necessary to: implement and use tracking and SW bugs fix, as well as program vulnerabilities; perform systematic search of program vulnerabilities.

**12.2.2.30** During development of SW documentation, as well as adjustment of its configuration it is necessary to:

- determine and accept the procedure of unique marking of each SW version;
- determine and accept SW configuration management system.

**12.2.2.31** During the management of SW development framework infrastructure the following actions shall be implemented:

- protection against unauthorized access to the program configuration components;
- backing up of the program configuration components;
- registration of events related to the facts of changing of the program configuration components.

**12.2.2.32** During the personnel management it is necessary to:

- ensure periodical training of the personnel;
- ensure periodical analysis of the personnel training program.

**12.2.2.33** List of protected information resources shall include:

- information containing the information classified as state secret;
- confidential information (including the information marked "for internal use", as well as sensitive restricted information);
- information resources, whose security violation may result in performance degradation of hardware forming part of MASS and, consequently, reducing of MASS efficiency and voyage assignments failure.

**12.2.2.34** Access matrix of access subject related to the protected information resources shall contain an indication of location paths of the protected information resources.

**12.2.2.35** When modelling the security threats to information processing by MASS, the procedure for threat relevance determination shall be developed and proposals on the actual threat neutralization shall be prepared.

**12.2.2.36** Information security arrangements shall include conducting of organizational measures, as well as application of information security technical means ensuring the following functions performance:

- identification and authentication;
- access control;
- event registration;
- trusted upload ensuring;
- integrity control;
- antivirus protection;
- intrusion detection;
- firewalling;
- emergency destruction of sensitive information.

**12.2.2.37** The necessity of MASS automated systems certification in the certification system of information security system of the Maritime Administration shall be determined.

### **12.2.3 Verification methods.**

**12.2.3.1** The documents according to [2.1.2.8.2](#) shall be submitted to the Register.

**12.2.3.2** The principles of operation shall be verified using logical analysis or hardware/software verification that simulates external cyber attacks.

## **12.3 REMOTE CONTROL CENTRE**

### **12.3.1 Tasks.**

**12.3.1.1** Performing a set of actions aimed at safe SW development for RCC systems.

**12.3.1.2** Maintenance of confidentiality, integrity and accessibility of information at all levels of interaction during RCC operation.

**12.3.1.3** Ensuring safe MASS monitoring and control.

**12.3.1.4** Ensuring safety of people on board (operators and personnel), equipment of ships being under the RCC control, and provision of environmental protection during autonomous and remote control navigation.

**12.3.1.5** Performing a set of actions aimed at prevention of immediate threats to security of information used for MASS operation, including:

ensuring safe and secure exchange of information between MASS, RCC and other participants of navigation maintained by the infrastructure of distributed information network;

ensuring the necessary, sufficient and excessive level of RCC cyber security;

generating plans of resumption of RCC systems and equipment functioning resumption after cyberattacks and other critical situations affecting cybersecurity and maintenance of continuous system operation;

prevention of leakage, misrepresentation of information related to RCC operation and MASS controlled by it;

prevention of unauthorized actions on destruction, misrepresentation, blocking of information and prevention of unauthorized access to the distributed information network infrastructure, RCC systems used for MASS control.

### **12.3.2 Requirements.**

**12.3.2.1** During the RCC design the following shall be taken into account:

the requirements for components of embedded devices of cyber security management systems (CSMS) that make up industrial automation and control systems (IEC 62443 series of standards);

the requirements for cyber security for industrial automation and control systems (IEC 62443-4-1:2018 standard);

plans and procedures of the shipping company, the ships being under the RCC control, for risk management regulated by the ISM Code and the ISPS Code;

the requirements and fundamental ergonomic principles and integrated approach to the design of work systems (ISO 6385 series of standards), main principles and structure of ergonomic design (ISO 11064 series of standards), ergonomics of visual information perception at the operator's workplace (ISO 8995-1-2002 standard / ISO 8995-2002 standard);

the requirements and criteria for the perception of visual danger signals in the area in which people are intended to perceive and to react to such a signals (ISO 11428:1996 standard);

principles of construction and safety for man-machine interface, marking and identification (IEC 60073 series of standards);

requirements for the redundancy of functions of the RCC information systems.

**12.3.2.2** The measures shall be taken on detection, identification and control of the possible cyber threats by means of analysis, risk assessment and control that may include:

specifying the responsibilities of operators and other key personnel;

identification of system parameters, data and technical characteristics of the RCC equipment and operational risks;

technical measures for cyber event prevention (protected networks, network access control, use of protected and detecting SW);

organizational measures for cyber event prevention (personnel training, SW update, access rights changing);

cyber event response plan (backup and network recovery after cyber event).

**12.3.2.3** Cyber security arrangements of RCC information systems shall include:

inhibit of external access to the RCC network structure;

lack of malicious hardware and software backdoors;

lack of hardware and software undeclared functions;

inhibit of unchecked control and technical means of RCC systems and equipment;

availability of specialists in the RCC key personnel capable of detecting, identifying and eliminating cyber threats in emergency situations;

provision of effective cyber security means (gateways, border security, unauthorized access control);

creating protected network resources;

formulation of cyber security policy;

implementation of up-to-date technical means for data security, authorization and control automation (firewalls, gateways, authorization means, antivirus systems).

**12.3.2.4** Control, analysis and assessment of RCC information system functioning shall be provided covering:

control equipment and systems, including cyber security control means;

valid methods of control, analysis and assessment of cyber security condition;

runtime of security level control performance;

personnel in charge of control.

**12.3.2.5** The following shall be developed for RCC operation:

program and procedure of information system checks indicating the intervals, methods, persons in charge considering the role of the processes to be verified and recent check results;

qualitative and quantitative criteria applicable for check performance.

**12.3.2.6** During the cyber security analysis and risk assessment of the RCC information systems the following shall be taken into consideration:

results of recent checks;

changes of external and internal conditions of the equipment and system operation;

information on functioning the equipment and systems ensuring cyber security;

results of assessment and fulfilment of risk management plan;

the possibility of cyber security level increase.

**12.3.2.7** During the detecting of nonconformities in the cyber security control parameters of the RCC information systems it is necessary to:

take measures on eliminating the nonconformities and effects;

evaluate the necessity of arrangements for eliminating the causes of cyber security violation;

perform the required corrective actions for preventing further threats;

perform analysis of the corrective actions result;

introduce changes in the RCC cyber security system.

**12.3.2.8** All information on cyber security risks and threats for the RCC information systems shall be documented.

**12.3.2.9** The procedure of cyber security risk assessment of information systems shall be specified and applied for:

specifying and ensuring the use of cyber security assessment criteria;

ensuring that the performed cyber risk assessments produce noncontradictory, reliable and comparable results;

- ensuring cyber threat detection;
- ensuring cyber security risk analysis;
- ensuring cyber security risk assessment.

**12.3.2.10** During design of the RCC information systems the need in internal and external communications required for the RCC and MASS functioning shall be determined and shall include:

- purpose and time of data exchange;
- objects of data exchange;
- technical means and procedures of data exchange.

**12.3.2.11** At the design stage of the RCC information systems the resources required for development, implementation and maintenance of functioning of cyber security management system shall be specified.

**12.3.2.12** The required competence levels of the RCC operators and other personnel shall be specified that may affect the cyber security level.

**12.3.2.13** RCC operator and personnel shall be familiar with:

- cyber security policy;
- boundaries of responsibility for cyber security ensuring;
- possible effects of cyber threats in their responsibility area.

**12.3.2.14** Data servers used for data receipt and storage shall be backed up and located in two different places (to be at least divided by "A-60" class fire-fighting bulkhead) and shall be dynamically updated. Failure of one server shall have no effect on RCC operation.

**12.3.2.15** Precise diagram of MASS information network and communication equipment shall be developed and regularly updated. The diagram shall describe network architecture and contain a list of the identified equipment (determined by a model number) and SW (determined by a version number).

**12.3.2.16** User access management shall be based on the secure authentication protocol containing the best practices, such as prevention of shared or anonymous accounts, as well as regular password updating with the required high degree of complexity.

**12.3.2.17** In emergency, the contingency plan shall be established for operation of MASS and its system in the reduced capacity mode.

**12.3.2.18** SW shall be regularly updated in compliance with updating policy. This policy shall include:

- list of components (machines and SW) to be updated;
- duties of different participants of updating process;
- means used for updating;
- check of updates prior to installation;
- recovery procedure of the previous configuration in case of upgrade failure.

**12.3.2.19** SW shall be installed and upgraded only from the server of control system SW manufacturer (supplier).

**12.3.2.20** Basic information and SW backup means shall be available to ensure recovery.

**12.3.2.21** During the analysis of RCC software requirements, the requirements for ensuring of information security considering the requirements of flag State Maritime Administration shall be specified.

**12.3.2.22** During design of RCC software architecture it is necessary to:

- develop a model of information security threats;
- clarify the SW architecture taking into account the list of actual threats;
- prepare proposals on manageability of detected potential threats.

**12.3.2.23** During the development and integration of RCC software it is necessary to:

- use identified tool for SW development;
- determine and accept the formatting procedure of source code of the program;
- perform statistic analysis of the source code of the program;
- make an expert examination of the source code of the program.

**12.3.2.24** During the testing in attendance of the RS surveyor, the following shall be performed:

- function testing of the program;
- anti-intrusion testing.

**12.3.2.25** During the program installation and support of RCC software acceptance it is necessary to:

- ensure SW protection against the threats related to violation of integrity during its delivery to the customer;
- deliver operating documentation to the customer.

**12.3.2.26** While solving the RCC software problems during its operation it is necessary to:

- implement and use tracking and rectification of SW bugs, as well as program vulnerabilities;
- perform systematic search of program vulnerabilities.

**12.3.2.27** During development of RCC software documentation, as well as adjustment of its configuration it is necessary to:

- determine and accept the procedure of unique marking of each SW version;
- determine and accept SW configuration management system.

**12.3.2.28** During the management of RCC software development framework infrastructure the following actions shall be implemented:

- protection against unauthorized access to the program configuration components;
- backing up of the program configuration components;
- registration of events related to the facts of changing of the program configuration components;

**12.3.2.29** During the personnel management it is necessary to:

- ensure periodical training of the personnel;
- ensure periodical analysis of the personnel training program.

**12.3.2.30** List of protected RCC information resources shall include:

- information containing the information classified as state secret;
- confidential information (including the information marked "for internal use", as well as sensitive restricted information);
- information resources, whose security may result in performance degradation of hardware forming part of MASS and, consequently, reducing of MASS efficiency and voyage assignment failure.

**12.3.2.31** Access matrix of access subject related to the RCC protected information resources shall contain an indication of location paths of the protected information resources.

**12.3.2.32** When modelling the security threats to information processing by RCC, the procedure for threat relevance determination shall be developed and proposals on the actual threat neutralization shall be prepared.

**12.3.2.33** Information security arrangements of RCC and distributed information system infrastructure shall include conducting of organizational measures, as well as application of information security technical means ensuring the following functions performance:

- identification and authentication;
- access control;
- event registration;
- trusted upload ensuring;
- integrity control;
- antivirus protection;
- intrusion detection;
- firewalling;
- emergency destruction of sensitive information.

**12.3.2.34** The necessity of the RCC automated systems certification and distributed information network infrastructure in the certification system of information security system of the flag State Maritime Administration shall be determined.

**12.3.3 Verification methods.**

**12.3.3.1** The documents according to [2.1.2.8.3](#) shall be submitted to the Register.

**12.3.3.2** Systems and equipment (including software and hardware) of RCC that renders services for ships shall be subject to the RS technical supervision.

**12.3.3.3** Maintenance procedures shall be established for RCC. Maintenance and tests shall be carried out on a regular basis.

**12.3.3.4** The principles of operation shall be verified using logical analysis or hardware/software verification that simulates external cyber attacks.

## **12.4 MOVEMENT DELIMITING MARKING**

### **12.4.1 Tasks.**

**12.4.1.1** Ensuring security of navigational information generated by the movement delimiting marking and applied for safe MASS navigation is based on:

use of information security approaches aimed at safe SW development;

ensuring confidentiality, integrity and accessibility of information at the stage of operation of movement delimiting marking;

use of territorial, software and hardware methods of information security.

**12.4.1.2** Ensuring safe resumption of operation of movement delimiting marking after disabling, complete failure or failure of its separate elements.

### **12.4.2 Requirements.**

**12.4.2.1** SW development for movement delimiting marking shall be followed by a set of actions aimed at ensuring safe development:

during SW requirements analysis;

SW architecture design;

SW development and integration;

SW testing;

SW installation and its acceptance support;

solving SW problems during its operation;

development SW documentation, as well as performance of its configuration (changing the program structure);

control of SW development environment infrastructure;

personnel management.

**12.4.2.2** Ensuring confidentiality, integrity and accessibility of information at the stage of operation of movement delimiting marking shall be provided by the following main protection means:

development of a list of protected information resources;

development of access matrix related to protected information resources;

modelling of information security threats;

development of information security measures (including, inter alia, application of technical security means ensuring identification and authentication functions, access control, event registration, integrity control, trusted upload, antivirus protection, intrusion detection, firewalling, emergency destruction of sensitive information).

**12.4.2.3** Ensuring territorial, software and hardware methods of the information security at the stage of operation of movement delimiting marking shall be provided by the following main protection means:

protection of directional source used of movement delimiting;

location of directional sources used for movement delimiting in places ensuring their persistence;

prevention of distortion of the submitted information from the source use for the movement delimiting.

**12.4.3 Verification methods.**

**12.4.3.1** The documents according to [2.1.2.8.4](#) shall be submitted to the Register.

**12.4.3.2** The principles of operation shall be verified using logical analysis or hardware/software verification that simulates external cyber attacks.

**12.5 INTERACTION OF DISTRIBUTED INFORMATION NETWORK COMPONENTS**

**12.5.1 Tasks.**

**12.5.1.1** Ensuring security of information used for MASS, RCC, movement delimiting marking, means of information delivery through hardware, software and territorial information security means.

**12.5.1.2** Ensuring safe resumption of operation of distributed information network after disabling, complete failure or failure of its separate elements.

**12.5.2 Requirements.**

**12.5.2.1** Current list of cyber threats for the distributed information network shall be maintained. The list shall contain separate lists for the network in general and its component parts: MASS, RCC, movement delimiting marking, standard means of information delivery, etc. (where required).

**12.5.2.2** Cyber threat security shall be provided by organizational and technical measures for each particular part of the distributed information network: MASS, RCC, movement delimiting marking, standard means of information delivery (where required).

**12.5.2.3** Cyber threat security shall be provided by methods of SW development of the distributed information system and shall be ensured by the architectural solutions of network design at hardware-software level.

**12.5.2.4** Cyber threat security shall be provided by methods of operation of the distributed information system ensuring confidentiality, integrity and accessibility of information for every component thereof: MASS, RCC, movement delimiting marking, standard means of information delivery, etc. (where required).

**12.5.2.5** Cyber security protection of the distributed information network shall be provided with means of self-checking and identification of abnormal scenarios of its use and shall ensure in the real time:

- check of access rights for SW control, update/recovery;
- detect exposure to communication channels, spoofing, etc.;
- check of integrity of the transmitted data in the communication systems and navigation control systems, as well as internationally standardized and open data (AIS, ASM, AtoN, VDES, GNSS, ENC, etc.);
- check of encryption of the transmitted data;
- check of operability of MASS being under the RCC control with the simultaneous control of interference immunity of communications, pass band, delay in reception-transmission of data.

**12.5.2.6** Hardware and software means of cyber security shall be annually verified during the RCC survey based on the developed test programs and procedures.

**12.5.2.7** Personnel in charge of operability of the cyber security means shall undergo annual testing and training.

**12.5.3 Verification methods.**

**12.5.3.1** For survey of cyber security of the distributed information, the following documents and plans/drawings shall be submitted to the Register:

documents confirming compliance with the requirements of [12.5.2.2 — 12.5.2.4](#);

documents according to [2.1.2.8](#) for the verification of each component of the distributed information network: MASS, RCC, movement delimiting marking, standard means of information delivery, etc. (if required).

**12.5.3.2** Cyber security of the distributed information network shall be verified during the annual survey for confirmation of compliance with the established requirements.

**CONCEPT OF MARITIME AUTONOMOUS  
AND REMOTELY CONTROLLED SURFACE SHIP (MASS) OPERATION**

No. \_\_\_\_\_ date \_\_\_\_\_

**1 MASS description**

1.1 Name (ship's flag and name) \_\_\_\_\_

1.2 Type \_\_\_\_\_

**2 Variants of MASS operation**

2.1 Basic variant of ship operation	(the most generic description of the main principles of ship operation in compliance with the accepted design standards)
2.2 Additional variant of ship operation	(the most generic description of the main principles of ship operation in compliance with the accepted design standards)

**3 MASS main particulars**

Design period of use	(years)
Ship control level	Remotely controlled / Autonomous
Length overall (LOA)	m
Breadth overall (BOA)	m
Empty ship weight	t
Displacement	t
Minimum draught	m
Maximum draught	m
Speed (maximum)	knots
Autonomy	days
Operational area	(restricted by distance, distance to refuge (function of time, speed and sea state), maximum operating draught)
Deadweight	Liquids per tanks dry cargo dangerous goods (weight, volume and location)

**4 MASS operating conditions**

4.1 Ambient conditions of operation	
Wind	(maximum wind force and speed for safe operation)
Atmospheric precipitation	(snow/rain)
Maximum temperature	(maximum average day air temperature to be indicated)
Minimum temperature	(minimum average day air temperature to be indicated)
Air humidity (at the temperature)	(one-hundred-percent relative humidity at all temperatures)
Icing	(where specially required)
Visibility	(with respect to night operation)
Atmospheric pressure	(where specially required)
Solar radiation	(where specially required, e.g. in the equatorial zone)
Electromagnetic radiation	(where specially required)
Air quality	(where specially required, e.g. in case of operation in coastal areas near desert)
Biological conditions	(where specially required, e.g. in the areas with known high life activity)
4.2 Marine operating conditions	
Depth	
Sea state	(sea condition, operational wave height, maximum wave height)
Ice class	
Maximum sea temperature	(average day maximum to be indicated)
Minimum sea temperature	(average day maximum to be indicated)

*Regulations for Classification of Maritime Autonomous and Remotely Controlled Surface Ships (MASS) – Appendix A*

Tidal motion	(permissible height and maximum speed (related to mooring))
Ship deck flooding	(ship area subject to flooding or splashing, frequency)
Oceanic currents	(where specially required, e.g. for drifting objects)
Water quality	(where specially required, e.g. while operating in river estuaries)
Sea surface quality (flotsam, impurity, vegetation)	(where specially required, in river estuaries)
Acoustic fields	(where specially required)
Electromagnetic field	(where specially required)
Seabed/ground	(where specially required)
Offshore shoals, channels	(dimensions, ground condition, where specially required)
<b>4.3 Special operating conditions</b>	
Noise and vibration	
Mooring arrangements	(including the maximum berth contact speed)
Launching/hook out	(proposals for ship construction)
Transportation/storage	
Towing and salvage	

## **5 MASS manoeuvring characteristics (for assessment of risks and manoeuvring safety)**

### **5.1 General parameters of MASS movement**

Maximum from equilibrium		
	Value	Period (sec)
Rolling (deg)		
Pitching (deg)		
Yawing (deg)		
Heaving oscillation (m)		
Heavy sea (m)		
Slow roll (m)		
Vibration (Hz)	(caused by wave motion and action)	
(design values of deviation from the static condition to be given)		

### **5.2 MASS controllability on even keel, fully loaded in deep water**

Nos.	Manoeuvre	Action/Description	Result
1	Turning circle of the ship	at full speed, at rudder deflection 35° starboard	Diagram, description
		at full speed, at rudder deflection 20° starboard	Diagram, description
		pushing the ship from 0 to 50 %, at rudder deflection 20° starboard	Diagram, description
2	Ship manoeuvre "Zigzag" at full speed	at rudder deflection 10°/10°	Diagram, description
		at rudder deflection 20°/20°	Diagram, description
3		Manoeuvre of evaluation of initial turning ability (manoeuvring ability of the ship at full load at ship turning 10° upon rudder deflection 10° starboard)	Diagram, description
4		Manoeuvre of turning the ship to constant angular velocity at rudder deflection 20° starboard/portside	Diagram, description
5		Relationship of stable angular velocity, speed loss and ship drift during turning at different rudder deflection starboard/portside	Diagram, description
6		Manoeuvre of ship change of heading at full speed to parallel heading	Diagram, description
7		Manoeuvre of ship change of heading at full speed to reverse heading ("manoeuvre man overboard")	Diagram, description

**5.3 MASS inertia and braking characteristics on even keel, fully loaded in deep water**

Nos.	Manoeuvre	Action/Description	Result
1		Accelerated movement of stationary ship up to full speed upon receipt of "Full ahead!" command	Diagram, description
2	Manoeuvre of active slowdown of the ship from full	speed to full stop upon receipt of "Full astern!" command	Diagram, description
		of speed to slow speed upon receipt of "Full astern!" command	Diagram, description
3		Manoeuvre of passive slowdown of the ship from full speed to 1 knot speed upon receipt of "Stop the engine!" command	Diagram, description
4	Basic parameters of ship direct movement	ship speed performance (cargo/ballast)	Diagram, description
		engine telegraph parameters (position, rate of sailing, power/rpm of main engine, pitch/propeller characteristics (for CPP))	Diagram, description
5		Accelerated movement of stationary ship up to full astern speed upon receipt of "Full astern!" command	Diagram, description
6		Accelerated movement of stationary ship up to full ahead speed, automated ship control system (with regard to autopilot limitations, SPP remote automated control)	Diagram, description

**5.4 MASS inertia and braking characteristics on even keel, fully loaded in shallow waters (1.5 N/T)**

Nos.	Manoeuvre	Action/Description	Result
1		Accelerated movement of stationary ship up to full speed upon receipt of "Full ahead!" command	Diagram, description
2	Manoeuvre of active slowdown of the ship from full	speed to full stop upon receipt of "Full astern!" command	Diagram, description
		of speed to slow speed upon receipt of "Full astern!" command	Diagram, description
3		Manoeuvre of passive slowdown of the ship from full speed to 1 knot speed upon receipt of "Stop the engine!" command	Diagram, description
4		Accelerated movement of stationary ship up to full astern speed upon receipt of "Full astern!" command	Diagram, description
5		Accelerated movement of stationary ship up to full ahead speed, automated ship control system (with regard to autopilot limitations, SPP remote automated control)	Diagram, description
6	Behavior of free-drifting ship in full load, on even keel, in calm water	Decaying rolling at initial heel of 10°	Diagram, description
		Decaying rolling at initial trim of 2°	Diagram, description

Nos.	Manoeuvre	Action/Description	Result
7	Behavior of free-drifting ship in full load, on even keel due to wave effect	Ship drift depending on wind direction	Diagram, description
		Course-keeping at wind disturbance depending on wind direction	Diagram, description
8	Behavior of free-drifting ship in full load, on even keel due to wave effect		Diagram, description
9	Ship drift depending on wave direction		Diagram, description
10	Course-keeping at wind disturbance depending on wave direction		Diagram, description

**5.5 MASS behavior in full load/ballast, on even keel in the shallow waters**

Nos.	Manoeuvre	Result
1	Squat depending on under-keel clearance	Diagram, description
2	Speed loss in the shallow waters	Diagram, description
3	Loss of control in the shallow waters	Diagram, description

**5.6 MASS behavior in full load/ballast, on even keel using ship positioning means**

Nos.	Manoeuvre	Result
1	Ship swinging manoeuvre by means of parallel-operated thrusters operated at full power	Diagram, description
2	Manoeuvre of ship stop by one anchor casted to sandy bottom in shallow waters at full length of the anchor chain	Diagram, description

**6 Control level of MASS systems**

Structure	Description
Situational awareness	
Communications means	
Means of navigation and manoeuvring	
Ship power plant (SPP)	
Hull	
Deck machinery	
Ship damage control means	
Environmental protection means	
Anti-intrusion protection of the ship	
<p><b>Notes:</b> 1. Add subsystems where necessary.                  2. It is advisable that backing up of ship active control means (propulsion devices and thrusters) shall be provided on board MASS and outage of one of them shall not interfere MASS safe navigation and not result in its stop.</p>	

**7 Main principles of operation**

Control methods	Manual/semi-autonomous/fully autonomous/remotely operated	
Limitations	Cargo limitations	
	Loading limitations	
	Structural limitations	
	Other limitations	
	(including all limitations permitted according to the variants of ship operation)	
Specific operations	(requirements related to ship specifics, e.g. cargo handling operations, requirements for cargo, including storage thereof)	
Anchorage and mooring	(frequency of limitation use due to sea state)	
Towing (not referred to emergency one)	(requirements for ship to be towed, operational scenarios, etc.)	
Launching, hoisting, transportation	(the way the ship will rotate for operation, etc.)	
Hull strength management	(approaches to structure state management)	
Buoyancy and stability	(approaches to stability control, e.g. approval of Stability Booklet, stability instrument, Damage Stability Booklet)	
Machines, machinery and electrical systems	Equipment	Main principles of operation
	Propulsion system	
	Manoeuvring system	
	Ship buoyancy and stability control systems	
	Deck machinery	
	Emergency power supply systems	
	Electrical power plant	
	High voltage/low voltage power supply and distribution systems	
	Control systems	
	Communication systems	
	Navigation systems	
	Auxiliary systems	

Control methods	Manual/semi-autonomous/fully autonomous/remotely operated
Fire safety	Fuel on board fuel in tanks storage batteries/accumulators
	liquid cargo in tanks cargo in tanks cargo handling equipment
	Anchorage, mooring, towing and other operations
	Fire detection equipment
	Fire extinguishing equipment
	External assistance shore connection MASS to ship connection
Flood control	
Navigational equipment	(operational requirements for navigational equipment)
Dangerous cargo transportation	(actions during cargo transportation)
Repairability	(means of ship resumption after failure of autonomous or remote control system)

**8 Main principles of inspection, maintenance and decommissioning**

Main principles of examination (inspection)	(review of inspection (examination) principles)
Inspection schedule	(frequency and extent of inspection)
Main maintenance principles	(review of maintenance principles)
Maintenance schedule	(maintenance schedule and scope of the planned maintenance)
Main principles of decommissioning	(review of decommissioning principles)

## METHODS OF VERIFICATION OF SYSTEMS OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS)

### 1 GENERAL

Equipment of MASS control systems shall be verified under normal operating and emergency conditions of its operation by means of full-scale tests or virtual platforms for navigation situation modelling for compliance with normative documents ensuring safety of navigation for these types of ships while moving on the high seas, in restricted waters, entering the port and mooring to the equipped terminals.

### 2 VERIFICATION PROCEDURE

**2.1** The following equipment installed on board MASS ([refer to Fig. B-1](#)) is subject to verification:

- .1** that receives information on external conditions, target situation (position of target ships) in the format of data from ship devices;
- .2** that receives information on the own ship position and condition of its systems, cargo;
- .3** that transmits control commands (control actions) in the format of data from control system installed on board the ship;
- .4** that receives own ship's response (including warning information) to control actions in the format of data from ship devices.

**2.2** The verification may be carried out onshore or on board the ship, therewith the equipment to be verified and devices used for verification thereof shall be isolated from the ship systems.

**2.3** The verification is carried out using full-scale tests or by means of software (SW) of the virtual platform for navigation situation modelling ([refer to Fig. B-2](#)), which:

- .1** simulates external conditions, target situation (target ships position) on the electronic chart basis, simulates the behavior (parameters) of the own ship movement;
- .2** transmits data from sensors (indicators), receives control commands (control actions);
- .3** monitors compliance with the requirements of COLREG-72 and SOLAS-74.

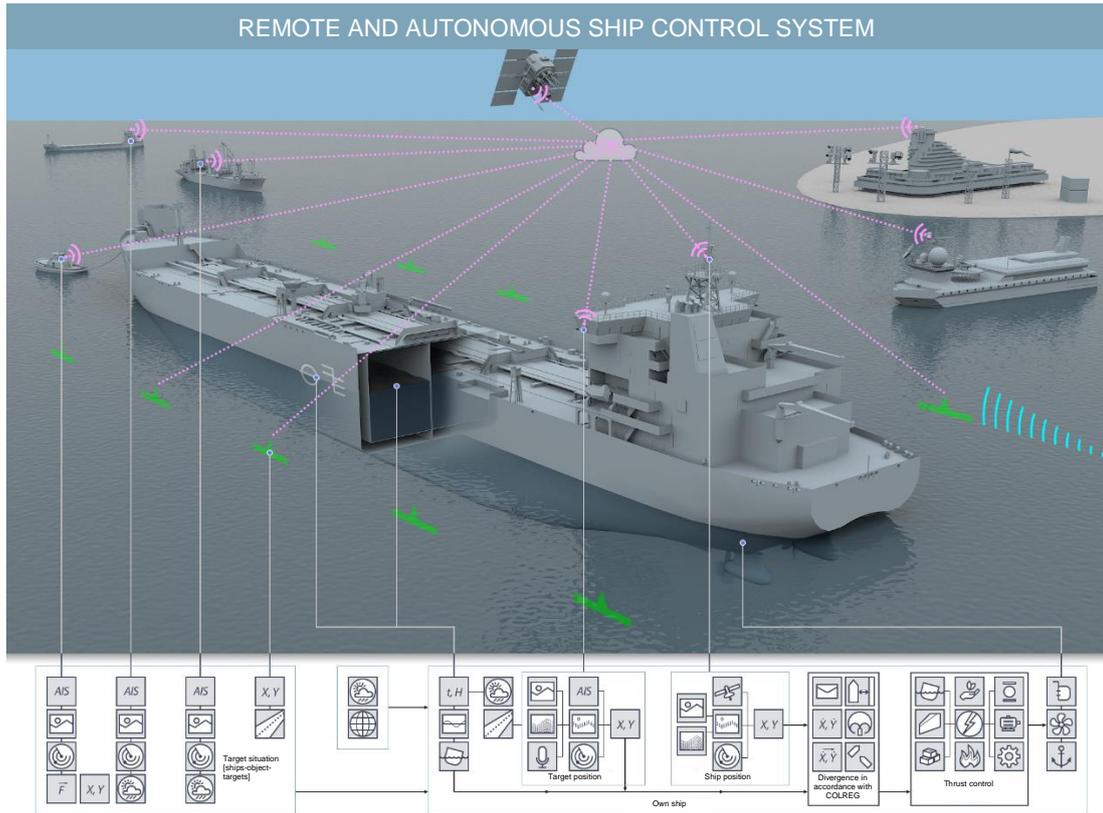


Fig. B-1  
Ship equipment to be verified

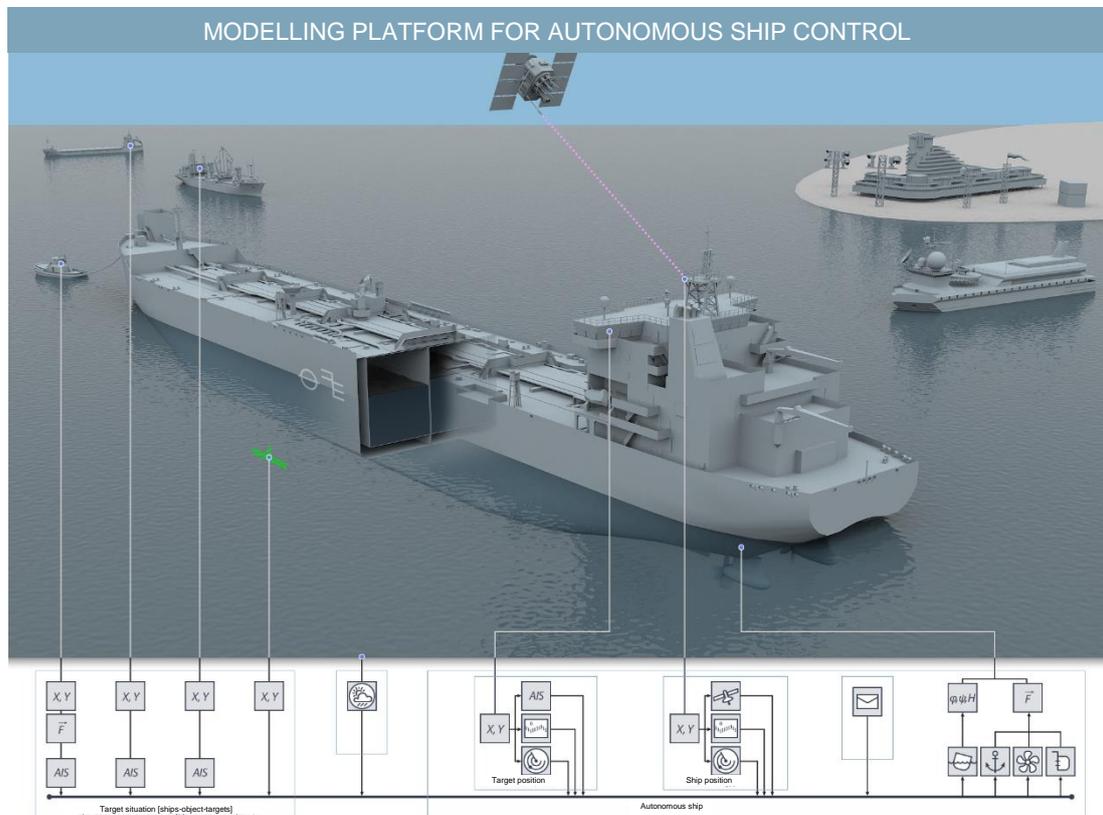


Fig. B-2  
Virtual platform for navigation situation modelling

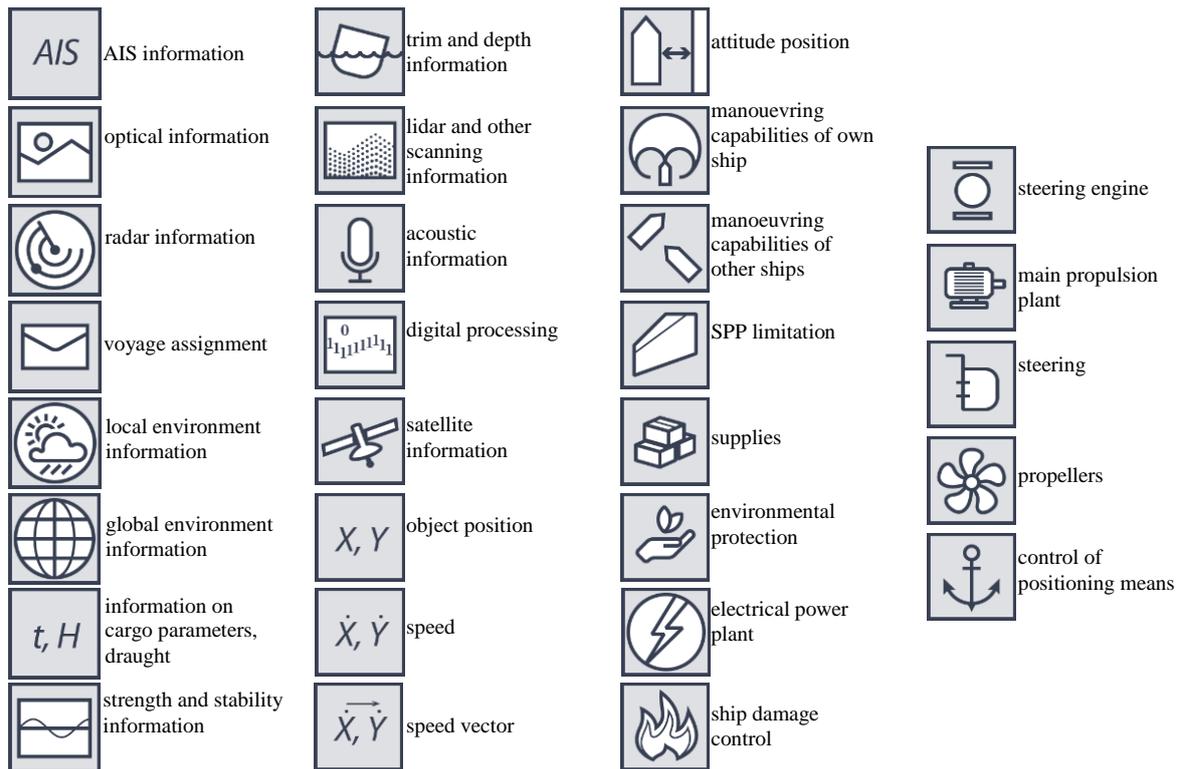


Fig. B-3  
Explanatory notes to pictograms given in Figs.B-1 and B-2

**2.4** The verification is performed in the course of full-scale tests (for example, sea trials) or using a numbered SW version of the MASS control system or a numbered SW version of virtual platform for navigation situation modelling, during the interaction of which:

- .1 all exchange data shall be documented, and in case of data loss the lost values shall be recorded with subsequent evaluation of their significance;
- .2 SW of the MASS control system and the virtual platform for navigation situation modelling shall operate synchronously in the real-time and accelerated time modes;
- .3 monitoring of exchange data between the equipment to be verified and the virtual modelling platform shall be performed;
- .4 the possibilities shall be available for inputting main failures of sensors, data delivery errors, signal noises, errors of control command.

**2.5** The verification is performed in accordance with the program and procedure of tests given for the main modules of control system, where:

- .1 the actual events specific to the type of equipment to be verified shall be reproduced in real time (and if possible, in accelerated time);
- .2 the possibilities to start and verify all functional capabilities of control system without manual (additional) adjustment of the exchange data shall be available;
- .3 the possibility shall be provided for verification of the system operational stability, verification by running the predefined tests with known result of the system operations.

**2.6** The verification is performed for separate and joint operation of three main systems used for MASS control:

- .1 target situation detection system and own ship position detection system with the possibilities of their displaying;
- .2 forecasting and safe ship passing systems in compliance with COLREG-72 regulations and good maritime practice;

.3 movement and manoeuvring control system for thrust control based on the decisions made by the forecasting and safe ship passing systems ([refer to 2.6.2](#)).

2.7 Generally, the verification of target situation detection system and own ships position detection system with the possibilities of their displaying is performed in compliance with the existing RS requirements for navigational equipment of ships (refer to Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships). Additionally, the following shall be verified:

.1 correctness of the excessive positioning information processing and timing from several coordinate-time and navigation support systems;

.2 meeting the requirements on target identification based on television information in visible and infrared bands in the conditions of increased and reduced lighting intensity;

.3 meeting the requirements on target positioning using the redundant information of several sources operating on the basis of different physical principles (radio detection, television, AIS, lidar, etc.);

.4 the possibility and sufficiency for ensuring safety of situation identification and positioning of the own ship with regard to its size in constraint environment conditions for manoeuvring (waterways, sea channels, port waters, in vicinity of cargo terminals, etc.);

.5 meeting the requirements of sufficiency, operativity and fidelity of transmitting the information on target situation identification and own ship positioning to the RCC;

.6 meeting the requirements on receipt and processing orders received from the RCC.

2.8 The verification of forecasting system and safe ship passing systems in compliance with COLREG-72 regulations and good maritime practice is performed to verify:

.1 receipt and processing of data on current navigation (target) situation from ship GNSS, AIS, ARPA equipment shall be verified, their synchronization and consistency check shall be made in analogy for each MASS surrounding target. Finally, the position, absolute and relative course and speed shall be established, as well as target ship identifiers (name, type, IMO number, MMSI), then the parameters for evaluation of possible manoeuvring shall be determined;

.2 the possibility of forming an area of navigation shall be verified (with regard to limitations/recommendations) based on electronic chart information (with corrections): coastal line, isobaths, depths, recommended routes, navigation hazards, special areas of navigation;

.3 the possibility of assessing and forecasting the development of navigation situation created by dynamics of the following shall be verified: MASS and surrounding target ships with regard to: navigation hazards, shipping route and application of regulations 13, 14, 15 and 18 of COLREG-72, as well as based on the established criteria of dangerously close approach evaluation;

.4 the rules of decision-making on safe target ship divergence in case of dangerously close approach shall be verified that ensure divergence with all target ships at the prescribed distance from MASS by means of verifying the compliance with the regulations of COLREG-72 with respect to: draught, navigation hazards, prohibited areas of navigation, as well as using the optimality criteria, evaluation of dangerously close approach on the basis of good maritime practice;

.5 correctness shall be verified of recommendations for choosing the safe route with safe movement parameters related to navigation hazards and target ships at a given distance;

.6 the following shall be verified: integrity of the recorded data during the situational analysis of target ships positions; assessment and forecasting of each ship situation according to COLREG-72; hazardous target extraction for MASS control systems; and data of recommendation log of forecasting system of ship safe passing according to MASS movement parameters, target ships, applicable regulations of COLREG-72.

**2.9** The verification of movement control and manoeuvring system for thrust control is performed to verify:

**.1** ensuring movement using commands received by forecasting and safe ship passing system based on receipt of:

or route points coordinates, given speed of MASS movement on a tack (straight-line segment of the route) and turning radius of MASS transfer from one tack to another;

or given course and given speed . Or as one more variant: based on given turning radius for the given side (given turning rate) and given speed;

**.2** the possibility of speed control by means of:

by main engine rotation frequency (ME remote automated control) and, where available: by pitch of controllable pitch propeller (CPP remote automated control);

or by propeller rotation frequency and turning angle of the main azimuth thrusters (azimuth thruster remote automated control);

**.3** the possibility of course control by means of:

rudder;

or by turning angle of the main azimuth thrusters (azimuth thruster remote automated control);

**.4** the possibility of MASS positioning by means of:

thruster control system (thruster remote automated control); or

separate MASS dynamic positioning system;

**.5** operation of a separate channel for receipt of MASS position feedback based on the data from GLONASS/GPS duplicated system, log, gyrocompass, electronic or magnetic compass, two wind sensors, ME remote automated control, CPP remote automated control, remote automated control of electric propulsion motor, thruster remote automated control.

**2.10** The possibility shall be verified of transmitting the current information on MASS position, speed and course, accepted control commands and information on navigation sensor condition and movement control means to the voyage data recording system (from which the information may be transmitted to RCC).

**2.11** The comprehensive check of the simultaneous operation of three main systems ([refer to 2.6](#)) used for MASS control shall be performed for verifying the implementation possibility of the following main functions:

**.1** navigation system:

voyage planning;

passage planning;

determination of MASS position data, course and speed;

passage;

supervisory monitoring;

determination of the closest point of approach and time of the closest approach to the potential navigation hazards, objects and other ships;

monitoring of depth, sea state, tide waters, currents, weather and visibility;

monitoring of sea passage and parameters of systems involved in performance thereof;

tracking of distress signals from other seafarers and response thereon;

determination of surrounding situation (free navigation without limitations, heavy traffic, coastal navigation, moving in restricted waters, restricted visibility, bad environmental conditions, glacial weather, ice conditions, pilot assistance necessity);

berthing, mooring operations;

manoeuvring;

control of propulsion system (main engine);

course-keeping and steering;

grounding and collision avoidance;

use of weather recommendations for the passage;

communications with other ships;

ship-to-shore communication (i.e. receipt of corrections, connection with navigation control centre, weather forecast receipt, salvage operations, pilotage and other data);  
indication of own and processing of navigation lights and audible signals;  
overall control of all navigation bridge systems;  
overall control of MASS condition and its operating capabilities;

**.2** ship power plant systems (SPP):  
overall control of the systems related to engine room;  
control and monitoring of main and auxiliary machinery (fuel system, cooling system, heating system, lubricating oil system, hydraulic system, high pressure air system and other systems, where necessary);  
overall control of electrical power plant operation and electrical power distribution;  
monitoring and control of standby and emergency power supply;  
monitoring and control of ballast system (where required by quick inclining system);  
control of embarkation, strength and stability systems of MASS hull, including damaged ship situation;  
control and monitoring of draining system, bilge water and sewage system;  
control and monitoring of fresh and sea water system;  
control of fuel consumption and fuel consumption optimization;  
monitoring and control of exhaust gas systems;  
automatic planning of maintenance and repair activities with due regard to maintenance schedule for all machinery;

**.3** MASS special systems:  
control and monitoring of cargo system and cargo condition;  
control and monitoring of watertight closures and doors;  
control and monitoring of high voltage systems;  
control of anchor operations systems;  
control of systems for mooring operations;  
control of fire detection and fire extinguishing systems;  
control of dynamic positioning systems;  
control of ship's event recording systems (self-recording apparatus).

## **RISK ASSESSMENT PROCEDURE OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS), REMOTE CONTROL CENTRE (RCC)**

### **1 TASK**

The procedure of MASS risk assessment in respect of the equipment on board with regard to the equipment characteristics expressly determined by expert opinions and the probabilities of the equipment outage shall be developed within an individual project.

The procedure of RCC risk assessment in respect of the equipment on board with regard to the equipment characteristics expressly determined by expert opinions and the probabilities of the equipment outage shall be developed in analogy and on the basis of MASS risk assessment procedure.

This Appendix contains the fundamental requirements to be taken as a basis for the individual project.

### **2 RISK CALCULATION PROCEDURE OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS)**

Select experts familiar with MASS equipment and systems or those of conventional ships.

Conduct an expert assessment of the exhaustive list of risks for each individual mechanism, the MASS system. Therewith, every risk shall be presented by an event independent of other events.

Conduct an expert assessment of each simple risk proportion for each mechanism as a whole.

Conduct an expert assessment of the probability of event occurrence related to each simple risk for each mechanism installed on board MASS (but, first of all, it shall be implemented for systems ensuring autonomous navigation and those specified in [Appendix A](#)).

To make risk calculation per each group of simple risks.

Make a composition of complex risks according to the systems based on a composition of feature-based (simple) risks.

### **3 METHODS OF VERIFICATION OF RISK CALCULATION OF MARITIME AUTONOMOUS AND REMOTELY CONTROLLED SURFACE SHIPS (MASS)**

Based on the submitted procedure, the software (SW) shall be developed enabling to make calculations in case of changing the configuration and operability of MASS ship equipment.

Based on the submitted procedure, the software (SW) shall be developed enabling to make calculations in case of changing the configuration and operability of RCC equipment.

**MASS STATEMENT OF COMPLIANCE**  
**Issued for confirmation of the ship compliance with**  
**the Regulations for Classification of Maritime Autonomous and Remotely**  
**Controlled Surface Ships (MASS)**  
**of the Russian Maritime Register of Shipping**

**PARTICULARS OF SHIP**

Name of ship	Reg. No.
Place of construction	Date of construction*
Shipyard	Construction (Hull) number
Type of ship	Design number
Operational area	MASS category
Limitations	concept of MASS operation No.                                  dated
*Date of actual completion of the RS surveys prescribed for technical supervision during construction of ship, and issue of this Statement.	

**MASS MAIN ELEMENTS, MEANS AND SYSTEMS**

1. Situational awareness system
  
2. Radiocommunication and data exchange means
  
3. Means of navigation and manoeuvring
  
4. Ship power plant (SPP)
  
5. Remote control centre (RCC)
  
6. Means of movement delimiting marking (means of marking)

**THIS IS TO CERTIFY:**

1. that MASS constructed under the RS technical supervision has been surveyed in accordance with the submitted concept of MASS operation No. \_\_\_\_\_ of \_\_\_\_\_ as per design documentation listed in the final conclusion letter No. \_\_\_\_\_ of \_\_\_\_\_;
2. that during the design, manufacture of materials and products, and construction the compliance with the requirements of normative documents specified in the contractual specification of the ship and related to the RS competence has been confirmed;
3. that the survey shows that the ship, its arrangements, systems, equipment, outfit and elements comply with the Regulations for Classification of Maritime Autonomous and Remotely Controlled Surface Ships for the following MASS category:

This Statement is valid until \_\_\_\_\_

Place of issue  
of the Statement \_\_\_\_\_

Date  
of issue \_\_\_\_\_

**Russian Maritime Register  
of Shipping**

\_\_\_\_\_  
(signature, name of the authorized official issuing the  
Statement)

L. S.

No. \_\_\_\_\_

**STATEMENT OF COMPLIANCE  
OF MASS REMOTE CONTROL CENTRE  
Issued for confirmation of compliance of the remote control centre (RCC) with  
the Regulations for Classification of Maritime Autonomous and Remotely  
Controlled Surface Ships (MASS)  
of the Russian Maritime Register of Shipping**

**INFORMATION ON THE REMOTE CONTROL CENTRE**

RCC type	Date of construction*
Location**	Design number
*Date of actual completion of the RS survey prescribed for technical supervision during construction of MASS RCC, and issue of this Statement. **For fixed RCC	

**LIST OF RCC SYSTEMS AND EQUIPMENT:**

**LIST OF RCC PERSONNEL:**

**LIST OF SHIPS UNDER THE RCC CONTROL:**  
(MASS type, reg. No.)

**LIMITATIONS:**

**NOTES:**

**THIS IS TO CERTIFY:**

1. that RCC constructed under the RS technical supervision has been surveyed in accordance with the submitted concept of MASS operation No. \_\_\_\_\_ of \_\_\_\_\_ as per design documentation listed in the final conclusion letter No. \_\_\_\_\_ of \_\_\_\_\_;

2. that the survey shows that RCC, its systems and equipment comply with the applicable requirements of the Regulations for Classification of Maritime Autonomous and Remotely Controlled Surface Ships (MASS).

This Statement is valid until \_\_\_\_\_

Place of issue  
of the Statement \_\_\_\_\_

Date  
of issue \_\_\_\_\_

**Russian Maritime Register  
of Shipping**

\_\_\_\_\_  
(signature, name of the authorized official issuing the  
Statement)

L. S.

No. \_\_\_\_\_

Russian Maritime Register of Shipping

***Regulations for Classification of Maritime Autonomous  
and Remotely Controlled Surface Ships (MASS)***

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