RULES
R012-2025

CHINA CLASSIFICATION SOCIETY

RULES FOR INTELLIGENT SHIPS

2025

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CONTENTS

CHAPTER 1 GENERAL

1.1 General requirements

1.1.1 The Rules apply to ships for which CCS Intelligent Ship class notation is requested.

1.1.2 Intelligentization means applications specific to certain object which are integrated by means of modern communication and information technology, computer network technology and intelligent control technology. Such applications generally include, but not limited to, assessment, diagnosis, prediction and decision making. Intelligentization is generally characterized by:

(1) Perception, i.e. the ability to perceive the ship itself and its equipment and the outside world and obtain outside information;

(2) Memory and thinking, i.e. the ability to store perceived outside information and knowledge arising from thinking, and at the same time analyze, calculate, compare, judge, associate and make decisions on information by making use of available knowledge;

(3) Learning and self-adaptability, i.e. the ability to continuously learn and accumulate knowledge by interacting with the environment so as to be adaptable to environmental changes;

(4) Behavioral decision making, i.e. the ability to respond to external stimulus, make decisions and convey relevant information.

1.1.3 Intelligent ships are those ships which automatically perceive and obtain information and data on ship itself, marine environment, logistics and port by making use of sensors, communication, the Internet of Things, the Internet and other technical means, and achieve intelligent operation in terms of ship navigation, management, maintenance and cargo transportation based on computer technology, automatic control technology and big data processing and analyzing technology, so that ships can become safer, more environmentally friendly, economical and efficient.

1.1.4 Base on a trend of development from local application to full ship application and from assisted decision-making to fully autonomous operation, the functions of intelligent ships normally consist of intelligent navigation, intelligent hull, intelligent machinery, intelligent energy efficiency management, intelligent cargo management, intelligent integration platform, remote control and autonomous operation.

1.1.5 Unless otherwise expressly provided in the Rules, ships for which an Intelligent Ship class notation from CCS is requested are also to comply with corresponding CCS rules and the applicable requirements of the Administration of the flag State.

1.2 Equivalence and exemption

1.2.1 Any ship which embodies structure and features of a novel kind may be exempted from relevant requirement of CCS rules if the application of which might impede the incorporation of its features or its service, subject to approval by CCS.

1.2.2 Any fitting, material, appliance or apparatus, other than that required in CCS rules, may be allowed to be fitted in a ship, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance or apparatus is at least as effective as that required in CCS rules.

1.2.3 Equivalence or substitution to those methods of calculation, criteria of evaluation, manufacturing procedures, materials, survey or test requirements specified by CCS rules may be accepted subject to approval by CCS, when relevant tests, theoretical basis or experience in application is provided, or recognized effective standards are available.

1.2.4 CCS encourages the application of new technologies. Where the new technologies are beyond the scope of the existing rules, risk assessment and tests are to be carried out to prove that the system and equipment adopting the new technologies can provide an equivalent level of safety to that required by CCS rules.

1.2.5 The risk assessment may be carried out in accordance with CCS Guidelines for Application of Formal Safety Assessment of Ships or methods given in relevant national or international standards.

1.2.6 The new technology may be approved in accordance with CCS Guidelines for Application of Alternative Design and Arrangements of Ships .

1.3 Alterations and repairs

1.3.1 A ship assigned Intelligent Ship class notation, which has undergone any alteration or repair of its equipment or system in association with intelligent ship functions, is to be subject to a survey, as appropriate, for confirming compliance with the technical requirements for the existing notation.

1.4 Class notation for intelligent ships

1.4.1 A ship, which has, upon its request, undergone plan approval and surveys by CCS and its compliance with the requirements of the Rules in terms of intelligent navigation, intelligent hull, intelligent machinery, intelligent energy efficiency management, intelligent cargo management, intelligent integration platform, remote control and autonomous operation is confirmed, may be assigned the following Intelligent Ship class notation according to the approaches specified below:

i-Ship (Ai, Ri, Nx, Hx, Mx, Ex, Cx, I)

where the letters in the parentheses stand for functional notations of intelligent ships, which may be assigned in accordance with the functions possessed by the ship. Functional notations can be added based on the development of technology.

1.4.2 Functional notations are defined as follows:

Ai– functional notation for autonomous operation, for which the requirements of Chapter 9 of the Rules are to be satisfied;

Ri– functional notation for remote control, for which the requirements of Chapter 8 of the Rules

are to be satisfied;

Nx– functional notation for intelligent navigation, for which the requirements of Chapter 2 of the Rules are to be satisfied;

Hx – functional notation for intelligent hull, for which the requirements of Chapter 3 of the Rules are to be satisfied;

Mx – functional notation for intelligent machinery, for which the requirements of Chapter 4 of the Rules are to be satisfied;

Ex – functional notation for intelligent energy efficiency management, for which the requirements of Chapter 5 of the Rules are to be satisfied;

Cx – functional notation for intelligent cargo management, for which the requirements of Chapter 6 of the Rules are to be satisfied;

I – functional notation for intelligent integration platform, for which the requirements of Chapter 7 of the Rules are to be satisfied;

i – numbers such as 1, 2, 3, indicating the scope and degree of remote control and autonomous operation. Only one corresponding number can be selected according to the specific functions of the ship.

x – additional notation for optional function. One small letter stands for one additional notation for function and a functional notation may have multiple additional notations for function, which shall be separated by comma. Detailed requirements are given in Chapters 2 to 7 of the Rules.

1.4.3 If one functional notation has already covered the function of another notation, only one notation is assigned. Functional notations may be combined according to the following principles:

(1) Nx, Hx, Mx, Ex, Cx, I can be assigned according to the actual functions of the ship;

(2) Between Ai and Ri, only one can be selected according to the practical condition of the ship;

(3) R1 can be assigned together with Nx, Hx, Mm, a, p, Ex, Cx;

(4) R2 can be assigned together with Hx, Mm, a, p, Ex, Cx;

(5) Ai can be assigned together with Hx, Mm, a, p, Ex, Cx.

1.4.4 Upon request, dredgers engaged in dredging operations may be assigned the functional notation for intelligent dredging Dx where the requirements of 10.2 of Chapter 10 of the Rules are complied with, subject to satisfactory plan approval and survey by CCS. The meaning of Dx and technical requirements are given in Table 1.4.4.

1.4.5 Upon request, scientific research ships engaged in scientific research tasks may be assigned the functional notation for intelligent scientific research SRx where the requirements of 10.3 of Chapter 10 of the Rules are complied with, subject to satisfactory plan approval and survey by CCS. The meaning of SRx and technical requirements are given in Table 1.4.4.

1.4.6 Upon request, harbor tugs used for assisting vessels in entering and leaving ports, berthing and unberthing, moving berths, turning around and entering and leaving dry docks, etc., may be

assigned the functional notation for intelligent towing operation Tx where the requirements of 10.4 of Chapter 10 of the Rules are complied with, subject to satisfactory plan approval and survey by CCS. The meaning of Tx and technical requirements are given in Table 1.4.4.

1.4.7 Upon request, geotextiles layers engaged in geotextiles laying operations may be assigned the functional notation for intelligent geotextiles laying Gx where the requirements of 10.7 of Chapter 10 of the Rules are complied with, subject to satisfactory plan approval and survey by CCS. The meaning of Gx and technical requirements are given in Table 1.4.4.

Functional notation for intelligent operations **Table 1.4.4**

Functional notation for intelligent operations	Meaning of functional notation		Technical requirements
Dx	Intelligent dredging	D — basic function of intelligent dredging as specified in 10.2.1.3, Chapter 10 of the Rules; x — additional functional notation, expressed by the following lowercase letters: a—the one-click dredging function specified in 10.2.1.4(1), Chapter 10 of the Rules can be realized; m—condition-based maintenance is implemented for dredging equipment; o—the optimization function of dredging operation parameters specified in 10.2.1.4(3), Chapter 10 of the Rules can be realized.	10.2 of Chapter 10 of the Rules
SRx	Intelligent scientific research	SR — basic function of scientific research operation management as specified in 10.3.3.1, Chapter 10 of the Rules; x — additional functional notation, expressed by the following lowercase letter: c— the monitoring function of scientific research operation as specified in 10.3.3.2, Chapter 10 of the Rules can be realized.	10.3 of Chapter 10 of the Rules
Tx	Intelligent towing operation	T — basic function of intelligent towing operation as specified in 10.4.6.3, Chapter 10 of the Rules; x — additional functional notation, expressed by the following lowercase letters: m — condition-based maintenance for towing equipment and system specified in 10.4.6.4(1), Chapter 10 of the Rules; s — towing operation coordination specified in 10.4.6.4(2), Chapter 10 of the Rules.	10.4 of Chapter 10 of the Rules
Gx	Intelligent geotextiles laying	G — basic function of intelligent geotextiles laying as specified in 10.7.1.3, Chapter 10 of the Rules; x — additional functional notation, expressed by the following lowercase letters: a—the one-click geotextiles laying function specified in 10.7.1.4(1), Chapter 10 of the Rules can be realized; m— condition monitoring and health management for geotextiles laying equipment specified in 10.7.1.4(2), Chapter 10 of the Rules can be realized; e — the function of assisted decision-making on energy efficiency optimization of geotextiles laying operations specified in 10.7.1.4(3), Chapter 10 of the Rules can be realized; o — the optimization function of geotextiles laying operation parameters specified in 10.7.1.4(4), Chapter 10 of the Rules can be realized.	10.7 of Chapter 10 of the Rules

1.4.8 Class memorandum is to be given for ships to which CCS Intelligent Ship class notation is assigned for the first time and the implementation survey is to be carried out by CCS surveyor no earlier than 6 months after installation survey and no later than the first annual/intermediate/special survey after 6 months (whichever is the earlier). During the implementation survey, the following is to be verified by a surveyor:

(1) relevant intelligent systems have been operated effectively according to the approval documentation, and pre-designed functions are achieved, including a comparison with baseline data;

(2) implementation report of intelligent systems (refer to annual report), including relevant survey and testing reports;

(3) relevant operating personnel are familiar with operating the scheme;

(4) detailed working records of intelligent system, including records of any limiting parameters (alarms and warnings) that have been modified during operation of the scheme;

(5) records of any failures and repair of the ship together with the equipment and systems are reviewed to ensure that relevant intelligent systems are effective.

The survey unit is to report to the Headquarters if the ship is found to fail to satisfy the requirements during the implementation survey, and the Headquarters will remind the owner or ship management company in writing as appropriate, and require the owner or ship management company to take corrective actions within a specified period and failure to do so will result in cancellation of the relevant Intelligent Ship class notation.

1.4.9 The assignment, maintenance, suspension, cancellation and reinstatement of Intelligent Ship class notation are to be in accordance with the requirements of Section 9, Chapter 2 of PART ONE of CCS Rules for Classification of Sea-Going Steel Ships.

1.5 Computer systems

1.5.1 Relevant hardware and software of intelligent systems covered by the Rules are to satisfy the relevant requirements of Section 6, Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-Going Steel Ships and to be subject to plan approval and survey by CCS.

1.5.2 Software development is to satisfy the requirements of CCS Guidelines for Assessment of Security and Reliability of Marine Software.

1.5.3 Risk assessment is to be carried out to the computer system. During system design and assessment, relevant failure conditions and system response to such failure conditions are to be determined. The interaction between faults is to be eliminated or restricted by means of design of software and hardware of relevant equipment while fault detection and tolerance are to be provided. In addition to the software testing within the normal range, the testing in abnormal range is also to be carried out, in order to ensure correct response ability of equipment and software under abnormal input and condition.

1.6 Personnel requirements

1.6.1 The owner or ship management company is to develop corresponding management regulations, training plans and operational procedures for intelligent systems, in order to specify requirements such as responsibilities, qualifications and training of personnel operating and using intelligent systems.

1.6.2 Relevant operating personnel are to be familiar with and competent for the operation and maintenance of the corresponding intelligent systems.

1.7 Cyber security requirements

1.7.1 In the Rules, intelligence-related computer systems of categories II and III are to comply with the SL0 cyber security requirements of Chapter 2 of CCS Guidelines for Ship Cyber Security. Computer systems of category I may refer to the above-mentioned requirements for implementation. For computer systems of category III (e.g. remote control systems, autonomous control systems), it is recommended to follow the higher-level cyber security requirements specified in Chapter 2 of CCS Guidelines for Ship Cyber Security.

1.7.2 If requirements of 1.7.1 cannot be met, an exemption may be requested in accordance with Section 4, Chapter 1 of CCS Guidelines for Ship Cyber Security.

1.7.3 For cyber security of intelligent systems, the inspection/assessment of products is to be carried out according to Chapter 3 of CCS Guidelines for Ship Cyber Security.

1.7.4 During the entire life cycle of the ship, if the intelligent system is changed, it is to comply with the provisions of 4.3.23 of Chapter 4 of CCS Guidelines for Ship Cyber Security.

1.8 Security system

1.8.1 For ships with remote control or autonomous operations (with Ri or Ai functional notations), their security systems are to, in addition to the applicable requirements of the Administration, comply with the requirements of 1.8.2 to 1.8.4.

1.8.2 Access control

1.8.2.1 The number of external openings of hull, superstructures and deck house for access are to be minimized to meet the minimum requirements of the intended usage.

1.8.2.2 The door to any means of access in the ship is to be capable of automatic closing. The locking arrangement of doors and access (e.g. small hatchways) is to be so designed that they can be remotely operated by the remote control station and opened or closed by authorized personnel.

1.8.2.3 For ships applying for R1 class notation (see definition in 8.1.3 of Chapter 8 of the Rules), requirements for access control are to be determined considering specific ship manning and responsibilities. If the ship manning and responsibilities meet the minimum manning requirements of conventional ship, requirements of 1.8.2.2 may be exempted.

1.8.3 Detection, surveillance and alarms

1.8.3.1 The range of onboard detection and surveillance systems is to cover overboard

surrounding areas, means of access to the ship and restricted areas onboard. The detection capacity is to be such that a suspected object around the ship, as well as its direction of movement and speed, can be identified.

1.8.3.2 The ship and its security system are to meet the following requirements:

(1) The detection system fitted on the ship is to be able to automatically send a warning to the remote control station and onboard control station (if applicable) once detecting the approach of a suspected object.

① If there‘s no crew on board, remote control station is to take appropriate actions according to the actual situation, such as sending security warning to the Administration or ship company, once the early warning is received;

② If there‘s crew on board, the crew is to activate security warning system according the actual situation to send warning to the Administration, ship company and remote control station.

(2) Onboard spaces and means of access are to be provided with adequate lighting. Detection, surveillance and lighting equipment is able to be controlled by the remote control station and/or onboard control station (if applicable).

1.8.3.3 For remote control ships provided with crew members (R1), requirements for detecting, monitoring and alarming are to be determined according to specific ship manning and responsibilities. If the ship manning and responsibilities meet the minimum manning requirements of conventional ship, requirements of 1.8.3.1, 1.8.3.2(1)①, 1.8.3.2(2) may be exempted.

1.8.4 Security communication

1.8.4.1 The communication systems of the ship and the remote control station are to be capable of keeping ship security communication, information and equipment smooth and unimpeded at all times, and security communication records are to be stored onboard and in the remote control station at the same time.

1.8.5 Identity recognition

1.8.5.1 The Ship is to take appropriate measures to carry out identity recognition of the embarking personnel in order to prevent unauthorized embarkation.

1.9 Operating manual

1.9.1 Operating manuals for relevant intelligent systems are to be provided onboard to specify procedures and descriptions in respect of system operation, inspection, maintenance and security.

1.9.2 Operating manual for Intelligent System is to be submitted to CCS for information. In general, the operating manual is to include:

(1) procedures and descriptions in respect of system operation, inspection, testing and maintenance;

(2) working conditions and limits in respect of system operation;

(3) emergency procedures.

1.9.3 Corresponding emergency procedures are to be established against the potential failure of intelligent systems during use, specifying the operation procedures and responsible person in the event of emergency, so as to minimize the effect on the safe operation of the ship and relevant equipment as far as possible.

1.10 Product certification requirements

1.10.1 In the rules, the functions corresponding to each functional notation may be implemented by one or more systems. The relevant systems and components are to meet the certification requirements in 1.10.2 of this Chapter, and the functions that the system can achieve are to be specified in the certificate.

1.10.2 Product certification of intelligent systems and components is to comply with the requirements of Table 1.10.2, where the symbols are explained as follows:

(1) C – Marine Products Certificate; E – Equivalent document; W – Manufacturer's document; X – Applicable; O – Optional;
(2) DA – Design approval; TA-B – Type approval B; TA-A – Type approval A; WA – Works approval; PA – Plan approval;
(3) X^3: If certification requirements for purchased parts can not be satisfied, complete type test is to be carried out with relevant intelligent system;
(4) Note ①: referring to marine data relay components, such as serial servers, protocol converters, aggregation switches, core switches, routers and other devices.

List of Certification Requirements for Intelligent Systems and Components Table 1.10.2

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
1	Intelligent navigation								
1.1	Aided navigation system	X	—	—	X	O	—	X	Applicable to ships applying for the functional notation Nx or Ai, see the relevant provisions of Chapters 2, 9 and 10 of the Rules
1.2	Autonomous navigation system	X	—	—	X	O	—	X	Applicable to ships applying for the functional notation Nx or Ai, see the relevant provisions of Chapters 2, 9 and 10 of the Rules
1.3	Remote control system	X	—	—	X	O	—	X	Applicable to ships applying for the functional notation Ri or Ai, see the relevant provisions of Chapters 8, 9 and 10 of the Rules
2	Intelligent hull								
2.1	Intelligent hull maintenance system	X	—	—	X	O	—	X	Applicable to ships applying for the functional notation Hh, see the relevant provisions of Chapters 3 and 10 of the Rules
2.2	Intelligent hull monitoring and assisted decision-making system	X	—	—	X	O	—	X	Applicable to ships applying for the functional notation Hm, see the relevant provisions of Chapters 3 and 10 of the Rules
3	Intelligent machinery								
3.1	Condition monitoring and health assessment system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation M or Mx, see the relevant provisions of Chapters 4 and 10 of the Rules
3.2	Assisted decision-making system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation M, see the relevant provisions of Chapters 4 and 10 of the Rules
3.3	Condition-based maintenance system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation Mx, see the relevant provisions of Chapters 4 and 10 of the Rules
4	Intelligent energy efficiency management								

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
4.1	Intelligent energy efficiency management system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation E or Ex, see the relevant provisions of Chapters 5 and 10 of the Rules
5	Intelligent cargo management								
5.1	Cargo/cargo hold monitoring, alarm and assisted decision-making system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation C or Cx, see the provisions of Chapter 6 of the Rules
5.2	Intelligent stowage system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation C or Cx, see the provisions of Chapter 6 of the Rules
5.3	Automatic cargo loading and unloading system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation Cl, see the provisions of Chapter 6 of the Rules
5.4	Intelligent tank washing system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation Cw, see the provisions of Chapter 6 of the Rules
6	Intelligent integration platform								
6.1	Intelligent integration platform system	X	—	—	X	—	—	X	Applicable to ships applying for the functional notation I, see the provisions of Chapter 7 of the Rules
7	Intelligent scientific research								Applicable to ships applying for the functional notation SRx, see the provisions of 10.3, Chapter 10 of the Rules
7.1	Intelligent scientific research system	X	—	—	X	—	—	X	
8	Intelligent dredging								Applicable to ships applying for the functional notation Dx, see the provisions of 10.2, Chapter 10 of the Rules. Product certification requirements for condition monitoring and health assessment, assisted decision-making, condition-based maintenance, energy efficiency management of equipment related to dredging operation are to

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
									comply with applicable requirements for intelligent machinery and intelligent energy efficiency management in the table.
8.1	Dredging operation parameter optimization system	X	—	—	X	—	—	X	
8.2	Dredging equipment control system	X	—	—	X	—	—	X	
9	Intelligent geotextiles laying								Applicable to ships applying for the functional notation Gx, see the provisions of 10.7, Chapter 10 of the Rules. Product certification requirements for condition monitoring and health assessment, assisted decision-making, condition-based maintenance, energy efficiency management of equipment related to geotextiles laying operation are to comply with applicable requirements for intelligent machinery and intelligent energy efficiency management in the table.
9.1	Intelligent geotextiles laying system	X	—	—	X	—	—	X	
10	Component of intelligent system								Applicable to ships applying for functional notations for intelligent ships
.1	Computer/server	—	X	—	X[3]	—	—	X	
.2	Display	—	X	—	X[3]	—	—	X	
.3	Uninterruptible Power Supply (UPS)	—	X	—	X[3]	—	—	X	
.4	Programmable controller	—	X	—	X	—	—	X	
.5	Data relay components①	O	X	—	X[3]	—	—	X	
11	Sensor/monitoring equipment								Applicable to ships applying for functional notations for intelligent ships
11.1	anemometer	—	X	—	X[3]	—	—	X	
11.2	Ship motion sensor	—	X	—	X[3]	—	—	X	
11.3	Short range detection equipment (such as infrared camera, photoelectric radar, etc.)	—	X	—	X[3]	—	—	X	
11.4	Vision enhancement system	—	X	—	X[3]	—	—	X	

CHAPTER 2 INTELLIGENT NAVIGATION

2.1 General requirements

2.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for intelligent navigation is requested.

2.1.2 Intelligent navigation means to obtain and perceive the status information necessary for ship navigation by means of advanced perception technology and sensing information fusion technology, and makes use of computer technology and control technology to carry out analysis and processing, so as to provide aided navigation decision-making suggestions. If feasible, the ship can realize autonomous navigation in open water, narrow channel, entering and leaving port, berthing and unberthing, and various navigation scenarios and complex environmental conditions.

2.1.3 Intelligent navigation is to have the following basic functions of aided navigation:

(1) route and speed design and optimization;

(2) vision enhancement;

(3) collision warning;

(4) grounding warning;

(5) integrated information display.

2.1.4 In addition to the basic function specified in 2.1.3, intelligent navigation may also have the following advanced functions:

(1) Autonomous navigation in open water;

(2) Autonomous navigation during entire voyage.

2.2 Functional notation for intelligent navigation

2.2.1 Upon request, the functional notation for intelligent navigation may be assigned subject to satisfactory plan approval and survey by CCS:

Nx

where: N – the ship with the function of aided navigation specified in 2.1.3;

No – based on the function of aided navigation, the ship is with the function of autonomous navigation in open water under the supervision of the personal onboard;

Nn – based on achieving the function of No, the ship is with the function of autonomous navigation and automatic berthing and unberthing in narrow channel and complex environmental conditions, so as to realize autonomous navigation during entire voyage.

2.3 Aided navigation

2.3.1 Route and speed design and optimization

2.3.1.1 For route and speed design and optimization, the route and ship speed are designed and optimized to achieve the voyage optimization goal, which is continuously optimized throughout the navigation period, in accordance with the technical condition and performance of the ship itself, specific navigation task, draft, cargo characteristics and sailing schedule and by taking into consideration such factors as wind, wave, current and swell, provided that the safety of ship, personnel and cargo is guaranteed.

2.3.1.2 Route and speed design and optimization are generally achieved by shipborne systems and shore-based supporting center.

2.3.1.3 Performance calculation model is to be built on the practical design parameters of the ship. The following data (if available) are in general to be considered:

(1) Ship general arrangement drawing;

(2) Ship lines plan and midship section with bilge keel details;

(3) Hydrostatic curves;

(4) Main engine particulars and shaft generator (if fitted) details;

(5) Main engine shop test results;

(6) Model test or ship trial reports;

(7) Typical past voyage reports showing ship speed, rate of revolution, power and fuel oil consumption (such data may be obtained from relevant systems of Chapter 5);

(8) Ship's performance of resistance against wind and wave;

(9) Ship loading manual.

Where such data is unavailable, the model may be established by means of theoretical analysis and empirical curves, and improvement may be made continuously based on data obtained from real ship.

2.3.1.4 Ship performance calculation model is to be provided with the function of dynamic adjustment. The model can be adjusted according to the practical operation conditions, so as to reflect actual performance of the ship and ensure the effect of route and speed design optimization.

2.3.1.5 The short-term and long-term weather data is to be considered and updated for route and speed design and optimization. The following data is to be obtained periodically:

(1) Wind direction and speed;

(2) Significant wave height;

(3) Wave height and mean period;

(4) Swell height, direction and mean period;

(5) Current speed and direction;

(6) Tropical cyclone (or typhoon): maximum wind speed, gust speed, radius of moderate gale, etc.;

(7) Extra-tropical cyclone: central pressure, moving path and speed, etc.;

(8) Warning of strong cold high pressure (cold wave and gale);

(9) Ice condition (where applicable).

2.3.1.6 Meteorological data are to be real-time and sufficiently accurate. The accuracy of short-term meteorological data (the weather forecast data within 1-5 days) is not to be less than 1.5deg*1.5deg, while the accuracy of long-term meteorological data (the weather forecast data within 6-14 days) is not to be less than 3deg*3deg.

2.3.1.7 The time span of meteorological data is to be able to cover the remaining navigation time period of the intended voyage of the ship. If the time span cannot completely cover the voyage days of the ship, a reasonable method for handling such situation that navigation days exceed the weather forecast period is to be described.

2.3.1.8 Route and speed design and optimization is to achieve one or more of the following goals in the highest sea scale for the set voyage:

(1) Optimization of navigation period, including fixed time of arrival and shortest time of arrival;

(2) Optimization of fuel oil consumption;

(3) Optimization of total cost.

2.3.1.9 Sea scale set for the voyage is not to exceed the design resistance level of the ship against wind and wave.

2.3.1.10 Navigation safety of the ship is to be the prerequisite for route and speed design optimization. The optimized route is to avoid obstacles and shoals and other hazardous areas for navigation.

2.3.1.11 The following route and speed design and optimization results are to be output and displayed: route, turning point and speed of each voyage segment. During the design stage, prompts for new solutions are to be based on the optimized results and relevant optimization information is displayed.

2.3.1.12 The ship is to be able to store the result of route and speed design and optimization and the actual navigational condition of the ship, for analysis and assessment of the optimized result.

2.3.2 Vision enhancement

2.3.2.1 The ship's multi-source perception information is to be fused and processed to generate an intuitive and stable visual picture that can assist the driver to make decisions, effectively compensate the driver's vision, and still can provide effective visual perception even under rain, snow, fog, light conditions and any other adverse weather conditions.

In the course of the ship's navigation, vision enhancement can accurately display at least 2000 m

away from the current position of the ship, and the surface navigation hazards within the angle of view of 112.5° from the front of the ship to the port and starboard sides of the ship in the horizontal direction.

2.3.3 Collision warning

2.3.3.1 Factors such as the external environmental conditions, current speed and maneuvering performance of the ship are to be comprehensively considered to analyze and evaluate the distance and encounter trend of the identified peripheral obstacles from the ship. The resulting trend prediction results are to be presented prominently.

2.3.3.2 According to the ship's expected nearest encounter distance and time under the current navigation state, and considering the collision avoidance distance and time required by the ship, audible and visual alarm is issued to the possible collision risk, indicating the relative position of the dangerous object and the ship, and the alarm can be immediately eliminated after being acknowledged by the driver, and the visual indication is retained.

2.3.4 Grounding warning

2.3.4.1 It is to be possible to obtain the historical data of the water depth of the ship's planned navigation waters, comprehensively consider the factors such as tide, water depth, heading, speed and draught state of the ship's navigation waters, predict the trend of the ship's grounding, and display it prominently.

2.3.4.2 Audible and visual alarm is issued to the possible grounding risk, indicating the grounding risk, and the alarm can be immediately eliminated after being acknowledged by the driver, and the visual indication is retained.

2.3.5 Integrated information display

2.3.5.1 The ship is to be provided with integrated information display, to comprehensively display route and speed design and optimization results, vision enhancement, collision trend, grounding trend and necessary information. The information display may refer to IMO Performance Standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays (resolution MSC.191(79), as amended).

2.3.6 Monitoring parameters and information

2.3.6.1 To realize the above-mentioned aided navigation functions, it is to be possible to monitor or obtain the following parameters and information, including but not limited to:

(1) Real-time perception of environmental and meteorological data during navigation, including:

① wind speed and direction;

② sea surface visibility;

③ flow velocity (historical data may be accepted instead).

(2) Real-time perception of the information on the ship itself:

① information on position, speed and heading;

② ship motion response, at least including pitch, roll and yaw;

③ port and starboard draught (bow, midship and stern draught);

④ main engine and/or propeller speed and rotation direction, pitch (if applicable), rudder angle, etc.

(3) AIS data of surface objects;

(4) Data of electronic charts and information updated;

(5) Waterway data and updates;

(6) Information on other objects at sea as follows:

① other ships, including position, motion direction, motion speed, size, actual distance and intersection angle with the ship itself, navigation status;

② information on other fixed obstacles and mobile objects on surface.

(7) Measured water depth of ship's position.

2.4 Autonomous navigation

2.4.1 Autonomous navigation in open water (No)

2.4.1.1 The ship is capable of autonomous navigation in open water. During such period, onboard personnel will supervise the navigational operation of the ship and can intervene at any time where necessary to obtain the control of navigation and maneuver the ship.

2.4.1.2 The ship is to fulfill basic functional requirements specified in 2.1.3 of this Chapter.

2.4.1.3 In a situation of open water navigation, the ship is to make analysis and decision-making based on the perceived and obtained navigational information, control the propulsion and steering system according to the intended route, and achieve autonomous navigation. The ship is to be capable of implementing collision prevention decisions and operations in accordance with the International Regulations for Preventing Collisions at Sea, 1972.

2.4.1.4 The ship autonomously navigating in open water is to be capable of perceiving and obtaining the parameters information specified in 2.3.6 of this Chapter at all times and using such information for autonomous decision-making:

2.4.1.5 The situation awareness system and autonomous navigation system are to have self-check and alarm functions, capable of providing continuous monitoring during the normal operation of equipment. When equipment failure is detected, it is to be capable of sending an alarm and failure message to the navigation control system and control station and generating a record.

2.4.1.6 The equipment and components of the situation awareness system and the autonomous navigation system are to be sufficiently reliable so as to minimize the failure probability. The equipment is to be so provided and arranged to ensure that the ship's perception, communication and navigation control capabilities are not affected or can be restored as soon as possible in case of single point failure of equipment.

2.4.1.7 The ship autonomously navigating in open waters is to be capable of fusing the data and information, at least the perceived data and information specified in 2.3.6 of this Chapter, so as to eliminate the perceptual errors from single source.

2.4.1.8 When the failure of the situation awareness system and the autonomous navigation system finally leads to the damage of autonomous navigation capability of the ship, an alarm is to be activated and the personnel onboard are to intervene and take over the operation of navigation of the ship.

2.4.1.9 The ship is to be provided with data server for the storage of information on condition and operation of the equipment and system related to navigation. The capacity of the data server is to be such that the data generated by 30 days as a minimum can be continuously stored. When the server capacity reaches its limit, the earliest historical data can be replaced by the latest data.

2.4.1.10 Where the design or equipment selection related to the autonomous navigation control and situation awareness function fails to meet the requirements of this Chapter, alternative or equivalent design may be accepted by CCS, provided that any risk existing in the design of intelligent navigation system in all autonomous scenarios is fully identified and analyzed by means of risk assessment method (e.g. FMEA), the risk control measure is proposed and the design of system is improved upon verification.

2.4.1.11 If the ship has other operating modes, switching between the operating modes is not to cause major changes in the direction and thrust and the operating status of related equipment.

2.4.2 Autonomous navigation during entire voyage (Nn)

2.4.2.1 The ship is to fulfil all requirements of autonomous navigation in open water (No).

2.4.2.2 The ship is capable of autonomous navigation in all scenarios including open water, narrow channel and entering/leaving port and of automatic berthing and unberthing. During such period, onboard personnel will supervise the navigational operation of the ship and can intervene at any time where necessary to obtain the control of navigation and maneuver the ship.

2.4.2.3 In all navigation scenarios, the ship is to make analysis and decision-making based on the perceived and obtained navigational information, control the propulsion and steering system according to the intended route, and achieve autonomous navigation. The ship is to be capable of implementing collision prevention decisions and operations in accordance with the International Regulations for Preventing Collisions at Sea, 1972.

2.4.2.4 In addition to the situation awareness requirements in 2.3.6 of this Chapter, the ship is to be capable of obtaining the following situation information for decision-making in navigational operation:

(1) Perception of the distance between the bow and stern and the shore as well as the angle between the ship and the shore;

(2) Information on changes of tide, flow velocity and direction at port and channels, and other relevant environmental information.

2.5 Equipment provision and performance requirements

2.5.1 General requirements

2.5.1.1 Systems and equipment related to intelligent navigation are to be subject to type approval and product inspection by CCS. Product certification of intelligent navigation systems and equipment is to satisfy the requirements of 1.10.1, Chapter 1 of the Rules.

2.5.2 Aided navigation

2.5.2.1 The ship applying for the functional notation of aided navigation is to be provided with:

(1) Gyro-compass or other ship heading systems;

(2) Electronic chart display and information system①;

(3) Position, navigation and timing (PNT) systems;

(4) Speed and distance measuring device;

(5) Anemorumbometer;

(6) Echo sounder;

(7) Ship motion sensor;

(8) Marine radar with ARPA function;

(9) Automatic Identification System (AIS);

(10) Visibility sensor;

(11) Flow velocity sensor;

(12) Ship draught meter;

(13) Ship communication devices;

(14) Vision enhancement system;

(15) Other necessary equipment and systems.

2.5.2.2 Aided navigation systems are to be at least supplied by the main source of electrical power.

2.5.2.3 Aided navigation systems are to comply with the requirements for category II computer systems.

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① Sea-going ships engaged on domestic voyages may use the electronic chart system (ECS).

2.5.3 Autonomous navigation

2.5.3.1 The ship applying for the functional notation for autonomous navigation is to be at least provided with the following:

(1) Autonomous navigation system;

(2) Redundant gyro compasses or other ship heading systems;

(3) equipment specified in 2.5.2.1(1)~(15).

2.5.3.2 For ships applying for functional notation for autonomous navigation during entire voyage, close range detection equipment, e.g. laser radar, is also to be provided.

2.5.3.3 The autonomous navigation system is to be directly supplied by two independent feeders from the main switchboard, one of which can be supplied by the emergency switchboard. Automatic change-over is to be realized in the event of failure of one power supply. In case that the system may be adversely affected by power interruption, power conversion is to be carried out in an uninterrupted manner.

2.5.3.4 Autonomous navigation systems are to comply with the requirements for category III computer systems and satisfy applicable provisions in Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

2.5.3.5 The measurement range, accuracy and delay of close range detection equipment are to satisfy the decision-making requirements for berthing/unberthing and realize continuous monitoring.

2.5.3.6 The radars are to have the detection capability of identifying marine hazardous objects on the water within 2.5 nautical miles.

2.6 Survey and test

2.6.1 The following plans and documents of intelligent navigation system are to be submitted for approval:

(1) Detailed documents of system design, including at least:

① the composition, function, overall performance, design and operation conditions of the main equipment of the system;

② hardware equipment technical specifications, configuration, input and output, connection between the main components of the system, power supply description;

③ software description;

④ user interface description.

(2) System function realization principle description;

(3) Type test program;

(4) Type test report (may be submitted after the type test is completed);

(5) Other drawings and documents as necessary.

2.6.2 The following plans and documents of intelligent navigation system are to be submitted for information:

(1) Risk assessment report;

(2) Operation manual.

2.6.3 For ships applying for the intelligent navigation notation, the following plans and documents are to be submitted for approval:

(1) Design specification;

(2) System diagram;

(3) Test program;

(4) Other drawings and documents as necessary.

2.6.4 For ships applying for the intelligent navigation notation, the following plans and documents are to be submitted for information:

(1) Main equipment layout;

(2) Intelligent navigation system instruction manual.

2.6.5 Initial survey

2.6.5.1 Confirming that relevant plans have been examined.

2.6.5.2 Confirming that the system related to intelligent navigation is furnished with relevant certificate.

2.6.5.3 Confirming, for different intelligent navigation functions, that a navigation officer is already familiar with the operation and maintenance of intelligent system and is competent to properly perform his duty.

2.6.5.4 Confirming the input, output and communication functions of intelligent navigation system.

2.6.5.5 Testing aided navigation system to verify aided decision-making function and safety warning function.

2.6.5.6 Confirming that relevant charts have been updated as appropriate.

2.6.5.7 For autonomous navigation in open water and autonomous navigation during entire voyage, verifying through real ship test the functions of situation awareness, navigation control and autonomous collision prevention, and intervention and taking over by personnel.

2.6.6 Survey after construction

2.6.6.1 For ships assigned with intelligent navigation functional notation, the actual effect of intelligent navigation function is to be verified through ships in service.

2.6.6.2 Previous service conditions of the systems are to be reviewed in combination with annual, intermediate and special surveys to confirm that they are in normal condition. It is also to be checked that the aided navigation system, situation awareness system and autonomous navigation system involved in intelligent navigation are in normal function.

2.6.6.3 Functions of the equipment and system are to be re-verified after their repair and renewal. Sea trial is to be carried out after renewal of the autonomous navigation system or repair or renewal of its core parts.

CHAPTER 3 INTELLIGENT HULL

3.1 General requirements

3.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for intelligent hull is requested.

3.1.2 System software related to hull maintenance is to satisfy the requirements for category I computer software.

3.1.3 System software related to hull monitoring and assisted decision-making is to satisfy the requirements for category II computer software.

3.2 Functional notation for intelligent hull

3.2.1 Upon request, the following functional notation for intelligent hull may be assigned subject to satisfactory plan approval and survey by CCS:

Hx

Where:

Hh– hull maintenance, for which the requirements of 3.3 of this Chapter are to be satisfied;

Hm –hull structure monitoring and assisted decision-making, for which the requirements of 3.4 of this Chapter are to be satisfied, and only assisted decision-making requirements for hull longitudinal strength and local strength in 3.4.3 need to be satisfied;

Hm+ --hull monitoring and assisted decision-making, for which the requirements of 3.4 of this Chapter are to be satisfied.

3.3 Hull maintenance

3.3.1 General requirements

3.3.1.1 To provide assisted decision-making for hull and deck machinery maintenance and structural renewal during in-service period of the ship based on the establishment and maintenance of hull database system and three-dimensional hull structural models.

3.3.1.2 Hull maintenance includes the following functions:

(1) Development of hull inspection and maintenance scheme;

(2) Development of deck machinery inspection and maintenance scheme;

(3) Recording and assessment of hull structural conditions;

(4) Development of structural renewal plan.

3.3.1.3 Hull database system is to be able to integrate data of three-dimensional hull structural models, hull and deck machinery inspection and maintenance data, structural thickness

measurement data and structural repair data.

3.3.2 Three-dimensional hull structural model

3.3.2.1 A visual three-dimensional hull structural model is to be established to store and transmit data produced from the ship in service in standardized electronic data forms, which should be timely maintained and updated for the in-service period of ship.

3.3.2.2 The three-dimensional hull structural model is to fully describe the actual hull structure, normally including at least plates (including properties such as thickness, materials), stiffeners (including properties such as structural scantling, material) and large brackets (including properties such as thickness, materials), etc.

3.3.2.3 Thickness change of hull structure is recorded and corrosion trend is predicted based on the three-dimensional hull structural model.

3.3.2.4 Hull structural repair data during ship in-service are recorded based on the three-dimensional hull structural model.

3.3.3 Development of hull inspection and maintenance scheme

3.3.3.1 Hull inspection and maintenance scheme means to develop a periodical inspection and maintenance scheme for hull structure using computer system, based on classification/statutory survey requirements for ships in service and the request from the ship operator, for guiding the crew to carry out routine inspection, maintenance and repair. This system is to satisfy the requirements from 3.3.3.2 to 3.3.3.6.

3.3.3.2 General inspection items, critical area and typical defect diagram are to be developed in accordance with the characteristics of hull structures.

3.3.3.3 The inspection results of coating and structure in each structural area of ship compartments are to be recorded. The inspection results of coating and structure, structural corrosion condition, defects and repair history are to be shown intuitively, including the following:

(1) Inspection standards and grading principle are to be established for “coating, average corrosion, pitting corrosion, grooving corrosion, deformation and crack”, generally consisting of GOOD, FAIR and POOR.

(2) In accordance with the inspection results of each structural area of ship compartments, the condition of each structural area and the compartment as a whole is to be graded, generally consisting of GOOD, FAIR and POOR.

(3) For structural areas graded as FAIR or POOR, the system is to provide necessary reminder and follow up.

3.3.3.4 The survey history of hull structures, information on the size of structural members of hull structures, historical data of thickness measurement, defect and repair history are reviewed.

3.3.3.5 The coating area and the weight of structural members during ship repair are calculated.

The repair work amount is assessed.

3.3.3.6 In addition to the periodical inspection and maintenance scheme, based on structural thickness records and assessment, the practical condition and reliability of the ship are analyzed comprehensively and an interim inspection and maintenance scheme of hull structures is developed.

3.3.4 Development of deck machinery inspection and maintenance scheme

3.3.4.1 Deck machinery inspection and maintenance scheme means to develop a periodical inspection and maintenance scheme for deck machinery using computer system, considering the characteristics of deck machinery, based on classification/statutory survey requirements for ships in service and the request from the ship operator, for guiding the crew to carry out routine inspection, maintenance and repair.

3.3.5 Recording and assessment of hull structural conditions

3.3.5.1 For hull structural thickness recording and assessment, the data of structural thickness is recorded within the in-service period of ship from completion of construction to decommissioning by using computer systems and based on the three-dimensional hull structural model, for which the requirements of 3.3.5.2 to 3.3.5.3 are to be satisfied.

3.3.5.2 Previous thickness measurement data and renewal history of structural members are recorded. Statistical analysis is carried out to previous thickness measurement data. Grading of corrosion condition of hull structures is shown intuitively and the trend of corrosion is predicted based on the change of thickness of structural members and the environment. Thickness measurement data analysis report is output.

3.3.5.3 The thickness measurement data is analyzed and graded in accordance with the following requirements or other equivalent methods based on collected thickness measurement data:

(1) The hull structure is divided into several compartments/spaces/areas, e.g. ballast tanks, cargo tanks (including void spaces, pump rooms etc.) and external structures (exposed strength deck and shell plating). For the thickness measurement data of each compartment/space/area, the statistical analysis method of 90% reliability (S-Curve method) is used for analysis.

(2) The grading result of thickness measurement is determined based on the grading section where the intersection point of 90% horizontal line (e.g. the horizontal dotted line in Figure 3.3.5.3 and thickness measurement curve is located (e.g. the thickness measurement of deck is assessed as grade 2 in Figure 3.3.5.3).

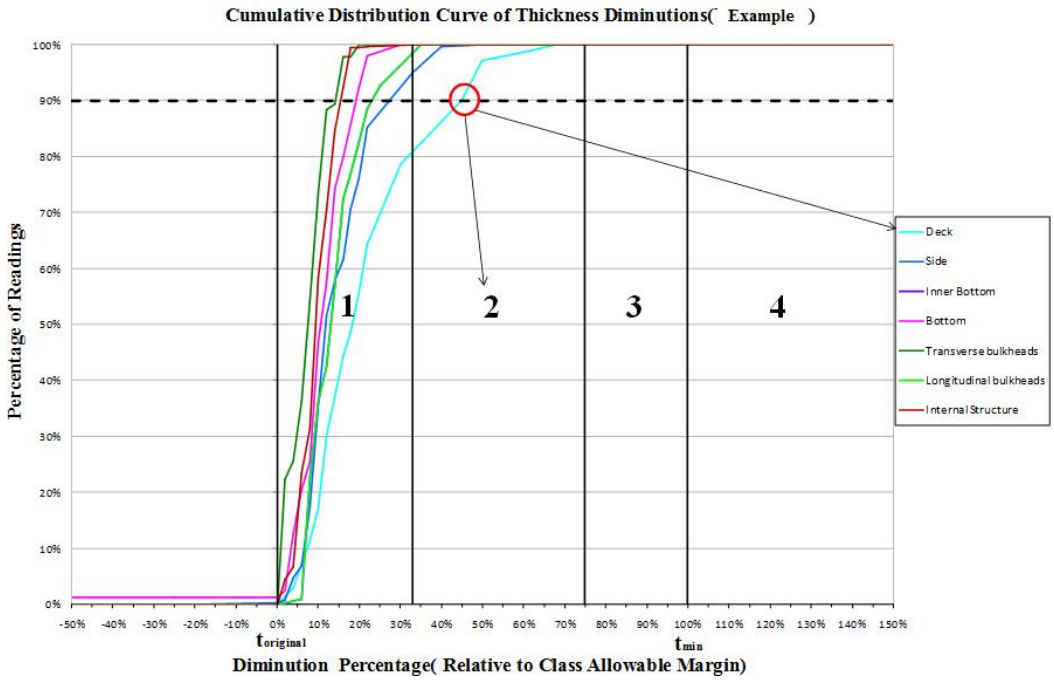

Figure 3.3.5.3 Analysis and grading of thickness measurement data

(3) For the boundary and structural members of each compartment/space/area, they are in general divided into several structural elements (including plates and attached stiffeners), e.g.: deck structure, side structure, bottom structure, inner bottom structure, transverse bulkhead structure, longitudinal bulkhead structure and internal structure (hatch cover and coaming are also to be included where applicable). Each structural element is divided into grade 1 to 4 in accordance with Table 3.3.5.3:

Grading standards of structural element **Table 3.3.5.3**

	Grade			
	1	2	3	4
Diminution percentage, r	$r \leq 33\%$	$33\% < r \leq 75\%$	$75\% < r \leq 100\%$	$r > 100\%$

(4) For compartments/spaces with common boundaries, the thickness measurement data of the common boundary is to be included in the compartment/space on both sides respectively.

3.3.6 Development of structural renewal plan

3.3.6.1 The report on structural renewal plan is to be developed and output based on thickness measurement data and corrosion trend prediction results, including renewal scope, calculation of renewed steels, workload assessment, etc.

3.3.7 Plans and documents

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

(1) Composition and description of three-dimensional hull structural model;

(2) System composition and function explanation.

3.3.7.2 The following documents are to be kept onboard the ship:

(1) The latest hull thickness measurement report;

(2) The latest hull thickness measurement data analysis report;

(3) Documents related to hull and deck machinery inspection and maintenance schemes.

3.3.8 Survey and test

3.3.8.1 The initial survey at least includes the following items:

(1) Confirming that the plans and documents have been approved;

(2) Confirming that the system related to intelligent hull maintenance has been approved;

(3) Confirming that general inspection items, critical areas and inspection interval of hull inspection and maintenance scheme satisfy requirements.

(4) After completion of the installation of relevant systems and equipment, tests are carried out in accordance with the approved testing procedures;

(5) Verifying hull maintenance related plans and implementation procedures (if applicable) to ensure that their contents are consistent with the real ship;

(6) Confirming that relevant drawings, manuals, procedures and relevant records are carried on board.

3.3.8.2 The annual/intermediate/special survey is at least to include the following items:

(1) The information specified by 3.3.7.2 is to be kept on board the ship.

(2) The thickness data of structural members and renewal history recorded in the hull database are consistent with practical conditions.

(3) The analysis report of hull thickness measurement data satisfies the requirements of 3.3.5.3.

(4) Personnel carrying out hull and deck machinery inspection and maintenance on board the ship are already familiar with the operation and maintenance of intelligent hull system.

(5) Witnessed by the surveyor, crew on board randomly select at least two ballast tanks for internal inspection, correctly determine the coating and structural conditions of the structural area under inspection and correctly enter the identified problem and assessed grade into the computer system.

(6) The records in the computer system of hull and deck machinery inspection and maintenance scheme are complete and consistent with practical conditions.

3.4 Hull monitoring and assisted decision-making

3.4.1 General requirements

3.4.1.1 The hull monitoring and assisted decision-making system collects, stores, analyzes and displays data such as hull structural stress, ship motion, ship loading, sea state, course and speed, which gives warning in case the change of such data exceeds the preset critical value and provides assisted decision-making on operation of ship.

3.4.1.2 The hull monitoring and assisted decision-making system is to include the following functions:

(1) Collecting and monitoring important parameters related to the safety of hull;

(2) Storing collected data;

(3) Carrying out calculation and abnormal analysis in accordance with the data collected by the monitoring system;

(4) Capable of giving alarms in a timely manner in case the analytical result is abnormal;

(5) Providing decision-making suggestions on ship operation in accordance with alarm parameters;

(6) Analyzing and recording sea state information and navigation parameters by link to the loading computer, gyro-compass and anemorumbometer, etc.

3.4.1.3 Hull monitoring is to comply with the relevant requirements for hull monitoring system in Chapter 21, PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships.

3.4.2 Parameter monitoring

3.4.2.1 The following data are to be obtained from hull monitoring:

(1) Sea environment data, e.g. wind force, wind direction, wave;

(2) Ship navigation parameters, e.g. course, speed;

(3) Ship motion and acceleration, at least including pitch, roll and heave;

(4) Ship floating condition, including draught of bow, midship and stern (port and starboard).

3.4.2.2 Hull structural monitoring parameters normally including the following according to the stress distribution feature of ship types:

(1) The longitudinal strength of the hull structure;

(2) Stress in the critical structural areas;

(3) Temperature of the structural members affected by high or low temperature;

(4) Bow slamming pressure (for applicable ship types);

(5) Liquid sloshing in tanks (for applicable ship types);

(6) Structural stress of ice belt region of ice-reinforced ships;

(7) Relevant monitoring parameters may be determined or further added in accordance with practical conditions of ship and safety needs.

3.4.2.3 Ship loading state is to be obtained from hull monitoring, normally including:

(1) Cargo hold loading volume (where applicable);

(2) Ballast tank loading volume (where applicable);

(3) Fuel oil, fresh water.

3.4.3 Assisted decision-making

3.4.3.1 Based on alarms from hull monitoring during navigation, cargo loading and unloading at docks and ballast water exchange, hull monitoring and assisted decision-making system is to be capable of providing appropriate assisted decision-making. Normally the following requirements are to be considered:

(1) During navigation, hull monitoring and assisted decision-making system is to be able to achieve the following functions:

① monitoring the hull's longitudinal strength. In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, course, speed, etc. so as to ensure that the ship's longitudinal strength is in safe condition;

② monitoring the hull's local strength (including critical structural areas). In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, course, speed, etc. so as to ensure that the ship's local strength is in safe condition;

(2) During cargo loading and unloading at docks, hull monitoring and assisted decision-making system is to be able to achieve the following functions:

① carrying out ship stability calculation (or obtain it from the loading instrument). In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, loading/unloading, etc. so as to ensure that the ship's stability is in safe condition;

② monitoring the hull's longitudinal strength. In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, loading/unloading, etc. so as to ensure that the ship's longitudinal strength is in safe condition;

(3) During ballast water exchange, hull monitoring and assisted decision-making system is to be able to achieve the following functions:

① carrying out ship stability calculation (or obtain it from the loading instrument). In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, etc. so as to ensure that the ship's stability is in safe condition;

② monitoring the hull's longitudinal strength. In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as to adjust ballast water, etc. so as to ensure that the ship's longitudinal strength is in safe condition;

(4) Relevant safety assessment and analysis and assisted decision-making requirements may be added in accordance with practical conditions of ship and safety needs.

3.4.4 Plans and documents

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

(1) Arrangement of sensors.

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

(1) System diagram;

(2) System operating manual;

(3) System hardware specification;

(4) System instructions;

(5) System testing procedure.

3.4.4.3 The following documents are to be kept onboard:

(1) The operating manual of hull monitoring and assisted decision-making system, which is at least to include description of the following:

① operation;

② setting and calibration of sensors and the system;

③ failure identification;

④ repair;

⑤ system maintenance and functional tests (showing testing methods for the components and the system and what is to be observed during tests);

⑥ explanations of test results.

(2) Maintenance and calibration log of hull monitoring and assisted decision-making system.

3.4.5 Survey and tests

3.4.5.1 The initial survey for hull monitoring and assisted decision-making system is at least to include the following items:

(1) Confirming that plans and documents have been approved;

(2) Confirming that the intelligent hull monitoring and assisted decision-making system has been approved;

(3) After completion of the installation of relevant systems and equipment, tests are carried out in accordance with the approved testing procedures;

(4) Confirming that relevant drawings, manuals, procedures and relevant records are carried on board.

3.4.5.2 During annual/intermediate/special surveys, at least the following items are to be examined for the hull monitoring and assisted decision-making system:

(1) Examining whether the system operates effectively;

(2) Examining the detailed working record of the system;

(3) Examining the repair record of system equipment;

(4) Confirming that the historical and analytical data are complete and carrying out random examination of report contents;

(5) Confirming that operators are familiar with the hull monitoring and assisted decision-making system and confirming the implementation condition;

(6) Examining and confirming that relevant instrumentation of the hull monitoring and assisted decision-making system has been calibrated in accordance with specified procedures and plans.

3.4.5.3 In case of any fault of the hull monitoring and assisted decision-making system, or any damage, repair or renewal of equipment, or any major change to the means of monitoring, the owner or ship management company is to apply for an occasional survey.

CHAPTER 4 INTELLIGENT MACHINERY

4.1 General requirements

4.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for intelligent machinery is requested.

4.1.2 Intelligent machinery is capable of carrying out analysis and assessment of the operating condition and health condition of the equipment and systems in machinery space by comprehensively using various information and data collected by the condition monitoring, thus providing support for decision-making on the usage, operation and control, servicing and repair, and management, etc. of the equipment and systems.

4.1.3 Intelligent machinery is to have the following basic functions:

(1) Carrying out monitoring of the operating condition of the equipment and systems related to main propulsion in machinery space;

(2) Carrying out analysis and assessment of the operating condition and health condition of the equipment and systems based on the condition monitoring data;

(3) Providing reasonable suggestions based on the result of analysis and assessment, in order to provide support for decision-making on the usage, operation and control, servicing and repair, and management, etc. of the equipment and systems;

(4) Main propulsion machinery is to be capable of being remotely controlled from bridge control station, and machinery space including machinery centralized control station is periodically unattended.

(5) During the unattended period, the equipment and systems in machinery space are to be capable of continuous and normal operation.

4.1.4 In addition to the basic functions of 4.1.3, relevant condition-based maintenance plan may be developed based on the result of analysis and assessment of the operating condition and health condition of the equipment and systems, which is used as the additional function of intelligent machinery .

4.1.5 For river to sea ships, high speed craft, small ships, pure battery-powered ships or other ships not engaged in transport of cargoes etc., designers may consult CCS to agree on the basic functions and associated requirements for intelligent machinery.

4.1.6 The condition monitoring scope of the equipment and systems may be determined through risk analysis, subject to the agreement by CCS.

4.1.7 For a ship directly propelled by conventional main diesel engine, at least the following equipment and systems shown in Table 4.1.7 is to be monitored:

List of equipment and systems being monitored **Table 4.1.7**

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Main diesel engine (direct propulsion)		
1.1		Cylinder combustion	Combustion condition
1.2		Cylinder liner	Sealing, heat transfer
1.3		Piston head (including piston ring)	Sealing, heat transfer
1.4		Cylinder cover (including intake valve and exhaust valve)	Sealing, heat transfer
1.5		Fuel nozzle/valve	Injection, atomization
1.6		Friction parts, e.g. main bearings, crankpin bearings, crosshead bearings (if fitted) and camshaft bearings, etc.	Wear, lubrication condition
1.7		Crankcase	Explosion-proof
1.8		Turbocharger	Turbocharging performance
2	Diesel engine for power generation		
2.1		Cylinder cover (including intake valve and exhaust valve)	Sealing, heat transfer
2.2		Cylinder liner	Sealing, heat transfer
2.3		Fuel nozzle/valve	Injection, atomization
2.4		Friction parts, e.g. main bearings	Wear, lubrication
2.5		Turbocharger	Turbocharging performance
3	Shafting for propulsion		
3.1		Gearbox (if any), e.g. bearings	Wear
3.2		Shaft and bearings	Wear, sealing condition①
4	Auxiliary system		
4.1	Fuel (oil) system (including the pilot fuel system of dual fuel engine)		
4.1.1		Fuel (oil) pump	Fuel (oil) supply capacity
4.1.2		Filter	Filtering of impurities
4.1.3		Heat exchanger (if fitted)	Heat exchange performance
4.2	Lubricating oil system		
4.2.1		Lubricating oil pump	Oil supply capacity
4.2.2		Filter	Filtering of impurities
4.2.3		Heat exchanger	Heat exchange performance
4.3	Water lubricating system		
4.3.1		Pump	Lubricating water supply capacity
4.3.2		Filter	Filtering of impurities

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
4.3.3		Heat exchanger (if any)	Heat exchange performance
4.4	Cooling system		
4.4.1		Pump	Cooling medium supply capacity
4.4.2		Heat exchanger	Heat exchange performance
4.4.3		Filter	Filtering of impurities
4.5	Hydraulic (servo) oil system		
4.5.1		Hydraulic oil pump	Oil supply capacity
4.5.2		Filter	Filtering of impurities
4.6	Starting and control air system		Air supply capacity
4.7	Air intake (four-stroke)/Scavenging (two-stroke) system		quality of cylinder combustion air
4.8	Exhaust gas system		Exhaust performance
4.9	Power supply for control-safety-alarm system (electrical, pneumatic, hydraulic)		Power supply capacity
Note①: For open water lubricated shafting, the monitoring of the sealing condition of the aft end of the tail shaft may not be necessary.			

4.1.8 In addition to the condition monitoring of applicable equipment and systems specified in Table 4.1.7, electric propelled ships are to satisfy the monitoring requirements specified in Table 4.1.8-1 or 4.1.8-2 respectively according to the type of distribution power system (AC or DC) used by the busbar.

List of equipment and systems of condition monitoring of AC distribution electric propulsion system

Table 4.1.8-1

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Generator		Overall working condition
1.1		Stator	Condition of stator, e.g. winding inter-turn insulation
1.2		Rotor (not applicable to permanent magnet motor)	Condition of rotor, e.g. rotor balance, inter-turn insulation condition, eccentricity condition
1.3		Bearing	Wearing condition
1.4		Excitation and AVR	Excitation and voltage regulating condition
1.5		Permanent magnet (applicable to permanent magnet synchronous generator)	Loss of excitation
2	Switchboard		Overall working condition

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
			Quality of power supply Insulation status
2.1		Panel circuit breaker	Order of circuit breaker switching on/off, condition of circuit breaker switching on/off
2.2		Bus bar	Quality of system power supply, including voltage, current, power, harmonic wave, etc. Insulation status of system
3	Transformer		
3.1		Winding	Working condition of winding
4	Motor driver		
4.1		Power electronics	Overall working condition
4.2		Braking resistance	Overload condition
5	Propulsion motor		
5.1		Stator	Condition of stator, e.g. winding inter-turn insulation
5.2		Rotor	Condition of rotor, e.g. inter-turn condition (synchronous motor), balance condition, eccentricity condition, broken rotor (induction motor), loss of excitation (permanent magnet motor)
5.3		Bearing	Wearing condition
6	Auxiliary system		
6.1		Cooling system (water-cooling, air-cooling)	Cooling condition
7	Propeller		
7.1		Sealing device	Sealing condition
7.2		Bearing device	Wearing condition

List of equipment and systems of condition monitoring of DC distribution electric propulsion system

Table 4.1.8-2

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Generator		Overall working condition
1.1		Stator	Condition of stator, e.g. winding inter-turn insulation
1.2		Rotor (not applicable to permanent magnet motor)	Condition of rotor, e.g. rotor balance, inter-turn insulation condition, eccentricity condition
1.3		Bearing	Wearing condition
1.4		Excitation and AVR	Excitation and voltage regulating condition
1.5		Permanent magnet (applicable to permanent magnet synchronous generator)	Loss of excitation
2	Switchboard		Overall working condition/Quality of power supply/Insulation status
2.1		Bus bar break solid state switch	Working condition, e.g. order of switching on/off, condition of switching on/off, voltage and current before and after switching on/off
2.2		Panel circuit breaker	Order of circuit breaker switching

No.	Name of equipment /systems	Monitoring Scope （e.g. equipment/parts/performance, etc.	Monitoring Purpose (e.g. condition, function, performance, etc.)
			on/off, condition of circuit breaker switching on/off
2.3		Bus bar	Quality of system power supply, including voltage, current, power, harmonic wave, etc. Insulation status of system pre-charge condition (where applicable)
2.4		Suppression capacitor, resistance, inductance (if any)	Working condition, e.g. charge/discharge action, temperature
3	Power transformer of DC distribution board to AC distribution board		
3.1		Winding	Working condition of winding
4	Converter		
4.1		Power electronics	Overall working condition
5	Propulsion motor		
5.1		Stator	Condition of stator, e.g. winding inter-turn insulation
5.2		Rotor	Condition of rotor, e.g. inter-turn condition (synchronous motor), balance condition, eccentricity condition, broken rotor (induction motor), loss of excitation (permanent magnet motor)
5.3		Bearing	Wearing condition
6	Auxiliary system		
6.1		Cooling system (water-cooling, air-cooling)	Cooling condition
7	Propeller		
7.1		Sealing device	Sealing condition
7.2		Bearing device	Wearing condition

4.1.9 For ships with power system of natural gas, propane, LPG, methanol/ethanol, ammonia and other gas/low flash point fuel engine, additional monitoring requirements specified in Table 4.1.9 are to be met in addition to the monitoring of the applicable equipment and systems specified in Table 4.1.7.

List of gas/low flash point fuel-related equipment and systems being monitored

Table 4.1.9

No.	Name of equipment / systems	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Gas/low flash point fuel engine for propulsion		
1.1		Pilot fuel nozzle	Ignition ability
1.2		Ignition device (gas/low flash point fuel only engine)	Ignition ability
1.3		Piston underside space of two stroke gas/low flash point fuel engine(if applicable)	Explosion-proof
2	Gas/low flash point fuel engine for power generation (including electric propulsion)		

No.	Name of equipment / systems	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
2.1		Cylinder combustion	Combustion condition (e.g. misfire, knocking, unsteady combustion, etc.)
2.2		Pilot fuel nozzle (applicable to dual fuel engine)	Ignition ability
2.3		Ignition device (applicable to gas/low flash point fuel only engine)	Ignition ability
2.4		Crankcase (applicable to trunk piston type gas/low flash point fuel engine)	Explosion-proof
2.5		Piston underside space (applicable to crosshead type gas/low flash point fuel engine)	Explosion-proof
3	Auxiliary system		
3.1	Gas/low flash point fuel system		
3.1.1		Ventilated double wall gas/low flash point fuel piping	Ventilation and air change capacity, leakage of gas/low flash point fuel
3.1.2		Pressurized inert gas double wall gas/low flash point fuel piping	Inerting capacity, leakage of gas/low flash point fuel
3.2	Lubricating oil system		
3.2.1		Lubricating oil piping	Leakage of gas/low flash point fuel (where applicable) ①
3.3	Cooling system		
3.3.1		Cooling water piping	Leakage of gas/low flash point fuel (where applicable) ①
3.4	Seal oil system (if fitted)		
3.4.1		Seal oil pump / seal oil booster	Oil supply ability
3.4.2		Filter (if fitted)	Impurity filtration
3.5	Inert gas purge system (if fitted)		
3.5.1		Inert gas purge piping	Purging ability
3.6	Water purge system (if fitted)		
3.6.1		Water purge piping	Purging ability
3.7	Fuel recovery processing system (if fitted)		
3.7.1		Gas-liquid separation device	Gas-liquid separation ability
3.7.2		Water sealing device	Water sealing ability
3.8	Exhaust system		
3.8.1		Exhaust pipe	Residual fuel impact to safety (if applicable)②
3.8.2		Purging fan (if fitted)	Purging ability

Note①: In accordance with 4.1.6 of this Chapter, this monitoring requirement is not applicable if a risk analysis determines that there is no risk of gas/low flash point fuel leaking into the relevant auxiliary system (e.g. lubricating oil system, cooling water system).

② : Applicable to methanol/ammonia fuel engine, if the risk analysis determines that the residual methanol/ammonia fuel in the exhaust gas will not affect the safety of personnel on board, this monitoring requirement does not apply.

4.1.10 If a ship uses lithium batteries and/or supercapacitors as part of the main power or propulsion power source, the condition monitoring of lithium batteries and/or supercapacitors and their charge/discharge devices is to meet the requirements of Table 4.1.10.

List of equipment and systems of condition monitoring of lithium battery/supercapacitor

Table 4.1.10

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Batteries (lithium batteries/supercapacitors)		
1.1		Battery system	Working condition, insulation condition, State of Charge (SOC), State of Health (SOH)
1.2		Battery pack cooling system (if any)	cooling performance
2	Charging devices		Charging status, charging interface temperature
3	Battery box/cabinet/compartment and its auxiliary system		
3.1		cooling system	Thermal management state/cooling performance
3.2		Emergency exhaust system	Working condition
3.3		Battery box/cabinet/compartment	Accumulation of combustible gas

4.1.11 For small high-speed diesel engines that cannot be monitored according to the provisions of this Chapter due to diesel engine design, standardized production, installation layout, etc., the diesel engine conditions, performance and function can be monitored as a whole, such as monitoring the power output capacity of the diesel engine, fuel consumption, overall vibration level, combustion balance of each cylinder, crankcase lubrication oil performance, etc., to assess its health status. The designer can work with CCS to determine the monitoring plan of the diesel engine.

4.1.12 For a ship propelled by a water jet unit which applies for the functional notation for intelligent machinery, additional monitoring requirements specified in 10.1 of Chapter 10 of the Rules are to be satisfied, in addition to the condition monitoring of applicable equipment and systems specified in Tables 4.1.7, 4.1.8 and 4.1.9 of this Chapter.

4.1.13 The condition monitoring and health assessment system is to be approved by CCS.

4.1.14 Where the health assessment result is intended to be used for the development of the maintenance plan for the equipment and systems in machinery space, the applicant is to provide sufficient evidence to demonstrate that the condition determined by condition monitoring is at least equivalent to that determined by direct inspection, and the implementation of condition-based maintenance may be carried out after approval by CCS.

4.1.15 For the equipment and systems already covered by the condition-based maintenance, their items subject to overhaul examination maybe handled in accordance with the condition-based maintenance plan. For equipment and parts not included in the condition-based maintenance, maintenance and survey are still to be carried out in accordance with the Planned Maintenance System (PMS).

4.1.16 Condition monitoring, health assessment and assisted decision-making (including condition-based maintenance) are to comply with, in addition to the requirements in this Chapter,

relevant requirements in Appendix 22: Condition monitoring and condition-based maintenance of Chapter 5 of PART ONE of CCS Rules for Classification of Sea-going Steel Ships and relevant requirements in CCS Guidelines for Surveys of Intelligent Machinery of Ships.

4.1.17 Upon completion of installation of the condition monitoring and health assessment system on board the ship, an initial survey is to be carried out in accordance with the provisions of 4.5.1 of this Chapter to verify that the condition monitoring and health assessment is carried out in accordance with approved procedures and plans, and that the relevant system can operate effectively as intended.

4.1.18 For the purpose of this Chapter:

(1) **Condition monitoring (CM)** means the process of acquiring and processing of information and data that indicate the state of equipment. The equipment state deteriorates if faults or failures occur.

(2) **Health assessment** means a process of analyzing and assessing of the operating conditions and health conditions of the equipment and systems basing on the condition monitoring data.

(3) **Assisted decision-making** means proposing suggestions based on the condition monitoring and health assessment results of the equipment and systems, in order to provide support for decision-making on the usage, operation and control, servicing and repair, and management, etc. of the equipment and systems.

(4) **Condition-based maintenance (CBM)** means to carry out maintenance in accordance with the results of condition monitoring and health assessment of the equipment and systems.

(5) **Baseline data** means the data measured and obtained when the performance of equipment and their parts reaches or at the initial healthy condition, which is used as the baseline for the analysis and comparison of health condition of equipment and their parts, and which is generally measured on board the ship.

(6) **Reference conditions** means the specified conditions for acquisition of monitoring data, including the operating conditions of monitored equipment (e.g. temperature, pressure, rate of revolution etc.), the operating conditions of ship (e.g. ship speed and draft) and relevant environmental conditions (e.g. temperature, pressure, sea state, wind speed etc.).

4.2 Functional notation for intelligent machinery

4.2.1 Upon request, the following functional notation for intelligent machinery may be assigned subject to satisfactory plan approval and survey by CCS:

Mx

where: M – the ship with the basic function of intelligent machinery specified by 4.1.3;

x – notation for additional function, expressed by the following small letters:

m – the condition-based maintenance is implemented for main propulsion engine(s) and parts;

a – the condition-based maintenance is implemented for engines used for auxiliary

power generation and its parts;

p – the condition-based maintenance is implemented for propulsion shafting.

4.2.2 For ships applying for intelligent machinery functional notation M, the following prerequisites are to be satisfied:

(1) Relevant requirements for AUT-0 notation in PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships are satisfied;

(2) Relevant systems and equipment for condition monitoring, health assessment and assisted decision-making are provided.

4.2.3 For ships applying for intelligent machinery functional notation Mx, in addition to complying with the requirements of 4.2.2, the following prerequisites are to be satisfied:

(1) Relevant requirements of Appendix 16: Guidelines for survey of the Planned Maintenance Scheme (PMS) of Chapter 5 of PART ONE of CCS Rules for Classification of Sea-going Steel Ships are satisfied;

(2) Condition-based maintenance is applied for relevant equipment and systems.

4.3 Plans and documents

4.3.1 The following plans and documents of intelligent machinery system are to be submitted for approval:

(1) A list and description of the equipment and systems being monitored, at least including the following information for each equipment and its components:

① monitoring purpose (condition, function, performance, etc.), e.g. combustion condition in the cylinder, wear condition of bearing and performance of turbocharger;

② monitoring parameters and normal range, e.g. temperature, pressure, flow and vibration;

③ monitoring devices/sensors;

④ monitoring procedures;

⑤ condition analysis/assessment method;

⑥ acceptance criteria.

(2) Detailed information on intelligent machinery system, generally including the following:

① system diagram, principle, functions, operating and maintenance description;

② system hardware description, e.g. sensor, data acquisition device, data storage/backup device etc.;

③ software description, e.g. data processing and analysis method, fault diagnosis method and condition assessment method;

④ type and content of output data/information.

Note: for system hardware in ② above, if data/information relating to condition monitoring and health assessment is uniformly acquired through ship integration platform, relevant hardware such as sensors and data acquisition devices may be described in the plans and documents of integration platform.

(3) Detailed plan for measuring/acquiring health assessment criteria, including measurement methods, time to establish criteria and method for assessing the effectiveness of criteria, etc.

(4) Type test program.

(5) Other plans and documents deemed necessary by CCS.

4.3.2 The following plans and documents of intelligent machinery system are to be submitted for information:

(1) Risk analysis report (in accordance with 4.1.6 of this Chapter);

(2) Operating manual (in accordance with 1.9, Chapter 1 of the Rules).

4.3.3 For ships applying for the functional notation for intelligent machinery, the following applicable plans and documents are to be submitted for approval:

(1) Intelligent machinery system diagram;

(2) List and description of monitored equipment and systems on real ship, at least including the following information of each equipment and part:

① monitoring purpose (condition, function, performance, etc.), e.g. combustion condition in the cylinder, wear condition of bearing and performance of turbocharger;

② monitoring parameters and normal range, e.g. temperature, pressure, flow and vibration;

③ monitoring devices/sensors;

④ monitoring procedures;

⑤ condition analysis/assessment method;

⑥ acceptance criteria.

Note: For acceptance criteria in ⑥ above, if acceptance criteria may not be provided before the condition monitoring and health assessment systems are installed onboard the ship, the designer is to provide detailed plan for measuring/acquiring acceptance criteria, including measurement methods, time to establish acceptance criteria and method for assessing the effectiveness of acceptance criteria, etc.

(3) List and descriptions of systems and equipment subject to condition-based maintenance(applicable to functional notation Mx);

(4) Procedures and schedules related to implementation of condition monitoring, health assessment and auxiliary decision-making, including:

① onboard testing procedures;

② procedures and schedules for data collection;

③ procedures and schedules for data storage/backup;

④ procedures and schedules for data analysis;

⑤ output of assessment result/report;

⑥ procedures and schedules for calibration of monitoring devices.

(5) Other plans and documents deemed necessary by CCS.

4.3.4 For ships applying for the functional notation for intelligent machinery, the following plans and documents are to be submitted for information:

(1) Onboard installation and arrangement plan of main equipment of intelligent machinery system;

(2) Instructions of intelligent machinery system, including system function, software and hardware, installation requirements;

(3) Relevant information on the company (if applicable), at least including:

① structure diagram of relevant posts (responsibilities) of company;

② working flow, including goal, method and strategy;

③ training plan and qualification requirements for relevant personnel carrying out assisted decision making and condition-based maintenance.

4.4 System requirements

4.4.1 General requirements

4.4.1.1 Computer systems covered by this Chapter are to be designed, manufactured, surveyed and tested in accordance with the requirements for category II computer systems.

4.4.1.2 Relevant parameters necessary for condition monitoring and health assessment are to be collected by selecting appropriate measurement technology/method. Such parameters are to be appropriate for displaying the trend of condition change of the equipment and systems within a period of time. The measurement data is to be documented in a standard format to be suitable for read and use.

4.4.1.3 The trend analysis based on condition monitoring data is to be feasible and convenient. The obtained trend data is to display condition change clearly. The analysis and assessment result is to be described intuitively.

4.4.1.4 Sensors used in condition monitoring are in general to be a fixed type. Where it is impracticable to fit fixed sensors, other equivalent means of measurement may be used subject to the agreement of CCS. Where portable instruments are used, the position of relevant measurement points and the direction of measurement (parameters related to direction) are to be permanently marked. For the connection of sensors to measurement points, the influences of any human factor are to be excluded. The measurement results are to be entered into the condition monitoring system according to a specified procedure and plan so as for health assessment.

4.4.1.5 The condition monitoring data may be collected via the ship alarm system provided that the normal function of ship alarm and safety system is not affected.

4.4.1.6 The data of condition monitoring is to be stored according to a specified procedure and plan, which may be replayed and displayed at any time as necessary.

4.4.1.7 Necessary data backup equipment is to be provided.

4.4.1.8 For a condition monitoring and health assessment system of novel design, the designer may consult with CCS to determine the requirements for system design, installation, measurement, test and survey, etc.

4.4.2 Assisted decision making

4.4.2.1 Analysis and assessment of operation state and health condition of the equipment and systems in machinery space is to be carried out based on monitoring data, and reasonable suggestions are to be provided as a foundation for decision-making on operation and management of the equipment and system, taking into account the knowledge base that has been established for the system.

4.4.2.2 The knowledge base used in decision making is to be updated and improved continuously with the accumulation of experience in system operation and the update of knowledge.

4.4.2.3 The assessment report of operating and health condition of the equipment and systems as well as suggestions on decision making are to be output.

4.4.2.4 Historical data on operating and health condition of the equipment and systems are to be easily searchable and relevant records required by survey can be output.

4.4.2.5 Where the shore-based supporting method is used for analysis, assessment and decision-making, etc., the related shore-based system is also to be considered as part of the decision support system，and the submitted plans and documents are to include information on the function, design, operation and maintenance of the related shore-based system.

4.4.3 Condition-based maintenance

4.4.3.1 The condition-based maintenance plan is to be capable of being developed based on the health assessment results of equipment and systems.

4.4.3.2 for the ship implementing condition-based maintenance, the maintenance plan is to be capable of being updated bases on the monitoring information during ship in-service.

4.4.3.3 Spare parts on board the ship are to consider the needs of the condition-based maintenance plan.

4.4.3.4 The system related to condition-based maintenance is to be capable of producing the following records:

(1) List of check items of equipment conducting condition-based maintenance;

(2) Records of condition-based maintenance service, examination and repair of fault.

4.4.3.5 Data and information related to condition-based maintenance are to be stored, and relevant information required by survey can be output.

4.4.3.6 The historical data of condition-based maintenance plan can be queried at any time as necessary.

4.4.3.7 Where the shore-based supporting method is used for condition-based maintenance, relevant plans and procedures are to be submitted to CCS for approval.

4.4.4 Condition monitoring

4.4.4.1 One or more applicable monitoring techniques are to be selected based on the monitored object, goal and purpose. Detailed instructions are to be provided for each monitoring technique that is selected.

4.4.4.2 Where the oil analysis technique is used for condition monitoring and health assessment of diesel engines and screwshafts, the requirements of Appendix 15 Guidelines for Lubricating Oil Condition Monitoring System of Diesel Engines and Appendix 14 Guidelines for Screwshaft Condition Monitoring System, Chapter 5 of PART ONE of CCS Rules for Classification of Sea-going Steel Ships are to be satisfied respectively.

Where the oil analysis technique is used for condition monitoring of other equipment, the implementation may refer to the requirements of the guidelines above and the following requirements are at least to be considered:

(1) All oil samples are collected by designated personnel.

(2) Representative oil samples are normally taken during normal operation period of equipment.

(3) The sampling period is determined in accordance with type, rate of revolution, working condition and performance of equipment.

(4) Sampling points are to be clearly identified and permanently marked.

(5) The oil analysis report is to be provided by a company approved by CCS. In case the analytical result exceeds the range allowed by standards, the ship manager or ship owner is obligated to report to CCS in a timely manner.

4.4.4.3 In order to ensure the normal function of monitoring equipment and correct measurement result, functional test and periodical calibration are to be carried out in accordance with approved procedures and plans. Test and calibration are to be recorded.

4.4.4.4 The monitoring data is to be measured in accordance with an appropriate time internal and sampling frequency. Data are in general to be measured in the reference condition. Where the reference condition cannot be met during practical measurement, the measured value is to be corrected to the value in the reference condition. The correction method and other related information are to be submitted to CCS for approval.

4.4.4.5 The record of monitoring parameters is at least to include the following information:

(1) General information describing the equipment and systems;

(2) Measurement position;

(3) The unit and processing method of the measured data;

(4) Information on measurement date and time.

4.4.4.6 The baseline data of the equipment and systems are to be measured in the initial healthy condition (after the run-in period) or obtained by other means. The reference condition during measurement is to be documented.

4.4.4.7 The baseline data are in general to be measured during shipboard trials and the following requirements are to be complied with:

(1) Baseline data are to be measured by designated personnel;

(2) The measured baseline data are to cover the expected operating conditions of the equipment and systems;

(3) The effectiveness of the measured baseline data used for fault diagnosis and health assessment is to be assessed.

(4) For new equipment or equipment after major conversion, the baseline data is to be measured after a period of running in.

4.4.4.8 The maintenance and/or repair of the equipment and systems are to be recorded and identified on the condition trend curve. After the repair of equipment, relevant monitoring parameters are to be measured, and the newly measured data is to be compared with the historical data (before repair) for examination of any deviation. The measurement data and deviation are to be documented.

4.4.4.9 Any fault/failure of the condition monitoring system is to be recorded in the annual report specified in 4.5.2.2 of this Chapter. Any major fault /failure which affects the trend analysis of measurement data is to be repaired immediately. In case parameters cannot be measured as planned due to such fault/failure, CCS is to be notified.

4.5 Survey and test

4.5.1 Initial survey

4.5.1.1 The initial survey is at least to include the following items:

(1) Confirming that plans and documents have been examined.

(2) Confirming that the system related to condition monitoring and health assessment has been approved.

(3) Confirming that the designated operating personnel are familiar with the operation and maintenance of intelligent systems.

(4) After completion of installation of relevant systems and equipment, tests are carried out in accordance with the approved testing procedures.

(5) Checking the condition-based maintenance plan and implementation procedures (if applicable) to ensure that the contents are consistent with real ship.

(6) Confirming that relevant plans and documents, manuals, procedures and relevant records are kept on board the ship.

4.5.2 Survey after construction

4.5.2.1 For ships which are assigned the functional notation for intelligent machinery, the survey is to be carried out in connection with the annual/intermediate/special survey of ship, in order to verify the normal function of systems related to intelligent machinery.

4.5.2.2 Prior to the annual survey, the owner or ship manager is to submit to the local survey offices of CCS an annual report on systems related to intelligent machinery, which at least is to include the following items from last annual survey:

(1) Maintenance records of systems related to intelligent machinery;

(2) General operating condition of systems related to intelligent machinery;

(3) Fault/failure conditions and cause analysis of the monitored equipment;

(4) Repair records and replacement of spare parts of the monitored equipment.

4.5.2.3 At annual survey, in addition to examining the annual report submitted by the owner (ship), the surveyor is also to examine the following items on board the ship:

(1) Examining whether the systems related to intelligent machinery operate effectively;

(2) Examining detailed working records of the systems related intelligent machinery;

(3) Examining repair records of the equipment and systems which are monitored. For replacement of important components and parts, the spare parts are to satisfy the certification requirements of CCS rules;

(4) Confirming that the historical data, trend analysis data, lubricating oil analysis report and vibration analysis report of systems related to intelligent machinery are complete and carrying out random examination of report contents;

(5) Confirming that operators are familiar with systems related to intelligent machinery and confirming the implementation condition;

(6) Some testing and analysis processes need to be verified if deemed necessary by the surveyor;

(7) Examining and confirming that relevant instrumentation have been calibrated in accordance with specified procedures and plans;

(8) The maintenance of equipment included in the condition-based maintenance is to be confirmed.

CHAPTER 5 INTELLIGENT ENERGY EFFICIENCY MANAGEMENT

5.1 General requirements

5.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for intelligent energy efficiency management is requested.

5.1.2 Intelligent energy efficiency management means to evaluate ship energy efficiency condition, navigation and loading condition based on the monitoring data and information on ship navigational condition and energy-consuming condition, and provide evaluation results and solutions for speed optimization and optimal stowage based on trim optimization, so as to realize real-time monitoring, evaluation and optimization of ship energy efficiency, and continuously improve level of energy efficiency management of ship.

5.1.3 Intelligent energy efficiency management is to have following basic functions:

(1) Online monitoring and automatic data collection of ship navigational condition, energy efficiency and energy-consuming condition;

(2) Providing evaluation, report and alarm on ship energy efficiency and energy-consuming condition;

(3) Providing assisted decision-making recommendations for energy efficiency management according to analysis and evaluation results.

5.1.4 In addition to basic functions specified in 5.1.3, intelligent energy efficiency management may also have following additional functions:

(1) Providing speed optimization plan based on different objectives and in combination with evaluation results of route characteristics, fuel oil consumption and cost effectiveness;

(2) Providing optimal stowage plan based on trim optimization according to initial loading and ship's optimal navigation state analysis.

5.1.5 If the intelligent energy efficiency management functions provided in the above 5.1.3 and 5.1.4 do not apply to some ships not engaged in transport of cargoes, designers may consult CCS to agree on the functions and associated requirements for intelligent energy efficiency management.

5.1.6 Ships for which functional notation for intelligent energy efficiency management is requested are to comply with relevant requirements of CCS Guidelines for Surveys of Intelligent Energy Efficiency Management of Ships in addition to the requirements of this Chapter.

5.1.7 Relevant definitions in this Chapter are as follows:

(1) Calendar year means the period from 1 January until 31 December inclusive.

(2) Transport work means product by multiplying the distance travelled by the ship with the

amount of cargo carried.

(3) Annual Transport Work means the product by multiplying the distance travelled by the ship with a ship's capacity expressed by the deadweight tonnage or gross tonnage[①] in a given calendar year.

(4) Annual Operational Carbon Intensity Indicator (CII) means ratio of the total mass of CO_2 (M) emitted to the total transport work (W) undertaken in a given calendar year.

(5) Ship Energy Efficiency Operational Indicator (EEOI) means ship's energy efficiency operation index, i.e. the ratio of mass of CO_2 emitted per unit of transport work.

(6) **Emission control area (ECA)** means the area requiring special compulsory measures to be taken to ship emission so as to prevent, reduce and control atmospheric pollution due to NO_x or SO_x and particulate matters or all three emission types, which will then cause adverse effect on human health and environment.

(7) **Main energy-consuming equipment** means main energy-consuming equipment including main engine, auxiliary diesel engine for power generation, boiler and gas turbine and inert gas generator, etc. For pure battery-powered ships, the battery system is considered as main energy-consuming equipment also.

5.1.8 Abbreviations and symbols are as follows:

(1) CII: Carbon Intensity Indicator;

(2) ECA: Emission Control Area;

(3) EEOI: Energy Efficiency Operational Indicator;

(4) MRV: Monitoring Reporting and Verification.

5.2 Functional notation for intelligent energy efficiency management

5.2.1 Upon request, the following functional notation for intelligent energy efficiency management may be assigned subject to satisfactory plan approval and survey by CCS:

Ex

Where: E—representing that the ship has basic functions of intelligent energy efficiency management as specified in 5.1.3;

x—notation for additional function, expressed by the following small letters:

s—speed optimization;

t—optimal stowage based on trim optimization.

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① According to IMO resolution MEPC.352(78) on 2022 Guidelines on Operational Carbon Intensity Indicators and Calculation Methods (CII Guidelines, G1), for cruise passenger ships, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships and ro-ro passenger ships, gross tonnage (GT) is to be used for calculating annual transport work.

5.2.2 Ships applying for the functional notation for intelligent energy efficiency management are to satisfy requirements for basic functions required by 5.1.3 of this Chapter. If relevant requirements for speed optimization and/or optimal stowage based on trim optimization are also satisfied, corresponding supplementary functional notations may be assigned.

5.3 Plans and documents

5.3.1 The following applicable plans and documents of intelligent energy efficiency management system are to be submitted for approval:

(1) Composition and explanation of energy efficiency on-line monitoring system, which is to include the following information:

① explanation of equipment composition;

② monitoring method and parameters;

③ special explanation on installation processes and positions of monitoring equipment (if necessary);

④ method for analyzing and evaluating energy efficiency/energy consumption;

⑤ (initial) set value of energy efficiency/energy consumption evaluation criteria;

⑥ type and contents of output data/information.

(2) Principle, function and instructions of speed optimization system (applicable to functional notation Es);

(3) Principle, function and instructions of optimal stowage system based on trim optimization (applicable to functional notation Et);

(4) Detailed plan for measuring/acquiring energy efficiency/energy consumption assessment criteria, including measurement methods, time to establish criteria and method for assessing the effectiveness of criteria, etc.

(5) Type test program;

(6) Other plans and documents deemed necessary by CCS.

5.3.2 The following plans and documents of intelligent energy efficiency management system are to be submitted for information:

(1) Operating manual (in accordance with 1.9, Chapter 1 of the Rules).

5.3.3 For ships applying for the functional notation for intelligent energy efficiency management, the following applicable plans and documents are to be submitted for approval:

(1) Electrical system plan (including system power supply, system input and output signal circuit and parameter list);

(2) Electrical system plan of shaft power measurement device (if fitted);

(3) List of main energy-consuming equipment and monitoring parameters;

(4) Test program;

(5) Procedure and plan, including:

① Procedure and plan for data collection/storage;

② Procedure and plan for relevant evaluation results/report output;

③ Plan for calibration of monitoring device;

(6) Other plans and documents deemed necessary by CCS.

5.3.4 For ships applying for the functional notation for intelligent energy efficiency management, the following applicable plans and documents are to be submitted for information:

(1) Installation and arrangement plan of main equipment;

(2) Instructions of intelligent energy efficiency system.

5.4 Ship energy efficiency on-line intelligent monitoring

5.4.1 General requirements

5.4.1.1 Energy efficiency on-line intelligent monitoring is to be able to monitor main energy-consuming equipment and ship navigational condition, collect, transmit, store and analyze data, and carry out evaluation and alarm on relevant technical index such as ship's energy efficiency and energy consumption.

5.4.1.2 It is to be able to carry out periodic general evaluation on ship's energy efficiency condition and provide assisted decision-making recommendations on energy efficiency optimization and improvement.

5.4.1.3 It is to be able to provide relevant data or analysis evaluation report according to demand and based on the results of monitoring, analysis and evaluation of energy efficiency and energy consumption data.

5.4.1.4 It is to be able to easily inquire the results of monitoring, analysis and evaluation of energy efficiency data and assisted decision-making recommendations.

5.4.1.5 Computer system of energy efficiency on-line intelligence monitoring is to satisfy requirements for category I computer system, and monitoring systems are to be approved by CCS.

5.4.2 Monitoring and measurement

5.4.2.1 It is to be able to carry out real-time collection of relevant data of main energy-consuming equipment, shaft power measurement device (if fitted), electronic fuel oil flowmeter, wind speed and direction indicator, global positioning system, log, electronic clinometer, sounding instrument and ship draft measuring equipment, etc.

Note: The above equipment may be adjusted based on ship types and ship propulsion types.

5.4.2.2 Monitoring parameters of ship's main energy-consuming equipment, metering

equipment and navigational equipment include, but not limited to:

(1) Power, pressure and temperature of main energy-consuming equipment, for details, see provisions of Chapter 9 of CCS Guidelines for Surveys of Intelligent Energy Efficiency Management of Ships;

(2) Fuel oil consumption of main energy-consuming equipment;

(3) Main engine shaft power①;

(4) Wind speed and direction;

(5) Ship position, course and speed;

(6) Speed through the water;

(7) Ship inclination angle;

(8) Water depth value;

(9) Ship draft value.

5.4.2.3 For ships using battery systems as propulsion power, the following parameters are to be monitored for battery propulsion related systems :

(1) For working parameters of the battery system, such as voltage, current, temperature, see the provisions of Chapter 9 of CCS Guidelines for Surveys of Intelligent Energy Efficiency Management of Ships for details;

(2) Current, voltage, and power of the main switchboard (DC, AC) and associated frequency converters (if applicable)/switchboard.

5.4.2.4 Considering the effect of ship deformation and local vibration on measurement of shaft power, the stator installation foundation for shaft power meter (if fitted) is to be welded tight, generally welded on ship's strong components, and welding on hull plating is not allowed.

5.4.3 Data transmission and storage

5.4.3.1 The system may receive and store equipment parameter data periodically, and the receiving period may be adjusted according to minimum period set of the equipment and management demands.

5.4.4 Energy efficiency and energy consumption calculation

5.4.4.1 The system is to be able to calculate following energy efficiency and emission index automatically:

(1) EEOI;

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① Output power of generators for propulsion and/or auxiliary power generation is permitted to be obtained by alternative means.

(2) Fuel oil consumption per distance travelled;

(3) Fuel oil consumption per transport work;

(4) CO_2 emission per distance travelled;

(5) CO_2 emission per transport work.

Note: The above indexes may be adjusted based on ship types, ship propulsion types and working condition.

5.4.4.2 The system is to be table to calculate following index of main energy-consuming equipment automatically:

(1) Fuel oil consumption per hour;

(2) Fuel oil consumption per day;

(3) Summary of fuel oil consumption per voyage (leg).

5.4.4.3 The system is to be able to calculate the following carbon intensity indicators and relevant parameters automatically:

(1) CII;

(2) annual total fuel consumption;

(3) annual total CO_2 emission.

Note: Above indicators and data are to be calculated according to IMO resolution MEPC.352(78) on 2022 Guidelines on Operational Carbon Intensity Indicators and the Calculation Methods (CII Guidelines, G1), and correction factors and voyage adjustments are to be applied to ship's annual CII, see resolution MEPC.355(78) on 2022 Interim Guidelines on correction factors and voyage adjustments for CII calculations (CII Guidelines, G5).

5.4.4.4 For pure battery-powered ships, the following energy efficiency and energy consumption indexes are to be calculated automatically:

(1) Electric energy consumption per transport work;

(2) Electric energy consumption per distance travelled;

(3) Power consumption per hour;

(4) Power consumption per day;

(5) Power consumption per voyage (leg).

Note: The power consumption can be calculated using the data of the battery management system and the energy consumption monitoring system of the main energy consuming equipment.

5.4.4.5 For ships fitted with hybrid power systems, designers may, considering the actual operation mode, design and arrangement of the ships, agree with CCS on the relevant requirements on energy efficiency and energy consumption calculation.

5.4.5 Energy efficiency and energy consumption evaluation

5.4.5.1 Real-time evaluation of energy consumption of main energy-consuming equipment is to be carried out according to the following provisions:

(1) Automatically judging ship's operational status such as mooring, maneuvering navigation, constant speed navigation, working conditions and power system operation modes according to actual operational condition of ship equipment;

(2) Using real-time data of ship's energy consumption, carrying out comparison and analysis according to set energy consumption evaluation method and criteria, automatically judging energy-consuming condition and outputting evaluation conclusion.

5.4.5.2 Evaluation of ship energy efficiency and emission index is to be carried out according to the following provisions:

(1) It is to be able to carry out automatic real-time monitoring of energy efficiency and emission indexes specified in 5.4.4.1. These evaluation indexes may be adjusted based on ship types and comparative analysis with energy efficiency evaluation criteria can be carried out.

(2) It is to be able to automatically generate yearly, quarterly, monthly and voyage-related index data report according to demands and carry out inquiry when necessary.

(3) It is to be able to predict the potential attained carbon intensity indicator (CII) which can be achieved according to the monitoring data of energy efficiency and emission indexes.

(4) It is to be able to rate the operational carbon intensity of the ship basing on the CII specified in 5.4.4.3 and relevant data calculation results, and automatically generate and output the annual report and relevant supporting data complying with regulations, for audit, compliance verification, check and inquiry according to demands. The relevant report and supporting data with regard to ship's annual CII used for audit and compliance verification are to comply with IMO *Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP)*.

Note: Reference may be taken to the following documents for CII reference line calculation, CII reduction factors and CII rating:

(1) IMO resolution MEPC.353(78) on 2022 Guidelines on the Reference Lines for Use with Operational Carbon Intensity Indicators (CII Reference Lines Guidelines, G2);

(2) IMO resolution MEPC.338(76) on 2021 Guidelines on the Operational Carbon Intensity Reduction Factors Relative to Reference Lines (CII Reduction Factors Guidelines, G3);

(3) IMO resolution MEPC.354(78) on 2022 Guidelines on the Operational Carbon Intensity Rating of Ships (CII Rating Guidelines, G4).

5.4.5.3 Ship's energy consumption distribution analysis is to be carried out according to the following provisions:

(1) It is to be able to obtain energy consumption distribution proportion and energy utilization efficiency of main energy-consuming equipment by analysis and according to ship's design parameters and relevant plans and information or real ship navigation data;

(2) It is to be able to output energy consumption distribution data and analysis result of energy utilization efficiency.

5.4.5.4 If ship's energy efficiency, energy consumption and carbon intensity index exceeds set value, the system is to give alarm or remind that the index exceeds limit.

5.4.6 Assisted decision-making on energy efficiency management

5.4.6.1 General evaluation on ship's energy efficiency and energy consumption condition may be carried out according to voyage and natural period (not exceeding one year). In addition, a comprehensive evaluation of the operational carbon intensity of the ship is to be carried out after the end of each calendar year.

5.4.6.2 It is to be able to propose assisted decision-making recommendations on energy efficiency optimization and improvement according to results of comprehensive evaluation.

5.4.7 Assistant management of energy efficiency

5.4.7.1 The intelligent energy efficiency management system is to be able to monitor and collect ship's carbon emission data in accordance with the requirements of SEEMP, and output the report and relevant supporting data for audit, compliance verification, check and inquiry according to specified format and requirements.

Note: The requirements for collection and verification of ship's fuel consumption data, see resolution MEPC.346(78) on 2022 *Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP)*.

5.4.7.2 The intelligent energy efficiency management system is to be able to monitor and collect ship's carbon emission data in accordance with the requirements of relevant MRV regulations, and output relevant report and supporting evidence according to specified format and requirements.

5.4.7.3 Emission control area (ECA) early warning: system is able to provide early warning for residual nautical miles and residual time within certain area away from ECA according to current ship voyage plan.

5.4.7.4 Fuel oil information management: management of fuel oil replacement during fuel oil bunkering and navigation, including information management on fuel bunkering and replacement.

5.5 Speed optimization

5.5.1 General requirements

5.5.1.1 It is to be able to provide speed optimization plan based on different objectives according to voyage plan, fuel oil consumption and general cost effectiveness analysis.

5.5.1.2 Speed optimization analysis is to generate speed optimization plan according to ship's navigational data and in combination with voyage plan, route characteristics and ship efficiency, fuel oil consumption evaluation results, etc., as well as with navigational cost accounting and analysis results.

5.5.1.3 Speed optimization function based on different objectives is to include speed optimization based on voyage plan and speed optimization based on cost effectiveness.

5.5.1.4 Computer system of speed optimization is to satisfy requirements for Category I computer system.

5.5.2 Speed optimization based on voyage plan

5.5.2.1 It is to automatically calculate navigated distance and navigated time based on voyage and leg management functions and according to information including ship's departure port, destination port, departure time, and predicted navigation distance, etc., and forecast arrival time according to residual voyage and current speed.

5.5.2.2 It is to automatically calculate specific fuel oil consumption under current speed according to parameters such as speed, main propulsion equipment power and fuel oil consumption, calculate oil consumption according to current speed and residual navigation distance and calculate fuel oil consumption for navigated miles and fuel oil necessary for residual miles.

5.5.2.3 It is to evaluate effect on speed according to set indexes which can reflect ship performance and efficiency during operation and considering the factors such as weather and sea conditions.

5.5.2.4 During navigation, it is able to provide speed optimization plan according to the analysis of fuel oil consumption rate, ship efficiency, etc.

5.5.3 Speed optimization based on cost effectiveness

5.5.3.1 Cost management and benefit index evaluation

(1) The system is to provide management functions for all cost involved in ship operation, including freight charge, port charge, fuel price, ship depreciation, material input, crew wages, shore-based personnel wages and management charges;

(2) The system may check each cost during ship operation and establish evaluation indexes on voyage benefits.

5.5.3.2 It is to be able to provide speed optimization plan based on cost effectiveness according to evaluation results of benefit index.

5.6 Optimal stowage based on trim optimization

5.6.1 General requirements

5.6.1.1 Optimal stowage system based on trim optimization is to have functions such as trim optimization and automatic stowage optimization, and can be used for calculating optimal trim condition under each loading condition.

5.6.1.2 Optimal stowage system is to firstly satisfy relevant requirements for loading instruments in Chapter 2, PART TWO of CCS Rules for Classification of Seagoing Steel Ships.

5.6.1.3 Optimal stowage system may provide optimal energy-saving stowage plan according to initial loading and target trim by adjusting cargo and ballast water with computer simulating automatic iteration.

5.6.1.4 Optimal stowage computer system based on trim optimization is to satisfy requirements

for Category I computer system.

5.6.2 Requirements for trim optimization and stowage optimization

5.6.2.1 Trim optimization system usually includes device collecting voyage data, basic database for trim performance and analysis system which can carry out trim optimization.

5.6.2.2 Database for trim performance can be established by means of model test and numerical calculation, or by model analysis on serial data obtained from real-time voyage data collected from ship.

5.6.2.3 Database for trim performance established by means of model test and numerical calculation is to at least cover conditions included in loading manual, and each condition is to include draft, speed and trim. Database for trim performance established by means of collecting ship's real-time voyage data is to include operational and navigational condition data such as trim, draft, speed, propulsive power and speed, wind speed and wind direction.

5.6.2.4 It is to be at least able to carry out optimal trim optimization calculation under any condition included in loading manual, and output optimized trim range which can be used for adjusting navigational floating condition.

5.6.2.5 When automatically optimizing loading plan based on target trim, operation is to be simple and convenient with acceptable calculation efficiency.

5.6.2.6 When optimal energy-saving loading plan is outputted automatically, the plan is to comply with objective of optimal navigational state and satisfy requirements for hull strength, intact stability, grain stability, damaged stability and serial safety index of initial navigation.

5.6.2.7 It is to be able to set several target trim for loading plan optimization according to user demand.

5.6.2.8 It is to fit optimal navigational state target selected by users as far as possible. The user is to be notified if data exceed limit and fitting is impossible, and output a plan which is nearest to the target.

5.7 Survey

5.7.1 Initial survey

5.7.1.1 The initial survey is at least to include the following items:

(1) Confirming that plans and information specified in this Chapter have been examined and approved.

(2) Confirming that computer system of intelligent energy efficiency management is furnished with relevant certificates.

(3) Confirming that system hardware has been approved.

5.7.1.2 In addition to satisfying relevant statutory and class survey requirements, the following

equipment within statutory and class ranges are to be inspected according to following requirements:

(1) Shaft power measurement device (if fitted):

① Examining that it is installed according to the approved plans and/or manufacturer's instructions;

② Witnessing check process and result of shaft power measurement device.

(2) Flowmeter:

① Checking verification report of flowmeter;

② Examining that it is installed according to the approved plans and/or manufacturer's instructions;

(3) Electronic clinometer:

① Examining that it is installed according to the approved plans and/or manufacturer's instructions;

② Confirming that electronic clinometer has been calibrated and confirming output results of inclination angle during functional test.

(4) Wind speed and direction indicator, sounding instrument, global positioning system, log, remotely draft measuring equipment:

① Examining that it is installed according to the approved plans and/or manufacturer's instructions;

② Inspection on functional test.

5.7.1.3 For signal-collecting equipment, the following items are to be checked:

(1) Integrity of parameter input to system;

(2) Consistency of parameter data of software system receiving end and parameter data of sending end of signal-collecting equipment.

5.7.1.4 Test and inspection are to be carried out according to test program.

5.7.1.5 It is to be confirmed that relevant plans and documents, manuals, procedures and relevant records are kept on board.

5.7.2 Survey after construction

5.7.2.1 Annual, intermediate and special surveys are to include the following items:

(1) Checking the service condition of systems within the latest survey cycle to confirm that they are in normal condition;

(2) Confirming that monitoring equipment have been calibrated according to the relevant

provisions.

5.7.2.2 For a ship assigned with the functional notation for intelligent energy efficiency management, if its monitoring equipment is damaged, repaired and renewed, or monitoring means are substantially changed, a request needs to be sent to CCS for interim survey.

CHAPTER 6 INTELLIGENT CARGO MANAGEMENT

6.1 General requirements

6.1.1 Intelligent cargo management carries out automatic collection of parameters of cargo/ cargo hold and cargo related system by using sensing equipment such as sensors, and based on computer technology, automatic control technology and big data processing and analysis, to realize monitoring, early warning/alarm, assisted decision-making and control of cargo hold/ cargo and cargo related system conditions, and at the same time, carry out intelligent stowage, automatic cargo loading and unloading and intelligent tank washing (applicable to oil tankers/chemical tankers) based on monitoring and obtained data to realize intelligent management of ship cargo.

6.1.2 Intelligent cargo management is to have following basic functions:

(1) parameter monitoring of cargo/cargo hold and cargo related system;

(2) early warning/alarm and assisted decision-making;

(3) intelligent stowage.

6.1.3 Intelligent cargo management may also have following supplementary functions in accordance with the characteristics of different ship types and functional needs:

(1) automatic cargo loading and unloading;

(2) intelligent tank washing.

6.1.4 The system software related to cargo/cargo hold monitoring alarm and assisted decision-making, intelligent stowage and intelligent tank washing is to satisfy the requirements for category II computer system. Automatic cargo loading and unloading system software is to satisfy the requirements for category III computer system.

6.1.5 Oil tankers applying for the functional notation for intelligent cargo management are, in addition to complying with the provisions of this Chapter, to satisfy the relevant requirements of CCS Guidelines for Survey of Intelligent Cargo Management of Ships (Oil Tankers).

6.1.6 Chemical tankers applying for the functional notation for intelligent cargo management are, in addition to complying with the provisions of this Chapter, to satisfy the relevant requirements of CCS Guidelines for Survey of Intelligent Cargo Management of Chemical Tankers.

6.2 Functional notation for intelligent cargo management

6.2.1 Upon request, the following functional notation for intelligent cargo management may be assigned subject to satisfactory plan approval and survey by CCS:

Cx

where: C—ship has functions related to monitoring of cargo/cargo hold and cargo related system,

early warning/alarm and assisted decision-making, intelligent stowage;

x—notation for additional function, expressed by the following small letter:

l—ship with function of automatic cargo loading and unloading;

w—ship with function of intelligent tank washing.

6.3 Monitoring of parameters

6.3.1 General requirements

6.3.1.1 The intelligent cargo management system is to monitor or obtain the following applicable data based on the specific condition of loaded cargoes:

(1) sea environment data, e.g. wind force, wind direction, wave;

(2) ship navigation parameters, e.g. course, speed;

(3) ship motion and acceleration;

(4) ship's floating condition, stability, still water bending moment and shear force;

(5) cargo type and capacity;

(6) ballast tank liquid level;

(7) temperature in the cargo hold;

(8) humidity in the cargo hold;

(9) flammable gas, harmful gas and oxygen content in the cargo hold area;

(10) water ingress in the cargo hold.

6.3.1.2 For ships with automatic loading and unloading functions, the tension of mooring lines also needs to be monitored.

6.3.1.3 Relevant monitoring parameters may be added in accordance with practical conditions of ship and safety needs.

6.3.2 Dry bulk carriers

6.3.2.1 In general the following parameters also need to be monitored:

(1) condition of cargo (e.g. cargo movement, liquefaction of ore in bulk, etc.);

(2) securing of cargo (whether the lashing is loose);

(3) open and closed condition of hatch cover of cargo hold.

6.3.3 Container ships

6.3.3.1 Each container is to have an independent identification number and provided with basic information such as its size, weight, type (general, reefer, dangerous goods container, etc.), loading and unloading port and location on board.

6.3.3.2 In general the following parameters also need to be monitored:

(1) position of the container;

(2) condition of the reefer container (temperature, power supply, status of temperature control device);

(3) condition of the cargo hold of containers carrying dangerous goods (ventilation, temperature, flammable gas, etc.);

(4) lashing of each stack on the deck (e.g. whether the lashing rods are loose).

6.3.4 Oil tankers/chemical tankers/liquefied gas carriers

6.3.4.1 In general the following parameters also need to be monitored for oil tankers/chemical tankers:

(1) cargo tank pressure and liquid level height;

(2) unit time temperature rise of cargo in cargo tank (where applicable);

(3) oxygen content in the cargo tank (where applicable);

(4) vapor pressure of liquid cargo vapor recovery system (where applicable);

(5) liquid level of ballast tank;

(6) operating status of liquid cargo pump/ballast pump;

(7) operating status of inert gas system;

(8) remote control valve position / opening;

(9) temperature of structural members adjacent to the independent cargo tank support block (where applicable).

6.3.4.2 In general the following parameters also need to be monitored for liquefied gas carriers:

(1) cargo tank pressure and liquid level height;

(2) oxygen content in the cargo tank;

(3) operating status of deep well pumps;

(4) operating status of inert gas system;

(5) remote control valve position / opening;

(6) temperature and pressure in the secondary barrier (if applicable);

(7) condition of the reliquefaction device;

(8) condition of the vapor compressor;

(9) temperature of structural members adjacent to the independent cargo tank support block (where applicable).

6.4 Assisted decision-making

6.4.1 General requirements

6.4.1.1 The monitored data is analyzed based on the specific design of the ship, the specific cargo loaded and comprehensive consideration of the trend of current condition. Reminders / warnings on possible abnormal situations that might occur in a short period of time are given. Reasonable recommendations and operational plans are given.

6.4.1.2 An alarm is given in case any abnormal condition is detected. The data is analyzed and processed in detail. Reasonable recommendations and operational plans are given.

6.4.2 Dry bulk carriers

6.4.2.1 The following scenarios are in general to be considered:

(1) water ingress in cargo hold;

(2) cargo movement or liquefaction of ore in bulk;

(3) change of cargo hold temperature, humidity, flammable gas concentration and harmful gas concentration;

(4) loose lashing, any change of the lashing force or support force (where applicable);

(5) scenarios deemed necessary based on the practical condition of the ship.

6.4.3 Container ships

6.4.3.1 The following scenarios are in general to be considered:

(1) shift or dropping of container;

(2) temperature change of reefer container;

(3) change of cargo hold temperature and flammable gas concentration;

(4) change of the environment surrounding dangerous goods containers;

(5) scenarios deemed necessary based on the practical condition of the ship.

6.4.4 Oil tankers/chemical tankers/liquefied gas carriers

6.4.4.1 The following scenarios are in general to be considered:

(1) change of cargo tank level;

(2) change of cargo tank pressure;

(3) change of flammable gas, harmful gas and oxygen content in cargo tanks;

(4) temperature change of secondary barrier of cargo containment system;

(5) scenarios deemed necessary according to the type of ship, the structure of the cargo tank and the cargo loaded.

6.5 Intelligent stowage

6.5.1 General requirements

6.5.1.1 Optimized stowage plan and cargo loading and unloading sequence are developed by considering various constraints such as cargoes, ships and docks, as well as carrying out simulated control of ship loading and unloading equipment to complete cargo operations.

6.5.2 Constraints

6.5.2.1 An optimized stowage plan and cargo loading and unloading sequence are generally to consider the following factors in terms of safety, environmental protection and efficiency:

(1) cargo type and quantity;

(2) floating condition, stability, strength of the ship and optimal trim (where applicable);

(3) cargo hold capacity and stowage factor;

(4) cargo loading and unloading sequence, speed and time;

(5) ballast water operation;

(6) emergency stop procedure;

(7) cargo hazard property;

(8) ship maneuvering, port and dock;

(9) cargo long-distance identification and tracking;

(10) route, weather and hydrology;

(11) residual water depth limit.

6.5.2.2 The following factors also need to be considered for oil tankers/chemical tankers/liquefied gas carriers:

(1) pipes and pumps;

(2) ventilation requirements;

(3) emergency procedure for oil spill and recovery of oil spill;

(4) preventing static electricity;

(5) loading and unloading rates (initial rate/maximum rate/trimming rate);

(6) temperature control procedure;

(7) stripping;

(8) special precaution against cargo.

6.5.3 Simulation of cargo loading and unloading operations

6.5.3.1 Carrying out simulation control of related components and equipment to complete the following cargo operations according to the loading and unloading plan and based on the data of products and ship's cargo loading and unloading equipment:

(1) cargo operations between empty loaded arrival and fully loaded departure;

(2) cargo operations between fully loaded arrival and ballasted departure.

6.6 Automatic cargo loading and unloading

6.6.1 General requirements

6.6.1.1 The intelligent cargo management system is to be able to automatically control the relevant systems to realize automatic cargo loading and unloading of ships based on intelligent stowage.

6.6.1.2 The intelligent cargo management system is to have the function of automatically filling in, generating, uploading and storing the necessary documents and reports in the process of cargo loading and unloading.

6.6.1.3 The intelligent cargo management system is to be able to deal with and control sudden failures of equipment, external environmental changes and other factors in a timely manner.

6.6.1.4 Risk assessment is to be carried out for automatic cargo loading and unloading systems. During assessment of the system design, the risks of the system in the whole process of automatic loading and unloading are to be fully identified and analyzed, and the risk control measures are to be proposed.

6.6.2 Dry bulk carriers/container ships

6.6.2.1 Automatic loading and unloading generally includes:

(1) operation of cargo loading and unloading equipment on board (where applicable);

(2) operation of cargo hold ventilation, tightness, opening and closing cargo hold hatches (where applicable);

(3) control of cargo loading and unloading process, generally including:

① cargo hold capacity;

① ballast water in ballast tank.

6.6.3 Oil tankers/chemical tankers/liquefied gas carriers

6.6.3.1 Automatic operations of oil tankers/chemical tankers may be carried out after completing the necessary preparations for cargo loading and unloading, e.g. connecting/removing pipes, opening/closing valves, etc., which are at least to include:

(1) cargo loading;

(2) cargo unloading;

(3) ballast, deballast and ballast water transfer.

Cargo tank stripping, inerting and gas freeing may be carried out manually or automatically, depending on the ship's equipment provision and actual needs.

6.6.3.2 Automatic operations of liquefied gas carriers generally include:

(1) cargo tank dehumidification

(2) cargo tank inerting;

(3) inerting of secondary barrier of cargo containment system;

(4) cargo tank inflation;

(5) cargo tank cooling;

(6) cargo loading;

(7) cargo unloading;

(8) cargo tank stripping;

(9) cargo tank warming;

(10) gas–freeing of cargo tank ;

(11) ballast, deballast and ballast water transfer.

6.7 Intelligent tank washing

6.7.1 General requirements

6.7.1.1 Based on the functions of cargo and cargo tank monitoring and assisted decision-making, oil tankers/chemical tankers can develop tank washing plans, monitor the tank washing process, evaluate the tank washing results according to the nature of the cargo and the form of the cargo tank, in order to realize intelligent tank washing.

6.7.2 Constraints of tank washing plan

6.7.2.1 The tank washing plan is in general to take into account the following factors in terms safety, environmental protection and efficiency:

(1) the nature of cargoes in the previous and next shipment;

(2) the size and structural type of the cargo tank;

(3) type, parameters and quantity of tank washing devices;

(4) weather and hydrology;

(5) ballast water operation;

(6) emergency stop operation;

(7) hazardous characteristics of the cargoes;

(8) ship operations, ports and terminals;

(9) floating condition of the ship.

6.7.3 Monitoring of the tank washing process

6.7.3.1 The intelligent cargo management system is to be able to monitor the following parameters during the tank washing process:

(1) cargo tank pressure;

(2) cargo tank temperature;

(3) condition of tank cleaning equipment;

(4) the concentration of flammable gas in the cargo tank;

(5) the concentration of toxic gas in the cargo tank;

(6) condition of the drainage system in the cargo tank.

6.7.4 Evaluation of the tank washing results

6.7.4.1 The intelligent cargo management system is to be able to evaluate the results of tank washing and put forward relevant suggestions, which are at least to include:

(1) evaluation of tank washing quality: The system can automatically judge the quality of cargo tank washing through evaluation of tank washing water quality or other approved means, and put forward operational suggestions such as completion of tank washing and repeated tank washing;

(2) tank washing safety evaluation: The system can determine the concentration of flammable gas and/or toxic gas in the cargo tank through real-time monitoring or other approved means, and put forward operational suggestions such as ventilation.

6.8 Plans and documents

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

(1) Arrangement plan of intelligent cargo management system;

(2) Power system plan of intelligent cargo management system;

(3) Items of monitoring, early warning/alarm and assisted decision-making of intelligent cargo management system.

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

(1) System composition and function explanation;

(2) System hardware specifications;

(3) System test procedure;

(4) Risk assessment report (as specified in 6.6.1.4 of this Chapter);

(5) Operation manual (as specified in 1.9, Chapter 1 of the Rules).

6.9 Survey and test

6.9.1 Initial survey

6.9.1.1 Relevant plans have been examined.

6.9.1.2 It is to be confirmed that the system has relevant certificate.

6.9.1.3 System design, system input and output as well as communication function are to be confirmed.

6.9.1.4 According to application for different functional notations for intelligent cargo management, different conditions are inputted for simulation operation to verify software function.

6.9.1.5 Capability of treating emergency situation is to be verified.

6.9.2 Survey after construction

6.9.2.1 Previous service condition of systems are reviewed at annual, intermediate and special surveys to confirm that they are in normal condition.

6.9.2.2 Functions of the equipment and system are to be re-verified after their repair and renewal. Test is to be carried out as necessary after repair or renewal of the intelligent cargo management system.

CHAPTER 7 INTELLIGENT INTEGRATION PLATFORM

7.1 General requirements

7.1.1 Intelligent integration platform is to be able to provide support for intelligent navigation, intelligent hull, intelligent machinery, intelligent energy efficiency management, intelligent cargo management, ship remote control and autonomous operation, in order to form unified integration platform of data acquisition/collection, storage, integration, interaction, sharing and demonstration and control command transmission (where applicable). Integration platform is to be open and be cable to integrate security system and information management system on board ship etc. to realize all-round monitor, control and intelligent management for ship as well as data exchange with shore base.

7.1.2 For dredgers engaged in dredging operations and scientific research ships engaged in scientific research tasks, the intelligent integration platform is to provide support for intelligent dredging operations and scientific research.

7.2 Functional notation for intelligent integration platform

7.2.1 Upon request, the following functional notation for intelligent integration platform may be assigned subject to satisfactory plan approval and survey by CCS:

I

where: I represents that the ship can at least integrate data of two systems and has basic functions for intelligent integration platform specified in 7.1.1; the platform is open, having capability of accessing newly-added system.

7.2.2 Ships applying for functional notation I for intelligent integration platform are to have at least two functional notations among Nx, Hx, Mx, Ex, Cx. Where the ship has more than two intelligent applications, the integration platform is to be able to provide services for all applications.

7.3 Illustrations for system layer

7.3.1 Overall structure of system

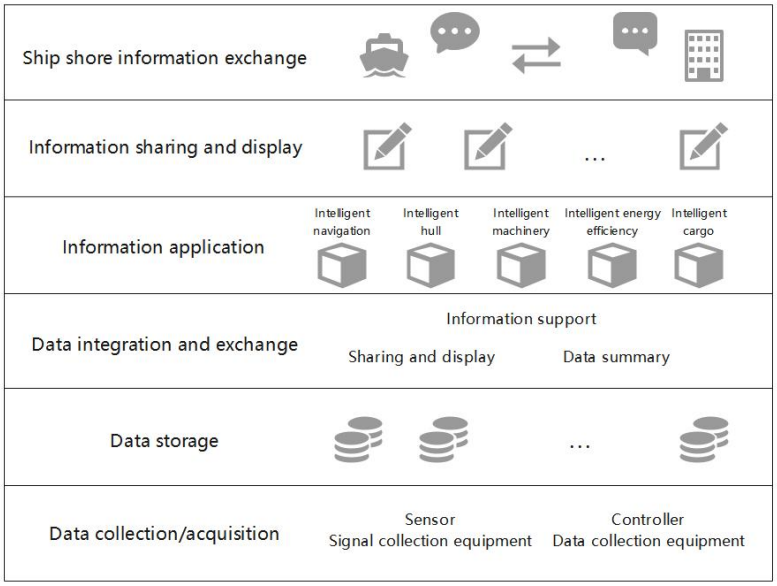

Figure 7.3.1 Illustration of Overall Structure of System

(1) Data collection/acquisition, i.e. using sensing equipment (e.g. sensor), control, signal collecting equipment and data collecting equipment to collect required data.

(2) Data storage, i.e. establishing data set to be kept during acquisition and processing process.

(3) Data integration and exchange, i.e. carrying out system processing, aggregation, analysis integration and exchange based on necessary selection and cleaning of existing data, using multi-dimensional analysis method, analyzing and comparing from different aspects, and extracting information hidden within data to provide information supporting for service application and assisted decision-making as well as play a role of information integration.

(4) Ship shore information exchange, i.e. realizing the sending and receiving of ship shore information through communication equipment.

(5) Information application, i.e. providing support for other intelligent applications.

(6) Information sharing and display, i.e. realizing visualized display of data and information exchange and sharing. By means of human-computer interaction and according to customization, providing results of relevant data, expressing failure cause in proper form and providing prediction and early warning for user's operational decision-making by using data trend.

7.4 System requirements

7.4.1 General requirements

7.4.1.1 Intelligent integration system is generally to be designed according to the requirements of Chapter 1 to Chapter 4 of CCS Guidelines for Verification of Digital Systems of Ships and Offshore Installations.

7.4.1.2 The system is to support multi-terminal (PC and mobile device) access.

7.4.1.3 The system is to realize multi-department and multi-user cooperative management according to company's relevant requirements for management system.

7.4.1.4 Where the integration platform has the function of transmitting control commands, it is to ensure the timeliness and accuracy of the transmission of commands.

7.4.1.5 Log management function of the intelligent integrated platform is to be provided, at least including error logs, query logs, and change logs, so that users with authorization for log maintenance may carry out the maintenance of log.

7.4.1.6 The integration platform providing support for assisted decision-making is to comply with the requirements for category II computer system, and the integration platform providing support for control is to comply with the requirements for category III computer system, as well as satisfying applicable requirements of Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

7.4.2 System integration requirements

7.4.2.1 Intelligent integration platform is to integrate existing information resource of intelligent system on board ship. Data collected through intelligent system can be stored in integration platform database, or establish effective call relation with it.

7.4.2.2 Intelligent integration platform can integrate functions relating to ship information management system and realize management for relevant ship information by ship and company, e.g. equipment maintenance management, crew delivery and basic information management, security management, system management, cost management and electronic management of maritime information.

7.4.2.3 Intelligent integration platform is to be able to integrate newly-added system (e.g. video monitoring system, integrated navigation system) according to conventions, regulations, rules as well as company management and operation needs. The system is to have certain expandability and complete data interface plan to facilitate access of other newly-added system. Data collected through newly-added system may be stored in intelligent integration platform database, or establish effective call relation with it.

7.4.3 Data collection/acquisition

7.4.3.1 Normalized data standards are to be established for collected/acquired data, including standards relating to data definition, data description, data quality, data transmission and data processing, so as to realize data traceability.

7.4.3.2 Validation check is to be carried out during data collection by deleting repeated data and error data, initially completing missing data and giving effective reminding of error data.

7.4.3.3 General data exchange, data transmission agreement and framework are recommended for data collection.

7.4.3.4 Data collection is to have fault-tolerant mechanism.

7.4.4 Data storage

7.4.4.1 A redundant design is to be used for data storage devices to ensure the availability of intelligent integrated platform functions.

7.4.4.2 Data kept in the integration platform is to satisfy the expected application demands and quality requirements.

7.4.4.3 Periodical evaluation is to be carried out for collected data to ensure the accuracy, integrity and availability of data.

7.4.5 Data integration and exchange

7.4.5.1 Integration platform is to be capable of data integrating, i.e. screening necessary data according to the expected application demands.

7.4.5.2 In different data exchange scenarios, the intelligent integration platform is to carry out reasonable resource scheduling to meet the services requirements of different intelligent systems. The exchange of data is to ensure the integrity, sequentiality and reliability of data transmission.

7.4.6 Ship shore information exchange

7.4.6.1 Stable and reliable communication agreement and data transmission mechanism is to be adopted for communication between ship and shore.

7.4.7 Information sharing and display

7.4.7.1 The system is to adopt general data exchange agreement to provide external data transmission and have capability of sharing data with relevant parties.

7.4.7.2 The system is to be able to provide the results of data analysis as request by the user, display in proper form and provide prediction and early warning for user's operational decision-making by using data trend.

7.5 Plans and documents

7.5.1 Detailed information on intelligent integration platform system generally includes following contents:

(1) Technical specification of the product, which is to specify the general performance requirements as well as general design requirements for the product, applicable parts of the following are to be included as a minimum:

① environmental conditions, system principles and descriptions of product functions as well as its use and maintenance;

② hardware description, e.g. technical specification of hardware and peripheral configuration, main hardware configuration, input and output devices and power supply equipment, etc.;

③ software description, e.g. software configuration, soft data processing and analysis method, fault diagnosis method, condition evaluation method, etc.;

④ categories and contents of output data/information.

(2) Wiring connection diagram of intelligent integration platform system, applicable parts of the following are to be included as a minimum:

① power supply arrangement: showing power supply arrangement of the system;

② circuit diagram of important hardware circuit, such as emergency operation and interlock, details of input and output devices, power supply condition of each circuit.

(3) User interface description

Applicable part of the following is to be included as a minimum:

① function distribution of each work station and operation station as well as description of control changeover among stations;

② layout of equipment and description of functions.

(4) Description of the operation and use of system (for information)

7.5.2 For ships applying for functional notation for intelligent integration platform, the following applicable plans and documents are to be provided:

(1) arrangement of system and main equipment;

(2) system schematic (including power supply);

(3) other plans and documents deemed necessary by CCS.

7.6 Survey

7.6.1 Initial survey

7.6.1.1 It is to be confirmed that plans have been examined.

7.6.1.2 It is to be confirmed that the system has relevant product certificates.

7.6.1.3 Survey items:

(1) confirming the completeness of the installation of the intelligent integration platform;

(2) confirming that process of data collection, storage, transmission, display and application of intelligent integration platform is implemented properly;

(3) testing relevant functions of each integration system;

(4) verifying data integration capacity of the intelligent integration platform;

(5) verifying data backup function of the intelligent integration platform.

7.6.2 Survey after construction

7.6.2.1 Following items are to be examined at annual survey, intermediate survey and special survey:

(1) examining that no substantial change of intelligent integration platform occurred since last survey;

(2) examining former service condition record of intelligent integration platform and confirming normal operation of intelligent integration platform;

(3) system data can be exchanged normally between ship and shore, and conforming historical record of data exchange;

(4) checking system backup record randomly and confirming system has implemented effective backup;

(5) verifying the data integration capacity of the platform.

7.6.2.2 If the equipment and system are repaired or renewed, verification of functions is to be carried out again, and the test is to be carried out again if necessary.

CHAPTER 8 REMOTE CONTROL SHIPS

8.1 General requirements

8.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for remote control is requested.

8.1.2 Remote control ship means that the ship can be controlled by remote control stations or positions other than the ship to achieve the operation of the ship.

8.1.3 Upon request, the following functional notation for remote control may be assigned subject to satisfactory plan approval and survey by CCS:

R1- The main function of the ship is controlled by the remote control station. Seafarers on board monitor the ship's condition, take over the operation of the ship in an emergency or when necessary, and operate the non-remotely controlled system and equipment according to the ship's operational scenario determined by the design.

R2- The ship is controlled remotely without seafarers on board.

8.1.4 A ship with R1 functional notation is to comply with the requirement of 8.2, 8.3 and 8.4 of this Chapter.

8.1.5 A ship with R2 functional notation is to comply with the requirement of 8.2, 8.3 and 8.5 of this Chapter.

8.1.6 Remote control of ships is to comply with the requirements of Chapter 7 of the Rules, capable of providing support for remote control of navigation and engine room.

8.1.7 When passenger ships apply for the class notation for remote control, appropriate measures are to be taken to protect the safety of passengers.

8.2 Remote control station

8.2.1 General requirements

8.2.1.1 The provisions apply to the function, safety and management requirements of remote control stations.

8.2.1.2 The goal of the remote control station is to monitor and control the ship from berth to berth by receiving the ship's status information, environmental information, and third-party support information such as charts, weather, and ports.

8.2.1.3 The provision of equipment and staffing of the remote control station are to be appropriate for the number of ships under control.

8.2.1.4 The equipment of the remote control station is to be suitable for the working environment.

8.2.2 Functional requirements

8.2.2.1 The remote control station is at least to have the following functions:

(1) developing voyage plans and approving routes planning；

(2) continuously obtaining ship's situation awareness information on a real-time basis and displaying such information;

(3) monitoring the safety condition of ships and systems, presenting maintenance suggestions based on the condition of ships, so as to ensure the hull and systems have adequate reliability to ensure navigational safety of subsequent voyages;

(4) capable of remote operation of ship's propulsion and manoeuvring system and communication and signal system, in order to achieve remote operation of ships in various navigation scenarios;

(5) carrying out voice and data communication with pilots (if applicable), terminals, auxiliary tugs, surrounding manned ships, ship owners, vessel traffic service (VTS), etc.;

(6) sending navigation supporting information in standardized content and format which can be automatically processed and used by the onboard navigation control system (e.g. meteorological and sea condition information, marine safety information, maritime safety traffic service information, etc.);

(7) playing back history control orders and operations of the ship;

(8) monitoring and controlling the cargo of ships (if applicable), including:

① developing cargo loading/unloading plans according to ship voyage plan and navigation plan, cargo type, infrastructures of port of call,etc.;

② monitoring and controlling the loading and unloading of cargo;

③ real-time monitoring of the status of the cargo and cargo maintenance related system (if any) during voyage;

(9) having the ability of data storage, processing and analysis to store, process and analyse the remotely transmitted ship operation data, and provide support for the optimization of ship operation decisions.

8.2.2.2 If the remote control station is only used for remote control of the manned ship (R1), only the functional requirements of (2), (4), (5), (6) and (7) in 8.2.2.1 need be met.

8.2.2.3 For ships of special operation types, designers may, according to the specific operation types and application scenarios of the ships, consult with CCS on the remote control functions and corresponding requirements.

8.2.3 Arrangement of remote control station

8.2.3.1 Arrangement of the remote control station is to facilitate ship control by personnel, and arrangement of console is to follow the principle of ergonomics.

8.2.3.2 At least the following information on ships is to be displayed in the remote control station:

(1) controlling status of ships: e.g. navigation, remote control, anchoring, berthing, etc.;

(2) routes of the ships: starting point, finishing point, turning point, current ship position, speed, direction, expected time of arrival, etc.;

(3) sea conditions and meteorological information of the sea area where the ship is located, including navigational warning;

(4) surrounding scenario information: including the information and state of surrounding moving and fixed objects, and displaying them in the nautical charts;

(5) display of ship conning information as required, including ship heading, UTC time, longitude and latitude, draft, revolutions of propulsion units, rudder angle, ship movement (heeling/rolling, trimming/pitching, heaving, etc.), etc.;

(6) display of state of ship systems as required. In case of an alarm, visual and audio alarm is to be released automatically.

8.2.4 System design principle for remote control station

8.2.4.1 The design of the display system, alarming system, control system and computer system of the remote control station is to comply with the applicable requirements Sections 2, 3, 4, 6, Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.2.4.2 Means of communication in the remote control station are to be provided and arranged to enable effective voice and data information communication with terminals, other ships, VTS centers, search and rescue centers, shipowners, ship personnel (if any) during remote navigation of the ship. Sufficient bandwidth is to be provided.

8.2.4.3 Data servers used for receiving and storing data are to be positioned in at least two different locations (of at least A-60 fire division or equivalent) and dynamically updated. Failure of one server is not to affect the function of the remote control station.

8.2.4.4 In case of one failure (excluding fire) of the systems of the remote control station, surveillance and control of ships are not to be affected.

8.2.4.5 The goal for design, arrangement and location of the human-computer interface and operation device of the remote control station system and equipment are to be simple, rapid and effective operation, so as to minimize the operation due to negligence of personnel and its impacts.

8.2.4.6 The control/surveillance position of the remote control station is to be so designed as to be easy to identify, easy for personnel to move, and to prevent mistouch.

8.2.4.7 In case of fire of the remote control station, surveillance and control of ships are to be able to be carried out in a backup control station or position in the distance (normally not in the same building). Such backup control station can be a mobile control station or a simple one.

8.2.4.8 The backup control station is at least to have the following functions:

(1) remotely operating a single ship;

(2) displaying main conditional information of the ship under control.

(3) having communication functions as specified in 8.2.2.1(5) of this Chapter.

8.2.4.9 Where the remote control station is only used for the operation and control of the remotely controlled vessel (R1) which seafarers are arranged on board, and according to the manning and duties of the ship and the remote control station, personnel on board can reliably take over the operation and control of the vessel in case of emergency, the backup control station may be dispensed with .

8.2.5 Firefighting

8.2.5.1 Firefighting of the remote control station is to meet the applicable requirements for appropriate locations of the region/state where the center is located.

8.2.6 Location of remote control station

8.2.6.1 Location of the remote control station is to be selected in compliance with the following principle requirements:

(1) with sufficient and reliable power supply, fast and smooth communication;

(2) away from the places where dust, oil fume and harmful gas are generated, or where corrosive, flammable and explosive materials are produced or stored;

(3) away from potential areas of natural disasters such as flood, earthquake;

(4) free from strong electromagnetic field interference;

(5) away from places with strong vibration sources and strong noise sources.

8.2.6.2 For ships with class notation R1, the location requirements of remote control stations may be agree on by taking into account the manning condition and duties on board, remote control function, etc.

8.2.7 Electric power supply

8.2.7.1 Relevant installations of the remote control station are to be supplied at least by two circuits from different substations. In case of loss of electric power of one circuit, the power supply is to be automatically switched to the other circuit.

8.2.7.2 Where the power supply of the remote control station cannot satisfy the requirements of 8.2.7.1, in addition to the power supply through the substation, the remote control station is also to be provided with backup power, e.g. diesel generator set, battery, etc. The capacity of the backup

power supply is to be able to meet the power needs of the remote control station for at least 12 hours.

8.2.7.3 Where the remote control station is only used for the operation and control of the remotely controlled vessel (R1) which seafarers are arranged on board, and according to the manning and duties of the ship and the remote control station, the seafarer on board can reliably take over the operation and control of the vessel in case of emergency, the standby power supply capacity is to be such that all remote ship control rights can be reliably transferred to the ship control station in the case of power failure at the substation, and the power supply time is not to be less than 0.5 hours.

8.2.7.4 In order to maintain continuous working of the remote control station, UPS is to be provided to the systems required to keep continuous running and operation, with power supply duration of not less than 0.5 hours.

8.2.7.5 Where the backup power supply specified in 8.2.7.2 above is battery, the remote control station can directly switch to the backup power supply in case the main power supply fails. Where the backup power is supplied by other means, it is to be switched to the UPS power supply immediately, and the backup power is to be able to supply the remote control station within 30 minutes.

8.2.7.6 If the backup power supply specified in 8.2.7.2 above is a diesel generator set, necessary lighting and power supply are to be provided in the space of diesel generators, considering the need of operation, repair and maintenance of the diesel generator set in case of failure of main source of electrical power.

8.2.8 Environment of the remote control station

8.2.8.1 The environment of the remote control station, including the temperature, humidity and ventilation, etc., is to be appropriate for the equipment and systems in the center.

8.2.8.2 The remote control station is to be provided with adequate lighting by at least two circuits as required in 8.2.7.1 of this Chapter. The lamps are to be crossly arranged. In case of failure of one circuit, the other circuit is still to be able to provide necessary lighting required by operation.

8.2.8.3 Lighting supplied by UPS is to be provided for essential positions of operation in the remote control station.

8.2.9 Operation personnel in the remote control station

8.2.9.1 The number of the operation personnel in the remote control station is to be appropriate for the number of the ships under control.

8.2.9.2 The manning of the remote control station is to take into account the remote operation of the ship, the management and maintenance of the remote control station, etc.

8.2.9.3 Operators engaged in remote control of ships are to have competent deck officer (master) certificate, and are familiar with the performance and operation of the ship.

8.2.9.4 Ship equipment and system management personnel are to be familiar with the function, management and maintenance of various systems of the ship.

8.2.10 Management requirements

8.2.10.1 The remote control station is to establish a management mechanism which is at least to include the following:

(1) manning requirements and on-duty requirements;

(2) responsibility and qualification requirements of different posts;

(3) remote operation procedure;

(4) emergency response procedure;

(5) equipment and system maintenance procedure;

(6) cyber security risk identification and control measures;

(7) security measures.

8.2.11 Survey and tests

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

(1) arrangement of the remote control station, including the firefighting system, lighting arrangement, arrangement of servicing power supply;

(2) electric power supply to equipment and systems of the remote control station;

(3) scenario display system;

(4) ship condition display system;

(5) rationale of condition-based maintenance system;

(6) rationale of the function of the remote control station;

(7) arrangement of data backup;

(8) cyber security risk identification and control measures;

(9) management procedure for the remote control station.

8.2.11.2 The systems and equipment of the remote control station (including the software and hardware) that provide service for ships are to be subject to survey and certification by CCS.

8.2.11.3 The remote control station is to be put into use after being subject to plan approval by CCS, and after the survey and tests are satisfactorily completed. After satisfactory plan approval

and survey and tests, the remote control station is to be issued a document of compliance by CCS.

8.2.11.4 Each ship with remote control function is to be linked to one or more remote control stations, and monitoring and control can only be implemented after real ship control has been satisfactorily verified.

8.2.11.5 Maintenance and operation management procedures are to be established for the remote control station, and maintenance and testing are to be carried out on a regular basis.

8.2.11.6 Inspection of the function and arrangement of the remote control station is to be carried out by CCS annually to ensure that the intended function as designed has been maintained.

8.2.11.7 In case of software or hardware updating of the remote control station, it is to be subject to re-survey and re-test by CCS.

8.3 Radio communication and signal equipment

8.3.1 General requirements

8.3.1.1 The provisions of this paragraph apply to radio communication and signal equipment of remote control ships.

8.3.1.2 The arrangement of ship radio communication equipment is to be such that effective voice and data communication with the dock, nearby ships, VTS center, search and rescue center and owner can be achieved automatically or via the remote control station throughout the voyage based on the functions provided on the ship. It is to be equipped with enough bandwidth.

8.3.1.3 When the ship is provided with the pilot control station, the communication equipment is to be able to realize the voice communication between the remote control station and the pilot control station. At the same time, it can realize the voice communication between the pilot control station and the surrounding docks, VTS center, etc.

8.3.1.4 The signal equipment of the ship is to be able to operate automatically or remotely controlled by the remote control station, and give the audible, visual and shape signals according to IMO International Regulations for Preventing Collisions at Sea, 1972.

8.3.1.5 Equivalent plan may be used for the design of communication and signal equipment of remote control ships subject to the agreement of CCS.

8.3.2 Functional requirements

8.3.2.1 The ship communication is to comply with the following requirements:

(1) at each sea area of the entire route, at least two separate independent devices with bandwidth and speed satisfying remote control are to set up the voice and data communication link with the remote control station and can also realize the ship-to-shore distress alarm;

(2) sending ship-to-shore and ship-to-ship distress alarm signals;

(3) sending and receiving the search and rescue coordination communication;

(4) sending and receiving the live communication;

(5) sending the search and rescue location signal;

(6) sending and receiving the marine safety information;

(7) sending and receiving the common radio communication to a coastal radio system or network;

(8) sending and receiving the ship-to-ship communication.

8.3.3 Equipment and requirements for communication

8.3.3.1 Each remote control ship is to be provided with at least the following communication equipment suitable to the navigation area:

(1) one satellite ship station or equivalent device with voice communication and data communication;

(2) one V-SAT ship station or equivalent device with internet data communication;

(3) two VHF radio units;

(4) one satellite position-indicating radio beacon;

(5) one Maritime safety information receiving device;

(6) LRIT equipment.

8.3.3.2 The communication equipment is to meet the applicable requirements of performance standards adopted by IMO. V-sat is to meet the requirements of marine environmental conditions and comply with the recognized international or national standards.

8.3.3.3 The states of all communication equipment are to be transferred to the remote control station and be remotely controlled by the remote control station.

8.3.3.4 The satellite position-indicating radio beacon should be able to automatically release and start up when the ship sinks.

8.3.3.5 When the ship sends a distress alarm, the alarm signal should include the location information of the ship.

8.3.3.6 The installation position of communication equipment is to be fit for the function of equipment and is to be installed outside the engine room.

8.3.4 Equipment and requirements for signal

8.3.4.1 Ship with remote control function is to be provided with the signal equipment in accordance with the requirements of IMO International Regulations for Preventing Collisions at Sea, 1972.

8.3.4.2 The mast light, side light and tail light are to be provided with two sets of lighting

fittings or double filament lighting fittings.

8.3.4.3 The bell and gong can be realized electronically and the shape signal can be electrically controlled. For ships with R1 functional notation, the bell, gong and shape can be operated by the crew on board in a conventional manner.

8.3.4.4 The states of all signal equipment are to be transferred to the remote control station and the equipment can autonomously operate or be remotely controlled by the remote control station in accordance with the function provided on the ship.

8.3.4.5 The performance of signal equipment is to comply with the technical requirements of IMO International Regulations for Preventing Collisions at Sea, 1972 and adapts to the environmental conditions of the ship.

8.3.4.6 When the ship passes through a special channel such as a canal, it is to be equipped with a specified signal according to the requirements of the canal authority or port State authority. The signal light is to be operated remotely from the remote control station.

8.3.4.7 The arrangement of the signal light is to comply with IMO International Regulations for Preventing Collisions at Sea, 1972 and relevant administrations.

8.4 Additional requirements for R1 functional notation

8.4.1 Navigation requirements

8.4.1.1 General requirements

8.4.1.1.1 The ship has the function of remote control of navigation. The personnel can remotely control the navigation operation of the ship at the remote control station, including at least the propulsion and manoeuvring system, radio communication and signal system. The ship is provided with crew responsible for the maintenance of navigation related systems and equipment such as ship communication, navigation, signals and situation awareness; and can take over and manually operate the ship through the ship's bridge or navigation control station in emergency.

8.4.1.1.2 The ship is to have the function of route design and capable of navigating along the designed route.

8.4.1.1.3 The ship is to comply with the requirements for situation awareness in 2.3.6 and 2.4.2.4, Chapter 2 of the Rules, and transmit the perceived information to the remote control station on a real-time basis.

8.4.1.1.4 In addition to the requirements of 8.4.1.1.3 of this Chapter, the following data and information is to be obtained:

(1) continuously obtain the real-time video picture within an angle of view from right ahead to 112.5° on each side of the ship in the horizontal direction;

(2) obtain the real-time video picture in the horizontal direction of the ship at any time when necessary;

(3) obtain the real-time video picture of 180° from bow to stern from an overlooking angle of ship

sides.

8.4.1.2 Design requirements

8.4.1.2.1 The ship’s remote control system is to be directly supplied by two independent feeders from the main switchboard, one of which can be supplied by the emergency switchboard. When one power supply fails, automatic conversion is realized. Automatic change-over is to be realized in the event of failure of one power supply.

8.4.1.2.2 The situation awareness system, radio communication system and signal system and remote control system are to have self-check and alarm functions, capable of providing continuous monitoring during the normal operation of equipment. When equipment failure is detected, they are to be capable of sending an alarm and failure message to the onboard control station and remote operation station and generating a record.

8.4.1.2.3 The equipment and components of situation awareness system, radio communication system and signal system and remote control system are to be sufficiently reliable so as to minimize the failure probability. The system is to be so equipped and arranged to ensure that the ship’s awareness, communication and remote control capability is not affected or it can be restored as soon as possible in case of single point failure of equipment.

8.4.1.2.4 The ship’s control right can be transferred between the onboard control position and remote control station. The transfer is not to cause serious change of operating condition of ship and equipment.

8.4.1.2.5 The transfer of control right is only to be carried out at the onboard control position and after acknowledgement at the remote control station.Where necessary, crew members at the bridge can directly obtain the control of the ship.

8.4.1.2.6 When the remote control function is affected due to the failure of the ship or failure of system of the remote control station, the ship's personnel are to transfer control from the remote control station to the ship's control station. Meanwhile, transfer warnings are to be generated onboard ship and at the remote control station. The failure is to be checked in time to restore the remote control function of the ship as soon as possible.

8.4.1.3 Provision and performance of equipment

8.4.1.3.1 A ship applying for R1 functional notation is to be provided with remote control system, situation awareness system and radio communication and signal system.

8.4.1.3.2 The provision and performance of situation awareness equipment are to comply the applicable requirements of 2.5.1 and 2.5.3, Chapter 2 of the Rules. An augmented visual system is to be provided additionally.

8.4.1.3.3 The augmented visual system is to at least have a visual range of 6 nautical miles, including maintaining the clearness and smoothness of acquired video picture in weather conditions of poor visibility such as dark night, heavy fog, and rainstorm.

Note: Augmented visual system achieves real-time video rendering in the condition of poor visibility based on (not less than) information perceived by electronic charts, radar, AIS, Positioning Navigation and Timing System (PNT), CCTV, by using twin technology, visual reconstruction technology, etc., so as to achieve real-time sharing of ship, shore base, and mobile devices.

8.4.1.3.4 The installation and arrangement of camera are to be such that the field of vision of video picture of ships meets the requirements in 8.4.1.1.4 of this Chapter and not inferior to the equivalent visibility requirements in SOLAS regulation V/22.

8.4.1.3.5 The provision and performance of radio communication and signal equipment is to comply with the requirements of 8.3.3 and 8.3.4 of this Chapter respectively.

8.4.1.3.6 Close range detection equipment and marine radar are to comply with the performance requirements of 2.5.3.5 and 2.5.3.6, Chapter 2 of the Rules respectively.

8.4.1.3.7 The remote control system is to comply with the general requirements for intelligent navigation system of 2.4.1 of the Rules.

8.4.1.3.8 The remote control system is to comply with the requirements for category III computer system and satisfy applicable provisions of Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.4.1.3.9 The situation awareness system, radio communication and signal system and remote control system are to be approved by CCS.

8.4.2 Machinery installations

8.4.2.1 General requirements

8.4.2.1.1 Machinery installations and their automation systems are, in addition to the provisions of this Section, to comply with relevant requirements of PART THREE and Chapters 1, 2 and 3 of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.4.2.1.2 At least the main propulsion machinery are to be capable of operation and control via a remote operations station. Main propulsion machinery includes main engines (such as main diesel engines, main steam turbines, main gas turbines and electric propulsion devices), transmission devices (such as clutches, reduction gear boxes, etc.), and thrusters (such as controller pitch propellers, etc.).

8.4.2.1.3 The means for communication of ship are to be able to meet the remote control needs of the remote control station to ensure that all data and information can be transmitted in a timely, efficient and reliable manner.

8.4.2.1.4 The ship is generally to be provided with necessary equipment operation and management personnel, who can take over the operation and control of the equipment as required by safe operation of the ship (e.g. entering and leaving port or berthing and unberthing) or in emergency.

8.4.2.1.5 The ship is generally to be provided with necessary servicing and maintenance personnel, who can carry out examination and maintenance of machinery and electrical

installation as well as replacement and repair of spare parts in accordance specified plans and procedures, so as to ensure the availability of equipment and systems at any time.

8.4.2.1.6 Where the provision of onboard personnel, system design and arrangement, provision of equipment are different from relevant provisions of this Section, equivalent and alternative designs may be used, provided that the goal and functional requirements for remote control ships are at least achieved. In case equivalent and alternative designs are used, assessment and approval are to be carried out in accordance with relevant requirements of CCS.

8.4.2.2 Remote control/automatic control

8.4.2.2.1 The control mode of main propulsion machinery generally includes control via the remote control station, bridge control, control via the centralized control room and local control. The setting of control mode permission is to be suitable for the ship's operational scenario.

8.4.2.2.2 Transfer of control between stations (rooms) is to comply with applicable requirements of Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.4.2.2.3 Transfer of control between the remote control station and onboard control station can only be carried out at the onboard control station.

8.4.2.2.4 A single failure of the control system and communication link is not to cause failure of remote control or automatic control functions for the propulsion machinery and steering gear.

8.4.2.2.5 Various orders for main propulsion machinery and steering gear are to be indicated at all control positions of main propulsion machinery.

8.4.2.2.6 When the remote control system of the remote control station cannot achieve the intended function, an alarm is to be given to notify the ship's personnel, and means are to be provided to ensure the change-over to onboard control is conducted in a timely manner.

8.4.2.3 Monitoring, alarm and safety protection

8.4.2.3.1 To achieve operation and control of the main propulsion machinery via the remote control station, the equipment conditions and/or parameters displayed at the remote control station are to be considered based on the selection, design, and arrangement, etc. of the ship’s main propulsion machinery.

8.4.2.3.2 For ships with propellers driven by main diesel engines (including gas-fuelled engines), in order to achieve operation and control of the main propulsion machinery via the remote control station, at least the following equipment conditions and/or parameters are to be displayed at the remote control station:

(1) main engine speed (including restricted speed range), ahead/astern direction (if it can be reversed), operation modes (if any);

(2) engaged/disengaged condition of gears (if fitted);

(3) propeller speed and direction of rotation;

(4) angle (or pitch) of controllable pitch propeller(where applicable);

(5) condition of clutches and shaft brakes (where applicable);

(6) the control station carrying out control;

(7) main engine starting air pressure or staring accumulator battery voltage;

(8) power supply to the control and monitoring system related to the remote control station;

(9) other parameters necessary for remote control via the remote control station.

8.4.2.3.3 For electrically propelled ships, in order to achieve operation and control of the electric propulsion unit via the remote control station, at least the following equipment conditions and/or parameters are to be displayed at the remote control station:

(1) operation mode selection (if fitted);

(2) propulsion shaft speed and direction of rotation;

(3) propulsion direction (where applicable);

(4) engaged/disengaged condition of gears (if fitted);

(5) condition of clutches (if fitted);

(6) the control station carrying out control;

(7) power supply to the control and monitoring system related to the remote control station;

(8) other parameters necessary for remote control.

8.4.2.3.4 For ships powered by waterjet propulsion, in order to achieve operation and control of the electric propulsion unit via the remote control station, at least the following equipment conditions and/or parameters are to be displayed at the remote control station:

(1) operation mode selection (if fitted);

(2) main engine speed (including restricted speed range) (where applicable);

(3) engaged/disengaged condition of gears (if fitted);

(4) condition of clutches and shaft brakes (where applicable);

(5) Rotational speed of the waterjet propulsion pump;

(6) Control condition and position of the steering and reversing bucket;

(7) the control station carrying out control;

(8) main engine starting air pressure or staring accumulator battery voltage (where applicable);

(9) power supply to the control and monitoring system related to the remote control station;

(10) other parameters necessary for remote control.

8.4.2.3.5 Alarm and display requirements for bridge control station given in Chapter 3, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships also apply to the remote control station.

8.4.2.3.6 In case failure of machinery is detected, the alarm system is to inform persons on watch in the remote control station of the following situations:

(1) a failure has occurred;

(2) the occurrence of failure has been noticed (e.g. acknowledged, silenced etc.);

(3) the failure has been eliminated.

8.4.2.3.7 The local elimination of the audible alarm signal by the remote control station is not to stop the audible alarm of bridge, accommodation space and machinery space. The visual alarm signal is to be different before and after the alarm is acknowledged.

8.4.2.3.8 If the equipment stops operating due to the action of the safety system, the equipment is to be put into operation again after remote reset via the remote control station or manual reset.

8.4.2.3.9 For ships with propellers driven by main diesel engines (including gas-fuelled engines), the remote control station is to be provided with a main engine emergency stop button independent of the remote control system, but its actuator may not require independence and its arrangement is to be protected against inadvertent actuation.

8.4.2.3.10 For electrically propelled ships, the remote control station is to be provided with an emergency stop device. The emergency stop is to be independent of normal stop. The arrangement of the emergency stop facility is to be protected against inadvertent actuation.

8.4.2.3.11 Other necessary auxiliary monitoring measures (such as video surveillance) may be provided as deemed necessary by safety assessment.

8.4.2.4 Condition monitoring and health assessment

8.4.2.4.1 Condition monitoring, health assessment, assisted decision-making of engine room machinery installations and systems are to comply with the relevant requirements for functional notation M for intelligent machinery in Chapter 4 of the Rules.

8.4.2.4.2 Where condition-based maintenance of machinery equipment and system is necessary to be carried out taking into account design arrangement of machinery equipment and system, the provision and responsibilities of crew onboard and maintenance demands, it is to comply with relevant requirements for functional notation Mx for intelligent machinery in Chapter 4 of the Rules.

8.4.3 Electrical installations

8.4.3.1 General requirements

8.4.3.1.1 Electrical installations and their automation systems are to comply with applicable

requirements of PART FOUR and PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships respectively.

8.4.3.2 Condition monitoring and health assessment

8.4.3.2.1 Where the ship is propelled by the conventional propulsion diesel engines, then generators、switchboards、transformers、frequency converters (if any) and auxiliary systems (if any) are to be monitored in accordance with the provisions of Table 4.1.8 of Chapter 4 of the Rules.

8.4.3.2.2 Condition monitoring, health assessment, decision-making assistance (including condition-based maintenance) of electrical installations are to comply with relevant requirements of Chapter 4 of the Rules.

8.4.4 Fire-fighting

8.4.4.1 General requirements

8.4.4.1.1 Fire-fighting is to comply with relevant provisions of PART SIX and Section 9, Chapter 3, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.4.4.1.2 For R1 ships, the operation and control of fire-fighting systems and equipment may be completed by crew on board or may be designed to be operated and controlled via a remote control station. In case of remote control, the applicable requirements of 8.5.4 of this Chapter are to be satisfied and the personnel on board are to be able to carry out overriding operation.

8.4.4.2 Monitoring, alarm and safety protection

8.4.4.2.1 Alarm signals of the following equipment as a minimum are to be displayed at the remote control station:

(1) fixed fire detection and fire alarm systems;

(2) automatic sprinkler, fire detection and fire alarm systems;

(3) flammable gas detection systems;

(4) sample extraction smoke detection systems.

8.4.4.3 Condition monitoring and health assessment

8.4.4.3.1 As a minimum, condition monitoring and health assessment are to be carried out to firefighting systems and equipment specified in Table 8.4.4.3.1.

8.4.4.3.2 Condition monitoring, health assessment, assisted decision-making (including condition-based maintenance) are to comply with relevant requirements of Chapter 4 of the Rules.

Firefighting equipment and systems **Table 8.4.4.3.1**

No.	Name of equipment/system	Monitoring scope （Equipment/spare parts/performance etc.）	Monitoring purpose （E.g. condition, function, performance etc.）
1	Mechanical ventilation systems	Fan	Air supply capacity
2	Fixed gas fire-extinguishing systems	Storage container and associated pipelines	Gas leakage
3	Fixed pressure water-spraying and water mist fire-extinguishing systems	Piping system	Water supply capacity
4	Automatic sprinkler systems	Pressure tank	Water supply capacity
5	Sample extraction smoke detection systems	Fan	Extraction capacity

8.4.5 Anchoring

8.4.5.1 General requirements

8.4.5.1.1 The provision of anchoring equipment and the design and construction of its hull supporting structure are to comply with the applicable provisions of Chapter 3, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

8.4.5.1.2 The operation and control of anchoring equipment may be completed by personnel on board or designed for remote control or autonomous control. If remote control or autonomous control is adopted, the applicable requirements of 8.5.6 of this Chapter are to be complied with, and personnel onboard are to be able to override the operation.

8.5 Additional requirements for R2 functional notation

8.5.1 Navigation requirements

8.5.1.1 General requirements

8.5.1.1.1 The ship has the function of remote control of navigation. There is no crew on board. The ship's operation is remotely controlled by remote control station.

8.5.1.1.2 The functional requirements of 8.4.1.1.2 to 8.4.1.1.4 of this Chapter are to be satisfied.

8.5.1.1.3 For R2 ship, data storage is to satisfy the following requirements:

(1) The ship is to be provided with redundant data servers for the storage of information on condition and operation of equipment and systems related to ship navigation.

(2) The capacity of each data server is to be such that at least the data generated by a single voyage but not less than 30 days can be stored. When the stored data reaches the upper limit of server capacity, the oldest data can be replaced by the latest data.

(3) The data on the data server can be transmitted to the remote control station according to the need.

8.5.1.2 Design requirements

8.5.1.2.1 The design requirements for R1 ships in 8.4.1.2.1 to 8.4.1.2.3 of this Chapter are to be met.

8.5.1.2.2 For systems and equipment required to be provided redundantly in accordance with 8.5.1.3.2 of this Chapter, the switching device is to have self-checking and failure alarm functions to ensure the effectiveness of the switching function.

8.5.1.2.3 The remote control station is to be connected to the situation awareness system, radiocommunication and signal system, propulsion and manoeuvring system through a redundant network.

8.5.1.2.4 The interfaces of redundant systems and equipment are to be independent from each other

8.5.1.2.5 When the ship's navigation capability is impaired due to equipment or system failure, the ship is to be able to report the details of the failure to the remote control station, and the remote control personnel will assess whether its seaworthiness is affected.

8.5.1.2.6 The ship is to have a fail-safe mode. If the remote control link is interrupted and cannot to be restored due to equipment failure or the seaworthiness of the ship is severely affected and normal remote navigation is not possible, the ship is to enter the safe mode to ensure the safety of the ship.

8.5.1.3 Provision and performance of equipment

8.5.1.3.1 Provision and performance of equipment of R2 ship is to satisfy the requirements of 8.4.1.3 of this Chapter.

8.5.1.3.2 The remote control system, marine radar, electronic chart, gyrocompass and VHF radio installations are to be duplicated to meet the requirements of 100% redundancy. The two remote control systems are to be hot backups to each other.

8.5.2 Machinery installations

8.5.2.1 General requirements

8.5.2.1.1 Machinery installations and their automation systems are, in addition to the provisions of this Section, to comply with relevant requirements of PART THREE and Chapters 1, 2 and 3 of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.5.2.1.2 At least the main propulsion machinery are to be capable of operation and control via a remote operations station. Main propulsion machinery includes main engines (such as main diesel engines, main steam turbines, main gas turbines and electric propulsion devices), transmission devices (such as clutches, reduction gear boxes, etc.), and thrusters (such as controller pitch propellers, etc.).

8.5.2.1.3 Equipment and systems in the engine room are to be provided with automatic control

system capable of automatic operation and running in accordance with the instructions or needs of ship navigation, manoeuvring and cargo management.

8.5.2.1.4 The safety, reliability and availability of machinery installations and systems in the engine room are not to be lower than the level of a manned ship.

8.5.2.1.5 The design, arrangement, operation and control and maintenance of equipment and systems are to be suitable for the operational and running mode expected for each scenario of the ship.

8.5.2.1.6 The running status, monitoring parameters etc. of equipment and systems are to be indicated at the remote control station.

8.5.2.1.7 Appropriate control and operational conditions are to be provided on board to facilitate installation and commissioning, testing and verification, maintenance and repair on board.

8.5.2.1.8 The setting of authority for various control modes of equipment and systems is to be suitable for the needs of ship's operational scenarios.

8.5.2.1.9 Emergency operational functions such as emergency stopping/boiler shutdown/cutting off/shutting down specified in CCS Rules for Classification of Sea-going Steel Ships are to be realized at the remote control station.

8.5.2.1.10 Means of communication are to satisfy various needs of remote control and automatic control via the remote control station, in order to ensure that timely, effective and reliable data and information transmission can be carried out.

8.5.2.1.11 A necessary recording system is to be provided to automatically record the various operations and response of equipment and systems in the engine room according to specified procedures and plans, including at least:

(1) various records and test results related to sea trials and test verification;

(2) various instructions from ship navigation control systems and remote control stations;

(3) operational response of engine room equipment and systems after receiving instructions;

(4) alarm and safety protection actions in the engine room;

(5) various emergency operations;

(6) various operation records required by relevant regulations, such as changeover between high-sulfur / low-sulfur fuel oil, fuel oil/ gas fuel (for dual fuel system), exhaust gas after-treatment device (e.g. start, stop and work mode switching of exhaust gas cleaning system (EGC) and selective catalytic reduction system (SCR)), start and stop of diesel EGR system, start and stop of oil-water separator, operation of incinerator, etc.);

(7) maintenance and repair records (which can be manually entered into the system).

8.5.2.1.12 It is to automatically output various records and reports according to the specified procedures and plans with feedback to the remote control station.

8.5.2.1.13 Means for filtering fitted in the equipment and systems of the engine room are to be

of the automatic cleaning type.

8.5.2.1.14 The relief device used for overpressure protection is to be able to return automatically after the overpressure is released.

8.5.2.1.15 The mechanical connection mechanism (if any) for emergency operation is to be able to be remotely controlled at the remote control station so that the ship can still have a certain navigation ability in case of failure.

8.5.2.2 Machinery piping system, oil tanker piping system, ship's piping and ventilation systems

8.5.2.2.1 In addition to the following provisions, machinery piping system, oil tanker piping system, ship's piping and ventilation system of ships are to satisfy the applicable requirements of Chapters 2 to 5, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) Fuel oil supply piping system, lubricating oil piping system, hydraulic transmission piping system, cooling water piping system and compressed air piping system (including driving system of automatic/remote control valves fitted to the piping system) serving the single main engine propulsion system are to be duplicated, unless it is demonstrated by the failure mode and effects analysis that a single failure will not lead to the total failure of the propulsion system. Where two or more main engines are provided and each engine is fitted with separate fuel oil supply piping system, lubricating oil piping system, hydraulic transmission piping system (if any), cooling water piping system and compressed air piping system, additional piping systems common to and readily available to multiple engines may be provided.

(2) For piping systems serving the main propulsion and ship's manoeuvring devices, effective measures are to be adopted to reduce the risk of leakage of piping, in order to reduce insofar as practicable the action of engine room safety and protection system due to leakage during the operation of ship.

(3) Pumps, valves and closing appliances of air vents related to automatic operation and running are to be capable of automatic operation in accordance with procedures.

(4) For automatic/remote control valves and closing appliances of air vents provided for oil tanker piping system, ship's piping and ventilation systems, their driving systems are to be redundant.

(5) Valves fitted in order to satisfy subdivision and watertight requirements in accordance with the provisions of Chapter 2 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships are to be automatically operated in accordance with procedures.

(6) Ballast water and bilge systems required by Chapter 3, PART THREE of the Rules for Classification of Sea-going Steel Ships are to be automatically operated in accordance with procedures.

(7) For all tanks, cofferdams and pipe tunnels as well as the bilges or bilge wells, the liquid level is to be monitored and the start/stop and on/off of pumps and valves of relevant systems are to be controlled automatically in accordance with procedures.

(8) Oil fuel transfer pumps, oil fuel unit pumps, lubricating oil service pumps, thermal oil circulating pumps, oil separators (purifiers), forced and induced draught fans for engine room ventilation, closing appliances of air vents and means of control required by SOLAS Chapter II-2 are to be automatically controlled or remotely controlled by remote control station in accordance with procedures based on engine room fire detection and monitoring information.

(9) Tanks provided with means for draining in accordance with CCS Rules for Classification of Sea-going Steel Ships are to be automatically drained in accordance with procedures or monitoring results.

(10) Condensate water observation tanks of boilers are to be provided with means for monitoring oil fuel leakage. In case any leakage is detected, feedback is to be given to the remote control station timely for making decisions on repair.

8.5.2.3 Boilers and pressure vessels

8.5.2.3.1 In addition to the following provisions, boilers and pressure vessels are to satisfy the applicable requirements of Chapter 6, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) Boilers are to be provided with automatic control systems.

(2) Boilers are to be provided with means for automatic blow-off, which is to be carried out in accordance with procedures or monitoring information.

(3) Air which might accumulate at the top of the boiler or drum is to be automatically discharged in accordance with procedures or monitoring information.

(4) The feed water quality of boilers is to be monitored and water quality is automatically controlled in accordance with procedures.

(5) The liquid level (where applicable) and pressure of pressure vessels are to be monitored.

(6) scum, water and oil which might accumulate inside the pressure vessel (including air bottle) during use are to be automatically discharged in accordance with procedures or monitoring information.

8.5.2.4 Diesel engines

8.5.2.4.1 In addition to the following provisions, diesel engines are also to satisfy the applicable requirements of Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) Diesel engines are to be provided with automatic control/remote control systems, automatically operated and run in accordance with the instructions of ship's remote control station.

(2) The speed (including restricted speed range) and ahead/astern direction (if it can be reversed) of main engines are to be indicated at the remote control station.

(3) The operation of diesel engines, fuel change-over and operational conditions are to be automatically recorded, with output of relevant records and reports when needed by examination/survey.

8.5.2.5 Shafting and transmission gearing

8.5.2.5.1 In addition to the following provisions, gears are to satisfy the applicable requirements of Chapter 10, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) Operations such as gear engagement and disengagement are to be remotely controlled through the remote control station. The condition of gear engagement/disengagement is to be indicated at the remote control station.

(2) Lubricating oil temperature and pressure in the pressure lubricating oil systems, pressure of hydraulic oil (if any) and oil level of the oil sump of splash lubrication are to be monitored, which can be indicated at the remote control station.

(3) For reversible gearing, the directions of ahead and astern running are to be indicated at the remote control station.

8.5.2.5.2 In addition to the following provisions, shafting and propellers are to satisfy the applicable requirements of Chapters 11 and 12, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) Clutches, hydraulic transmission arrangements of shafting, controllable pitch propellers, Z propulsion arrangements and transverse propulsion arrangements are to be remotely controlled through the remote control station.

(2) Parameters necessary for the remote operation of the above transmission gearing and propulsion plants are to be indicated at the remote operation station of the remote control station, e.g. speed and rotation direction of propellers, clutching /declutching and astern/ahead direction (if any) of the clutches, pitch angle (controllable pitch propeller), lubricating oil/hydraulic oil pressure.

8.5.2.6 Steering gear

8.5.2.6.1 In addition to the following provisions, the steering gear is to satisfy the applicable requirements of Chapter 13, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

(1) all steering gear or steering arrangements are to be operated by power and can work automatically in accordance with the instructions of the remote control station;

(2) a single failure is to be automatically isolated so that the steering capability can be maintained or quickly regained without manual intervention;

(3) gas that might enter the hydraulic system is to be automatically drained from the system;

(4) in case of low oil level due to normal loss of the hydraulic system, oil is to be automatically

re-filled;

(5) steering gear (including main and auxiliary steering gear) is to be remotely controlled at the remote control station. For this purpose, monitoring and alarm items are to be real-time transmitted to the remote control station;

(6) accessibility and space, for the purposes of maintenance, inspection and repair of equipment, are to be provided in steering gear room;

(7) the effectiveness of remote control function of steering gear is to be confirmed by test.

8.5.2.7 Monitoring, alarm and control

8.5.2.7.1 In addition to the following provisions, the monitoring, alarm and control system and the safety system of machinery installations are to satisfy the applicable requirements of Chapters 1 to 3, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships:

(1) the means of control of machinery installations and systems generally consist of automatic control and remote control by the remote control station.

(2) the safety of automatic control/remote control system is to be not less as that of the ships with machinery spaces being attended. Means are to be provided to ensure that essential equipment can be remotely controlled effectively from the remote control station in case of failure of the automatic control systems;

(3) the remote control station is generally to satisfy the requirements applicable to the monitoring, alarm and control of bridge control stations in CCS Rules for Classification of Sea-going Steel Ships;

(4) all machinery and electrical installations essential for the safe operation of the ship are, in the case of failure in or out-of-action of any part of automatic control system including failure of power supply, to be capable of sending out alarm signals to the remote control station and putting the back-up arrangements into service in time for recovering normal operation;

(5) for machinery piping systems which are duplicated and can be operated independently, their monitoring, alarm and control systems as well as power sources are also to be independent from each other. Any common part is to be redundant in order to effectively isolate a single failure;

(6) for a single ship's piping systems, the monitoring, alarm and control systems (including sensors, controls, cables etc.) and power sources (including electrical power, gas source of pneumatic system, pressure relief valve, filter and dryer, hydraulic pump of hydraulic power system, solenoid valve etc.) are to be designed in redundancy. Any single failure will not lead to the failure of the whole system;

(7) in addition to starting standby pump, mode c protective action of the safety system may also start the standby system;

(8) after the occurrence of mode a protective action of the safety system, relevant equipment can generally be re-started after being reset by the remote control station. Where it is designed with

automatic reset, it is to be ensured that relevant machinery installations will not be damaged due to such function;

(9) the self-check scope and extent of the monitoring, alarm and control system and the safety system are to take into account the factor of automatic operation and match the maintenance plan;

(10) the automatic monitoring items required in applicable rules are to give a single alarm and/or indication at the remote control station;

(11) for the monitoring, alarm and control system and the safety system, the authority of adjusting the setting value is to be strictly controlled and managed;

(12) the alarm system is to be capable of blockading meaningless signals intelligently during certain processes;

(13) the overriding function is to be realized for the main engine, e.g. overriding operation of main engines for the purpose of collision prevention;

(14) valves for controlling the flooding due to damage are to be capable of being closed automatically in accordance with the instructions.

8.5.2.8 Condition monitoring and health management

8.5.2.8.1 A condition monitoring and health assessment system is to be provided to conduct condition monitoring and health assessment of the main propulsion machinery, auxiliary power generating diesel engines, boilers, essential auxiliary systems, etc. in the engine room, and feasible maintenance, repair and inspection plans are developed by considering factors such as ship's route / voyage arrangement and berthing time.

8.5.2.8.2 Condition monitoring, health assessment and assisted decision-making (including condition-based maintenance) are to meet the requirements of Chapter 4 of the Rules.

8.5.2.8.3 In addition to the equipment and systems specified in Chapter 4 of the Rules, at least the equipment and systems listed in Table 8.5.2.8.3 are to be subject to condition monitoring and health assessment.

List of equipment and systems subject to condition monitoring

Table 8.5.2.8.3

No	Equipment/system name	Monitoring scope (Equipment/spare parts/performance etc.)	Monitoring purpose (E.g. condition, function, performance etc.)
1	Boiler		
1.1		Combustion chamber	Combustion condition
1.2		Burner	Fuel supply capacity Air supply capacity
2	Water supply system		Water supply quality
2.1		Water supply pump	Water supply capacity
3	Emission treatment device (if any)		
3.1		Reactor	Flow capacity
3.2		Pump	Medium supply capacity

No	Equipment/system name	Monitoring scope（Equipment/spare parts/performance etc.）	Monitoring purpose（E.g. condition, function, performance etc.）
3.3		Filter	Filtering impurities
3.4		Fan (if any)	Ventilation capacity
4	Ballast water management system		
4.1		Pump	Medium supply capacity
4.2		Filter	Filtering impurities

8.5.2.9 Protection against flooding

8.5.2.9.1 In addition to the following provisions, protection against flooding of engine room is to satisfy the applicable requirements of CCS Rules for Classification of Sea-going Steel Ships:

(1) any valve serving a sea inlet, a discharge below the waterline or a bilge injection system, for controlling flooding upon damage is to act automatically to control flooding upon damage in case of alarm of high bilge water level as specified in Section 9, Chapter 3 of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships;

(2) bilge pumps are to be operated automatically in accordance with specified procedures. The operational conditions of bilge pumps are to be indicated at the remote control station. In case the influx of liquid is greater than the pump capacity or the pump is operating more frequently than would normally be expected, timely feedback is to be sent to the remote control station for making decisions on repair.

8.5.2.10 Procedures and plans

8.5.2.10.1 Detailed control and operational procedures (including control logic, functional block diagram etc.) are to be developed by taking into account various control and operational modes of machinery installations and systems of engine room.

8.5.2.10.2 Detailed examination procedures and plans are to be developed. Main working parameters, operational status of machinery installations and various records and reports are to be periodically examined by watchkeepers at the remote control station.

8.5.2.10.3 Corresponding emergency procedures are to be developed with regard to any failure that might occur during the operation and use of machinery installations and systems.

8.5.3 Electrical installations

8.5.3.1 General requirements

8.5.3.1.1 In all working conditions and modes, electrical installations are able to provide continuous and reliable power supply to equipment which is necessary for the operation and safety of ships.

8.5.3.1.2 The automatic control systems are able to be operated according to ship’s navigation, maneuvering, cargo management or other modes, and means are to be provided to ensure that when automatic control systems fail, essential equipment can be effectively operated and

controlled from the remote control station.

8.5.3.1.3 The safety, reliability and availability of electrical installations in the engine room are not to be lower than the level of a manned ship.

8.5.3.1.4 The design, arrangement, operation, control, maintenance for equipment and systems are to be suitable for the intended operational mode of the ship.

8.5.3.1.5 The running status, monitoring parameters of electrical installations are to be indicated at the remote control station.

8.5.3.1.6 Appropriate control and operational conditions are to be provided on board to facilitate installation, commissioning, testing, verification, maintenance and repair work.

8.5.3.1.7 The command transfer shall follow the ship's operational scenarios.

8.5.3.1.8 Means of communication are to satisfy various needs of remote and automatic control function, in order to ensure that timely, effective and reliable data and information transmission can be carried out.

8.5.3.1.9 A recording system is to be provided as necessary, capable of automatically recording various information in accordance with procedures and plans, at least including:

(1) Various records and test results related to sea trial, test and verification;

(2) Various control command from ship's control system and remote control station;

(3) Feedback and key parameters of electrical installations and relevant auxiliary systems;

(4) Alarm and safety protection action;

(5) Various emergency operation;

(6) Maintenance and repair records (manually entered into the system after completion).

8.5.3.1.10 Records and reports can be updated automatically according to the specified procedures and plans, it is possible to be sent the remote control station.

8.5.3.2 Prescriptive requirements

8.5.3.2.1 A power system is to be arranged to provide continuous power supply for shipborne systems. The power system includes the prime mover, generator, transformer, frequency converter, switchboard, control gear, uninterruptible power supply, cables, automation and auxiliary system serving the above equipment.

8.5.3.2.2 The power system is to have redundancy arrangement, in case of any single failure for the power system, the standby system is to be able to start automatically and supply power to essential equipment, so as to restore or maintain functions of each system, and the following requirements are to be met:

(1) Essential equipment means the equipment necessary for maintaining the propulsion, steering and other safety function of ships, any single failure of the power system is not to result in loss of

the function concurrently;

(2) The scope of a single failure includes any active components and systems belonging to or serving the power system, but does not include static component failures, fire or flooding in a single compartment;

(3) The power system is to have sufficient capacity to satisfy the power supply demand under normal and failure conditions.

8.5.3.2.3 Under various working conditions, the energy for starting and controlling of the power system is to be equipped with automatic charging function, and such energy system is to meet the same redundancy requirements as those for the power system.

8.5.3.2.4 When the power supply system needs to rely on other auxiliary systems in order to be available in the standby mode, the function is to be automatically controlled. At the same time, such function needs to have self-diagnosis function to determine whether the power supply system can be automatically started and supply the relevant equipment. The diagnostic function needs to check the running status, the most likely failures mode and the mode of equipment.

8.5.3.2.5 The power management system is to be able to automatically start and stop the power supply according to the load demand and operation mode of ships in order to maintain sufficient reserve power in all working conditions.

8.5.3.2.6 Automatic power plant control system serving power system is to have redundant arrangement. In case of any single failure of the control system, the system is to be designed to be fail-safe and the necessary automatic function can still be maintained.

8.5.3.2.7 The remote control and monitoring are to meet the following requirements:

(1) the power grid's parameters of the ship and the status of the electrical equipment serving essential equipment are to be monitored by the remote control station, the priority and monitoring intervals are to be determined according to the importance;

(2) The electrical system for power system and other essential system are to be equipped with the functions of automatic control and remote control by the remote control station. The function of remote control is to include at least the start/stop of the generator sets, parallel running, breaker control, motor start/stop of motors, mode selection, etc.;

(3) If necessary, the remote control function is to be able to override the automatic control in order to control the same device. The automatic and remote controls are to be mutually independent of each other.

8.5.3.2.8 If arranged, the change-over, sequential startup and standby startup function for essential equipment needs to be arranged with sufficient self-diagnostic capability.

8.5.3.2.9 The control system serving shipborne systems is to be supplied by the uninterruptible power supply. The corresponding uninterruptible power supply needs to meet the same redundancy requirement as for the equipment being served, and the required uninterruptible power supply is to be the on-line UPS type and be equipped with the automatic by-pass function.

8.5.3.2.10 In addition to the special provisions of this Section, the ship's electrical installations

need to comply with applicable requirements of PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

8.5.4 Fire-fighting

8.5.4.1 General requirements

8.5.4.1.1 The provisions of this Section apply to design and arrangement for fire protection, fire detection and fire extinction (hereinafter referred to as fire-fighting) of ships applying for the R2 functional notation.

8.5.4.1.2 Spaces of fire risk onboard ships are those spaces where combustible substances (including solid, gas and liquid), electrical installations and machinery equipment are located or having other fire risk, including:

(1) machinery spaces of category A;

(2) other machinery spaces;

(3) cargo spaces;

(4) spaces containing electrical installations;

(5) other spaces prone to fire.

8.5.4.1.3 Spaces of fire risk onboard ships are to be constructed and arranged by steel and non-combustible materials as far as possible and one of the following measures are to be taken:

(1) separation from combustible substances;

(2) separation from sources of ignition;

(3) inerting of the spaces.

8.5.4.1.4 If none of the three measures mentioned in 8.5.4.1.3 can be satisfied, combustible gas detection, fire detection and alarm, and fire extinguishing measures, or other measures providing equivalent safety level based on risk analysis, are to be provided, according to the applicable requirements of this Section.

8.5.4.1.5 The safety, reliability and availability of fire-fighting equipment and systems are not to be lower than the level of a manned ship.

8.5.4.1.6 The design, arrangement, operation and control and maintenance of fire-fighting equipment and systems are to be suitable for the running mode and operational scenario expected for the ship.

8.5.4.1.7 Appropriate control and operational conditions are to be provided on board to facilitate installation and commissioning, testing and verification, maintenance and repair on board.

8.5.4.1.8 The setting of authority for various control modes of fire-fighting equipment and systems is to be suitable for the needs of ship’s fire control and suppression.

8.5.4.2 Fire safety objectives

8.5.4.2.1 The fire safety objectives of ships are to:

(1) prevent the occurrence of fire and explosion;

(2) reduce the risk of damage caused by fire to the ship, its cargo and the environment;

(3) contain, control and suppress fire and explosion in the space of origin.

8.5.4.3 Functional requirements

8.5.4.3.1 To achieve the objectives set out in 8.5.4.2.1, the following functional requirements on fire-fighting are to be met:

(1) detection of leakage of combustible substance and accumulation of flammable gas in spaces of fire risk;

(2) detection of any fire in spaces of fire risk;

(3) operating conditions, monitoring parameters etc. of fire-fighting equipment and systems are to be displayed at the remote control station;

(4) receiving remote control instructions from remote control station;

(5) in case of failure of remote control function, the ship can carry out control of fire-extinguishing operation autonomously;

(6) The ship structure and arrangement of compartments are to be such that occurrence and spread of fire can be prevented.

8.5.4.4 Probability of ignition

8.5.4.4.1 Arrangements of fuel oil, lubricating oil and other flammable oil are to comply with the applicable requirements of SOLAS Regulation II-2/4.2.

8.5.4.4.2 In addition to the requirements of 8.5.4.4.1, fire protection measures for machinery spaces are also to comply with the applicable requirements of Chapter 3 of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

8.5.4.4.3 Use of fire protection materials is to comply with applicable requirements of SOLAS Regulation II-2/5.3. If primary deck coverings are applied in spaces with electric installations, they are to be of approved materials which will not readily ignite, and fire resistance is to be determined in accordance with the IMO Fire Test Procedures Code.

8.5.4.4.4 In spaces where penetration of oil is possible, the surface of insulation is to be impervious to oil or oil vapors.

8.5.4.5 Detection and alarm

8.5.4.5.1 The following means are to be provided for detection of leakage of combustible substance and accumulation of flammable gas:

(1) For spaces where leakage or volatilization of flammable gas is possible, a fixed flammable gas detection system is to be provided, the arrangement of which is to take into account of the compartment arrangement and ventilation, so as to readily and effectively detect potential leakage or volatilization of flammable gas;

(2) When the flammable gas concentration reaches the preset threshold value (i.e., not higher than 10% of the lower flammable limit), an alarm signal is to be automatically sent to the remote control station, and meanwhile power ventilation system is to be automatically activated or increase the ventilation capacity so as to prevent accumulation of flammable gas.

8.5.4.5.2 Spaces of fire risk are to be provided with a video monitoring system, which is to be so designed and arranged that all important parts of the space are covered. The system is to be capable of sending images to the remote control station.

8.5.4.5.3 Spaces of fire risk are to be provided with a fixed fire detection and fire alarm system that complies with the following requirements:

(1) The type and arrangement of the detector is to comply with the applicable requirements of SOLAS Regulation II-2/7 and the International Code for Fire Safety Systems of IMO;

(2) The system is to be so designed and arranged that it can quickly detect the initial fire within the space in a normal condition. False alarm is to be prevented. The air flow caused by machinery is not to lead to the failure of the detection system;

(3) The detector is to act due to heat, smoke or other products from combustion, flame or any combination of them. The detector in each space is to be the combination of two different types of probes, so that the system can response to more than one type of signs of fire;

(4) The system is to be capable of self-check. An alarm sign is to be sent to the remote control station in case of failure of electric power supply or the system;

(5) The detector is to be so positioned that the remote control station can determine the location of fire origin;

(6) If means for calibration of detector sensitivity is installed, necessary measures are to be provided to ensure the fixing and identification of its set value;

(7) If temporary switching off of a special loop or detector is intended, this situation is to be clearly indicated. After a given interval of time, the function of this loop or detector is to be automatically resumed;

(8) If any sign of fire is detected by a detector, the ship is to be capable of timely sending fire alarm signal to the remote control station.

8.5.4.6 Condition monitoring

8.5.4.6.1 The conditions, main operating parameters and alarm signals of the following systems

and equipment as a minimum are to be displayed at the remote control station:

(1) fixed fire detection and fire alarm systems;

(2) automatic sprinkler, fire detection and fire alarm systems;

(3) flammable gas detection systems;

(4) sample extraction smoke detection systems;

(5) inert gas systems;

(6) mechanical ventilation systems;

(7) watertight doors;

(8) fire doors;

(9) fire dampers and smoke dampers.

8.5.4.6.2 The ship is to be capable of sending the condition monitoring information as described in 8.5.4.6.1 to the remote control station in real time, and timely sending alarm signals in case of system failure.

8.5.4.6.3 The following systems are to be capable of receiving the operation and control from the remote control station, as applicable:

(1) power ventilation system;

(2) local water-based fire-extinguishing system;

(3) gas fire-extinguishing system;

(4) oil pumps in machinery spaces, etc.

8.5.4.7 Containment of fire

8.5.4.7.1 The minimum fire integrity of the bulkheads and deck are to comply with the provisions in Tables 8.5.4.7.1 and 8.5.4.7.2.

Fire integrity of bulkheads separating adjacent spaces[1] **Table 8.5.4.7.1**

Spaces		1	2	3	4	5
1	Electric installation spaces[2]	A-0	A-0	A-60	A-15	A-60
2	Means of access		C	A-0	A-0	A-0
3	Category A machinery spaces			*	A-0	A-0[3]
4	Other machinery spaces				A-0	A-0
5	Cargo spaces					*

Fire integrity of decks separating adjacent spaces **Table 8.5.4.7.2**

Spaces below deck \ Spaces above deck		1	2	3	4	5
1	Electric installation spaces	A-0	A-0	A-60	A-0	A-0
2	Means of access	A-0	*	A-0	A-0	A-0
3	Category A machinery spaces	A-60	A-0	*	A-60	A-30
4	Other machinery spaces	A-15	A-0	A-0	*	A-0
5	Cargo spaces	A-60	A-0	A-0	A-0	*

Note: 1 See SOLAS Regulation II-2/3 for the definition of fire integrity classes.

2 Pilot station is included.

3 If dangerous cargoes are carried, the requirements of SOLAS Regulation II-2/19.3.8 are to be complied with.

4 An asterisk * in the table indicates that the separation is required to be steel or equivalent material, but "A" class is not required.

8.5.4.7.2 Penetrations in the fire divisions are to comply with the applicable requirements of SOLAS Regulation II-2/9.3, so as to prevent heat transmission.

8.5.4.7.3 Doors on fire divisions are to comply with the applicable requirements of SOLAS Regulation II-2/9.4.2.

8.5.4.7.4 Openings on the boundaries of machinery spaces are to comply with the applicable requirements of SOLAS Regulation II-2/9.5.

8.5.4.7.5 The design and arrangement of the ventilation system is to comply with the applicable requirements of SOLAS Regulation II-2/9.7.

8.5.4.8 Fire-fighting

8.5.4.8.1 A fixed gas fire extinguishing system or equivalent system is to be provided in spaces of fire risk. Means are to be taken to prevent the influence on ship safety due to the release of fire-fighting media of equivalent fire-fighting system.

8.5.4.8.2 Unless fire in a space where any equipment located within will not cause failure of propulsion, internal combustion engine for main propulsion and serving as other driving sources, boilers, inert gas generator supplied by fuel oil and fuel oil units are to be provided with a local water-based fire-extinguishing system or equivalent system. Such system is to comply with the following requirements:

(1) design and arrangement of the system are to comply with the requirements of IMO MSC.1/Circ.1387;

(2) the system can automatically release fire extinguishing medium. The automatic release is to be jointly triggered by any of the following detector combinations:

① combination of two approved flame detectors;

② combination of approved flame detector and smoke detector;

③ combination of other approved detectors.

8.5.4.8.3 In the event of a fire, the ship is to be capable of automatically closing the ventilation system and openings in the space of origin before starting the fire-extinguishing system in accordance with the prescribed procedures. Other than machinery spaces of category A, the automatic release of the fire-extinguishing system is to be triggered by combination of two different types of probes. For machinery spaces of category A, after activation of probes, confirmation is to be given by the remote control station. If the remote control station has no further response and action, the following devices are to be automatically closed and the fire-extinguishing system is to be automatically activated 2 minutes after activation of probes:

(1) ventilation fans;

(2) external openings, and ventilator dampers;

(3) forced and induced draught fans;

(4) pumps, including oil fuel transfer pump, oil fuel unit pumps, lubricating oil service pumps, thermal oil circulating pumps and oil separators (purifiers);

(5) emergency shut-off valves.

8.5.4.8.4 The fire extinguishing system is to be designed with self-check function. In case of failure of the system, a failure alarm signal is to be sent to the remote control station.

8.5.4.8.5 The volume of gas fire media is not to be less than twice that of the space of the maximum volume.

8.5.4.9 Structural integrity

8.5.4.9.1 In order to ensure that the structural integrity is not degraded due to fire, the following requirements are to complied with:

(1) the hull, structural bulkheads, decks, superstructures and deckhouses are to be constructed of steel or other equivalent material;

(2) crowns and casings of machinery spaces of category A are to be of steel construction;

(3) if the structure of aluminum alloy is provided, the requirements of SOLAS Regulation II-2/11.3 are to be complied with.

8.5.4.10 Inert gas system

8.5.4.10.1 If inert gas system and nitrogen generator system are installed for inerting of compartments onboard, the systems are to comply with applicable requirements of Chapter 4, PART SIX of CCS Rules for Classification of Sea-going Steel Ships. However, the nitrogen

content in a space is to be determined according the specific feature of the space, and normally is to be kept below 8%.

8.5.5 Environmental protection

8.5.5.1 General requirements

8.5.5.1.1 This Section specifies requirements for the design, arrangement and management of ships in relation to environmental protection.

8.5.5.1.2 Environmental protection indexes, energy efficiency indexes, structural arrangement and application of material of ships are to comply with the provisions of the International Convention for the Prevention of Pollution from Ships (hereinafter referred to as MARPOL), the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (hereinafter referred to as BWM Convention), the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (hereinafter referred to as AFS Convention), Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (hereinafter referred to as the Recycling Convention).

8.5.5.1.3 The operational requirements specified in plans, procedures, manuals and records, etc., which need the participation of crew members, as provided in MARPOL, BWM Convention, AFS Convention and the Recycling Convention, are to be satisfied by means of equivalent alternative methods.

8.5.5.1.4 Environmental protective equipment and its systems onboard (mainly including oil-contaminated water management, exhaust emission control and ballast water management) are to be capable of autonomous operation and can be switched to the remote control mode by the remote control station as required.

8.5.5.1.5 For oil and oily mixtures, noxious liquid substances, harmful substances carried by sea in packaged form, sewage as well as garbage defined respectively in Annexes I, II, III, IV, V of MARPOL, if zero discharge at sea is achieved, the notation ZWPD may be assigned.

8.5.5.2 Goal

8.5.5.2.1 In order to preserve the human environment in general and the marine environment in particular, eliminate or alleviate the pollution from ships on sea waters and the atmosphere, measures are to be provided to prevent harmful influence from ships on the environment as far as practicable, and emergency response is to be initiated after the occurrence of a pollution accident.

8.5.5.3 Functional requirements

8.5.5.3.1 In order to achieve the goal in 8.5.5.2, ships are to at least have the following functions:

8.5.5.3.2 Perception

(1) Oil-contaminated water management: ship position information, ship speed information, oil-contaminated water level, condition of oil-contaminated water treatment facility, etc.;

(2) Exhaust emission control: ship position information, condition of fuel change-over equipment, condition of post treatment facility, etc.;

(3) Ballast water management: ship position information, condition of ballast water treatment facility, etc.

8.5.5.3.3 Communication

(1) Environment protection equipment and system operation condition is to be sent in real time and malfunction alarm is to be sent timely to the remote control station, and instructions from the remote control station is to be received.

(2) Reports are to be sent to the remote control station according to the specified procedures.

8.5.5.3.4 Decision-making, operation and report

(1) Oil-contaminated water management: decision of management is to be made according to the ship position, total volume/oil content of oil-contaminated water, emission requirements of the navigation area, etc., and such operation is to be conducted automatically or through remote control from the remote control station;

(2) Exhaust gas emission: decision on change-over of fuel and/or starting or stopping of post-treatment unit is to be made according to the ship position information, the boundaries of emission control areas, and emission requirements of navigation areas, and such operation is to be conducted automatically or through remote control from the remote control station;

(3) Ballast water management: decision on ballast water treatment or exchange is to be made according to the ship position information, and such operation is to be conducted automatically or through remote control from the remote control station;

(4) Reports on the above three decisions and operations are to be prepared according to the prescribed procedures.

8.5.5.4 Prescriptive requirements

8.5.5.4.1 For oil-contaminated water management, in addition to the applicable provisions in MARPOL Annex I, the following requirements are to be complied with:

(1) Oil and oily mixtures, including oily bilge water, oil residue (sludge) and slops are to be automatically collected and stored.

(2) Autonomous decision is to be made on whether to discharge overboard and operate related equipment and systems as appropriate, according to the tank level, oil concentration, ship position and ship speed.

(3) Operation status of equipment and systems related to oily-water separation for bilge water, and monitoring of oil discharge as well as failure alarms are to be sent to the remote control station, and remote instructions from the remote control station are to be accepted as necessary.

(4) After connection to the reception facility, automatic or remote-controlled discharge is to be carried out as instructed by the remote control station.

(5) Electronic recording of all automatic operation are to be made.

(6) For oil spillage control, plans are to be designed and developed at least according to but not limited to the following requirements so as to minimize the hazards of oil or oily mixtures to the environment:

① video surveillance on oil spillage is to be installed or equivalent measures are to be taken, such as installing oil spillage monitoring radar;

② the remote control station is to keep watching every hour and once oil spillage is detected, the video is to be played back to evaluate the degree of pollution and identify origin of spillage; where monitoring equipment can give oil spillage alarm automatically, the remote control station does not need to monitor regularly;

③ the remote control station is to immediately report the pollution to the nearest coastal state and/or port Authority;

④ the remote control station is to be capable of controlling or mitigating oil spillage by means of remote control;

⑤ depending on the situation of oil spillage, the remote control station may appoint a designated person to quickly handle the spillage.

8.5.5.4.2 For control of exhaust gas emission, the following requirements are also to be complied with in addition to MARPOL Annex VI, CCS Guidelines for Application of Selective Catalytic Reduction (SCR) System Onboard Ships, and CCS Guidelines for Design and Installation of Exhaust Gas Cleaning Systems:

(1) The exhaust gas treatment devices (e.g. EGC system, SCR system etc.) installed for compliance with SOx and NOx emission requirements are to be capable of automatic control of system starting, stopping and operation according to the position of the ship and the emission regulations in the waters of intended voyage.

(2) The exhaust gas treatment devices are to be subject to conditional monitoring and fitness assessment according to the requirements in 8.5.2.8 of this Chapter, and plans for maintenance, servicing, examination and survey are to be made based on the monitoring and assessment results.

(3) Primary working parameters, starting/stopping and operation of the exhaust gas treatment devices are to be automatically recorded and be transmitted to the remote control station for archiving so that they can be readily available if required during inspection.

(4) After the ship is satisfactorily connected to the reception facility, residue generated from the operation of the EGC system is to be discharged automatically or by remote-control as instructed by the remote control station.

(5) If the ship cannot meet the prescribed emission requirements due to system failure, failure information is to be automatically sent to the remote control station so that a timely report can be sent to the Administration.

(6) Filters installed in auxiliary systems of exhaust gas treatment devices are to be capable of automatic cleaning according to the prescribed procedure.

(7) Working parameters and equipment status information required for remote control of exhaust gas treatment devices are to be indicated in remote control station, e.g. working conditions of bypassing or isolation device, starting/stopping of pumps/fans, etc.

(8) If the chemical agent used may potentially generate hazardous gas, real time monitoring and automatic eliminating is to be carried out. If the hazardous gas concentration is not reduced to the reasonable range, an alarm is to be sent to the remote control station.

8.5.5.4.3 For ballast water management, in addition to the applicable requirements in the BWM Convention and Chapter 26 of PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships, the following requirements are to be complied with:

(1) All manual testing, controlling and recording required for the operation of the BWMS are to be automatically achieved.

(2) When the BWMS is bypassed or overridden, an alarm is to be sent to the remote control station.

(3) If the BWMS may potentially generate hazardous gas, automatic detection and elimination is to be carried out. If the hazardous gas concentration is not reduced to the specified range, an alarm is to be sent to the remote control station.

(4) Appropriate sampling facilities are to be provided and the sampling process is to be recorded.

8.5.5.5 Survey and tests

8.5.5.5.1 The following plans and documents are to be submitted for approval in addition to the plans and documents required by applicable rules and guidelines for submission:

(1) checklists for monitoring and alarming of pollution prevention equipment and its system;

(2) autonomous decision- making systems for oil-contaminated water management, exhaust gas emission and ballast water management (including control logic, functional diagrams, etc.).

8.5.5.5.2 Effectiveness of condition monitoring and health assessment and remote control/automatic control function is to be verified.

8.5.6 Anchoring

8.5.6.1 General requirements

8.5.6.1.1 The provision of anchoring equipment and the design and construction of its supporting structure are to comply with the applicable provisions of Chapter 3, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

8.5.6.1.2 The anchoring equipment is to be designed for remote control and/or autonomous control. For design of autonomous control, the requirements of 8.5.6.4 of this Chapter are to be

complied with.

8.5.6.2 Anchoring equipment

8.5.6.2.1 The operation of the anchoring equipment may be designed as one-click standby for anchoring, one-click dropping anchor and one-click heaving up anchor for any set of anchoring equipment, or corresponding operation and control may be achieved through multiple operations.

8.5.6.2.2 The windlass is to be controlled remotely. The windlass is to automatically haul and release the chain, brake, open and close clutch according to the instruction. The windlass is to monitor the release length, speed and tension of anchor chain.

8.5.6.2.3 Safety interlocks are to be provided between the chain stopper, hawse wheel brake, anchor and anchor cable holding device and the windlass master control device.

8.5.6.2.4 The chain stopper, anchor chain flush device and anchor chain water discharge device, anchor and anchor chain holding (at sea) device are to operate remotely.

8.5.6.2.5 In case of emergency, the chain releasing device is to be remotely operated. The chain releasing device and its remote control device are to be provided with means to prevent inadvertent operation.

8.5.6.3 Anchoring information and data

8.5.6.3.1 In order to realize anchoring decision-making as well as operation and control, the anchoring system is to be capable of obtaining the following information:

(1) the position, size and relative movement (distance, bearing, speed, etc.) of surrounding targets;

(2) weather and sea state data (wind, wave, current, water depth, etc.);

(3) sound, light, radio signals, etc. of surrounding targets;

(4) anchorage information;

(5) data of anchoring ships and windlasses and their power units (ship’s speed and course, anchor chain speed and tension, current, voltage, pressure and alarms of power units, working condition of chain stoppers, anchor chain flushing devices and anchor chain water discharge devices, anchor and anchor chain holding devices, etc.);

(6) other information for decision-making (anchor chain condition, out-of-control of other ships, etc.).

8.5.6.4 Anchoring autonomous decision-making

8.5.6.4.1 When the anchoring system is taking control, it is to be remotely monitored by the remote control station, and if necessary, remotely controlled by he remote control station.

8.5.6.4.2 The autonomous decision-making system is to control the windlass, chain stopper, chain releasing device, anchor chain flushing device and anchor chain water discharge device, anchor and anchor chain holding (at sea) device.

8.5.6.4.3 The anchoring autonomous decision-making system is to have the following decision-making functions:

(1) evaluation on whether anchoring operation can be carried out in accordance with the signal and data detected and received on a real-time basis, and the limitation of the ship's anchoring and manoeuvring capability;

(2) a plan of anchor handling is developed if the capability is sufficient as determined by the evaluation result;

(3) having the ability to make decisions on preparation for dropping or heaving up anchor, completion of operations, and displaying anchoring signals.

(4) determination that there is no abnormality in the preparation for dropping or heaving up anchor, and during the execution of anchor dropping or heaving up, the environment, anchor chain tension and anchor chain conditions are monitored on a real-time basis, and if necessary, the plan is to be adjusted;

(5) when it is determined that there is abnormality in the preparation for anchor dropping or heaving up and the ship's safety condition cannot be maintained, an alarm message is to be sent to the remote control station. If necessary, the remote control station can take over control and control remotely;

(6)in the anchoring condition, in case that it is judged that collision might be caused by abnormal proximity such as the dragging of the anchor of the ship itself or other ships, the system is to give alarm signals to the remote control station and provide suggestions on decision making of adjusting the chain cable condition or sailing away by hoisting/abandoning anchor. If necessary, the remote control station can take over control and control remotely.

8.5.7 Hull safety

8.5.7.1 General requirements

8.5.7.1.1 The hull safety system is to be capable of carrying out real-time monitoring of information/status related to hull safety, data transformation and storage, anomaly analysis to form operational suggestions and sending them to the remote control station. The following functions are to be available:

(1) collecting and monitoring important parameters related to hull safety;

(2) automatically calculating stability according to the changes in loading, giving early warning and adjusting operation suggestions;

(3) monitoring opening and closing of cargo hold hatch covers, watertight doors and watertight small hatch covers, and ensuring they are closed during navigation;

(4) monitoring watertight spaces water ingress and water level, giving alarms and operation instructions.

8.5.7.2 Load lines, subdivision and stability

8.5.7.2.1 The following requirements are to be complied with in addition to those specified in 8.5.7.2.2, 8.5.7.2.3 and 8.5.7.2.4 of this Chapter:

(1) applicable requirements of Annex I of ICLL;

(2) applicable requirements of Part B, B-1～B-4 of Chapter II-1 of SOLAS on cargo ships;

(3) applicable requirements of Chapter VI of SOLAS;

(4) for bulk carriers: applicable requirements of Chapter XII of SOLAS;

(5) applicable requirements of Annex I of MARPOL.

8.5.7.2.2 The following provisions are to be complied with:

(1) where it is anticipated that personnel will be onboard for a short period due to emergency, mandatory piloting, etc., the open deck where personnel are anticipated to have access to or any spaces the entry of which is anticipated for essential operations are to be provided with appropriate personnel protective measures (i.e. guardrails, bulwarks and/or other safe means of access) according to ICLL regulation I/25;

(2) when applying the requirements of ICLL regulation I/10, the approved Loading Manuel, including stability and structural strength information, is to be shown electronically onboard and in the remote control station;

(3) the leakage detected by the leakage detection device mentioned in ICLL regulation I/21(4) is to be indicated in the remote control station, and the screw-down valve controlling drainage is to operate automatically according to the prescribed procedures;

(4) when applying ICLL regulation I/22:

① paragraph(1)(b) and (1)(c) may not be applied;

② the automatic non-return valve with a positive means of closing it from a position above the freeboard deck mentioned in paragraph(1)(a) is to operate automatically according to the prescribed procedures and be remotely operated by the remote control station; the status of opening/closing of the valve is to be indicated in the remote control station;

③ the locally operated positive closing valve at the shell mentioned in paragraph(1)(d) is to operate automatically according to the prescribed procedures and be remotely operated by the remote control station;

④ the individual screw-down valve operated from the deck mentioned in paragraph(1)(f) is to operate automatically according to the prescribed procedures and be remotely operated by the remote control station;

⑤ paragraph(3) is implemented as follows: in machinery spaces, main and auxiliary sea inlets

and discharges in connection with the operation of machinery are to operated automatically according to the prescribed procedures and are to be remotely operable by the remote control station; the opening/closing of the valve is to be indicated in the remote control station.

8.5.7.2.3 The following provisions are to be complied with:

(1) when applying Chapter II-1 of SOLAS, the approved stability information mentioned in regulations 5 and 5-1 and the approved damage control plan and damage control information mentioned in regulation 19 are to be shown electronically onboard and in the remote control station;

(2) the as-built construction drawings mentioned in SOLAS regulation II-1/3-7 are to be shown electronically onboard;

(3) for ships to which SOLAS regulation II-1/3-10 is applicable, where the construction drawings are not kept onboard, they are to be shown electronically onboard;

(4) all openings (including cargo hold covers; internal and external doors, windows, small hatch covers; scuttles; other openings on the shell, excluding closing appliances of the ventilation system), if fitted, are to be provided with automatic control systems which can automatically operate according to ship's navigation, maneuvering, cargo management orders and demands, and means are to be provided to ensure that when automatic control systems fail, essential equipment can be effectively operated and controlled through remote control by the remote control station. These openings are to be closed automatically before the ship leaves port and they are not to be opened before the ship arrives at the next port;

(5) the screw-down valve mentioned in SOLAS regulation II-1/12 and the controls to equalization devices are to be automatically operable according to the prescribed procedures and are to be remotely operable by the remote control station;

(6) all detection and alarm devices (e.g. cargo hold water level detectors in regulation II-1/25; bilge well high water level alarms in regulation XII/9; and water level detectors and alarms fitted in cargo holds, ballast tanks forward of the collision bulkhead and any dry or void space, any part of which extends forward of the foremost cargo hold in regulation XII/12) are to be automatically operable according to the prescribed procedures and the alarm information is to be indicated in the remote control station.

8.5.7.2.4 Measures in the aspect of access, lighting, ventilation and electrical protection are to be provided for the construction and arrangement of ship so as to ensure that the survey, overhaul and maintenance of ship are carried out safely when the ship is under construction and at berth.

8.5.7.3 Hull structure

8.5.7.3.1 The following principles are to be considered based on the characteristics of unmanned remote control ships:

(1) structural arrangements concerning personnel passage, such as manholes, passages, may be

submitted to CCS for special consideration according to the design requirements of specific ships;

(2) requirements concerning crew's cabin, accommodation, recreation, potable water, the International Labor Organization (ILO), training and drills need not be considered.

8.5.7.4 Monitoring of parameters

8.5.7.4.1 In addition to the requirements of 3.4.2.1 and 3.4.2.3 of Chapter 3 of the Rules, the hull monitoring is to perceive and obtain the following data:

(1) watertight integrity

① The opening and closing status of watertight doors and watertight small hatch covers, if applicable;

② water ingress and condition of watertight spaces, e.g. cargo hold water level, bilge well water level, forepeak and aftpeak tank water level, bow hold or void space water level;

(2) relevant data may be added or redundancy may be considered according to the actual conditions and safety needs of the ship.

8.5.7.4.2 The perceived data mentioned in 8.5.7.4.1 above are to be able to be transmitted to the remote control station.

8.5.7.5 Assisted decision-making

8.5.7.5.1 Assisted decision-making is to comply with the following provisions:

(1) data related to calculations and criteria of stability and structural strength are to be included, such as the Loading Manual (including stability information), the loading instrument, loading and unloading sequence, sequential ballast water exchange, to realize the functions of the information;

(2) the damage control function specified in SOLAS regulation II-1/19 is to be realized;

(3) before the ship leaves the port, the assisted decision-making is to be able to:

① carry out self-inspection of the whole system;

② check the opening/closing condition of all cargo hold hatch covers (where applicable), watertight doors, watertight small hatch covers to ensure that they are closed before the ship leaves the port;

③ check whether the hatch trackway (where applicable) is in order;

④ give an alarm to the navigation control system and remote operation center in case of malfunction or abnormality;

(4) during navigation, ballast water exchange and cargo loading and unloading, in case of anomaly of monitored parameters, a warning message is to be sent to the remote control station and an assisted decision-making plan is to be provided. The remote control station is to carry out control

of decision-making. The following are generally considered:

① ship stability, longitudinal strength;

② flooding of monitored compartment;

(5) relevant safety evaluation analysis and decision-making requirements may be added based on the actual conditions and safety needs of the ship.

8.5.7.6 Remote control station

8.5.7.6.1 The remote control station is to be able to remotely control the following systems and appliances:

(1) the operation mechanism of the cargo hold hatch cover, opening and closing the hatch cover;

(2) the operation mechanism of watertight doors and watertight small hatch covers, opening and closing;

(3) the ballast water system to adjust ballast water volume of ballast tanks;

(4) the bilge system, discharging bilge;

(5) navigation control system;

(6) other related systems or appliances may be added based on the actual conditions and safety needs of the ship.

8.5.7.7 Self-check and failure handling

8.5.7.7.1 Self-check and failure handling are to comply with the following requirements:

(1) auto-check of systems and related equipment;

(2) in case of systematic failure, report is to be timely sent to the navigation control system and remote control station.

8.5.8 Cargo management

8.5.8.1 General requirements

8.5.8.1.1 Cargo management is to comply with the requirements of 6.3 and 6.5 of Chapter 6 of the Rules.

8.5.8.1.2 The cargo management system is to transmit the corresponding system status, early warning, alarm content and assisted decision-making information to the remote control station in real time and reliably, reminding the relevant personnel of the remote control station to pay attention, and the remote control station remotely performs relevant procedure operations as necessary.

8.5.8.1.3 The remote control station is to be able to remotely control the following systems and

appliances:

(1) the operation mechanism of the cargo hold hatch cover, opening and closing the hatch cover;

(2) the ballast water system to adjust ballast water volume of ballast tanks;

(3) other related systems or appliances may be added based on the actual conditions and safety needs of the ship.

8.6 Survey and test

8.6.1 For ships applying for R_x functional notation, the following drawings and documents are to be submitted to CCS for approval/information:

(1) diagram of perception equipment;

(2) arrangement of perception system equipment;

(3) diagram of communication equipment system;

(4) diagram of signal equipment system;

(5) communication equipment arrangement plan;

(6) signal equipment arrangement plan;

(7) plan to achieve ship's remote control function, including design plan of perception system, radiocommunication and signal system and remote control function; for R1 ship, the responsibilities of shipboard personnel and remote operation center are to be defined;

(8) emergency response procedure for remote control failure(for information);

(9) risk assessment report of ship's remote control(for information);

(10) equipment installation techniques(for information);

(11) equipment maintenance plan(for information);

(12) mooring and sea trial programmes;

(13) product instructions of relevant systems of remote control of ship navigation (for information);

(14) relevant plans and documents of remote control station required by 8.2.10.1 of this Chapter;

(15) additional plans and documents found necessary to be submitted during the plan approval process

8.6.2 For ships applying for R2 functional notation, the following drawings and documents are to be submitted to CCS for approval:

(1) arrangement of hull safety sensors;

(2) arrangement of cargo management sensors.

8.6.3 For ships applying for R2 functional notation, the following drawings and documents are to be submitted to CCS for information:

(1) diagram of hull monitoring and assisted decision-making system;

(2) operating manual of hull monitoring and assisted decision-making system;

(3) hardware specification of hull monitoring and assisted decision-making system;

(4) instruction of hull monitoring and assisted decision-making system;

(5) testing procedures of hull monitoring and assisted decision-making system;

(6) composition and functional explanation of cargo management system;

(7) hardware specification of cargo management system;

(8) testing procedures of cargo management system.

8.6.4 Initial survey

8.6.4.1 Confirm that relevant plans have been approved.

8.6.4.2 Confirm that relevant systems are furnished with corresponding certificates.

8.6.4.3 Confirm that the crew on board and at the remote control station are familiar with ship's performance and operation.

8.6.4.4 Conduct real ship test in accordance with approved mooring and sea trial programme to fully verify functions of situation awareness, information transmission and display; verify control function of propulsion and manoeuvring system, communication and signal system; verify change-over function between control positions.

8.6.5 Survey after construction

8.6.5.1 For ships assigned the functional notation for remote control, the previous service condition of the systems is to be reviewed in conjunction with annual surveys, intermediate surveys and special surveys to confirm that they are in a normal state; the function of situation awareness system involved in remote control of navigation is to be examined and the function of the remote control of propulsion and manoeuvring system, radio communication and signal system is to be examined to confirm that they are in a normal state.

8.6.5.2 When equipment and systems are repaired and renewed, the function is to be re-verified. After repairing or renewing the system and equipment of the ship or remote control station related to the remote control function, the sea trial needs to be carried out again as necessary.

CHAPTER 9 AUTONOMOUS OPERATION SHIPS

9.1 General requirements

9.1.1 The requirements of this Chapter apply to ships for which CCS functional notation for autonomous operation is requested.

9.1.2 Autonomous operation ship means a ship is capable of fully autonomous operation in open waters or during the entire voyage, normally without seafarers to operate on board.

9.1.3 Upon request, the following functional notation for autonomous operation may be assigned subject to satisfactory plan approval and survey by CCS:

A1 - The ship can realize autonomous operation from anchorage to anchorage, with remote control and monitoring. When necessary, the remote control station can remotely control the ship. The ship is operated by crew and / or pilots when entering and leaving the port and during berthing.

A2 - The ship can realize autonomous operation from anchorage to anchorage, with remote control and monitoring. When necessary, the remote control station can remotely control the ship. The ship is operated by remote control station when entering and leaving the port and during berthing.

A3 - The ship can realize autonomous operation from berth to berth, with remote control and monitoring. When necessary, the remote control station can remotely control the ship.

9.1.4 Autonomous operation ships are to satisfy the requirements of 8.2 (remote control station) and 8.3 (radiocommunication and signal equipment) of the Rules.

9.1.5 Ships with A1 functional notation are also to satisfy the requirements of 9.2 of this Chapter.

9.1.6 Ships with A2 functional notation are also to satisfy the requirements of 9.3 of this Chapter.

9.1.7 Ships with A3 functional notation are also to satisfy the requirements of 9.4 of this Chapter.

9.1.8 Autonomous operation ships are to satisfy the requirements of Chapter 7, capable of providing support for remote control of navigation and engine room.

9.1.9 When passenger ships apply for the class notation for autonomous operation, appropriate measures are to be taken to protect the safety of passengers.

9.2 Additional requirements for A1 functional notation

9.2.1 Navigation requirements

9.2.1.1 General requirements

9.2.1.1.1 A1 ship is to have the following functions:

(1) basic functional requirements for intelligent navigation are to be met;

(2) carrying out comprehensive analysis and decision-making using information of situation awareness, carrying out control of the propulsion and manoeuvring system, communication and signal system in accordance with pre-determined route and achieving autonomous navigation from anchorage and anchorage;

(3) implementing collision prevention decisions and operations based on navigation scenario information perceived and obtained and in accordance with the International Regulations for Preventing Collisions at Sea, 1972 of IMO;

(4) the signal equipment on board is to be capable of sending audible, visual and shape signals automatically in accordance with the International Regulations for Preventing Collisions at Sea, 1972 of IMO;

(5) accepting the operation request and the condition information from systems such as machinery installations, electrical installations, hull construction and safety, communication and signal, fire safety and environmental protection, making corresponding decisions and controlling the safety and environmental protection of ship;

(6) data storage requirements in 8.5.1.1.3, Chapter 8 of the Rules are to be met;

(7) during autonomous navigation, the ship can be monitored by the remote control station and has the function of remote control. The remote control station can take over the control of ship to carry out remote operation as necessary;

(8) a navigation control station is to be provided on the ship. In complex operation scenarios such as entering and leaving ports, narrow waterways, and berthing and unberthing, the navigation operation is completed by onboard personnel by means of crew members or piloting. The navigation control station is to meet the requirements of 9.2.1.1.2 of this Chapter.

9.2.1.1.2 The navigation control station on board is to satisfy the following requirements:

(1) a ship with remote control function may be provided with a simplified navigation control station, if necessary, to be capable of controlling ship’s speed and course, in order to achieve manual operation and manoeuvring of ship as necessary or in emergency;

(2) the ship instruction information is to be indicated at the navigation control station, at least including heading information, rudder indicator, thruster speed, nautical chart information, radar information, etc.;

(3) the visibility of the navigation control station is to meet the applicable requirements of SOLAS regulation V/22 or it is achieved by equivalent means;

(4) the navigation control station is to be provided with VHF installation for voice communication with other ships, docks and VTS centers. The navigation control station is to be provided with relevant communication terminals for voice communication with the remote control station;

(5) the navigation control station is to be provided with necessary personal life-saving appliances,

including lifejackets, lifebuoys, etc.

(6) appropriate means of embarkation on and disembarkation from ships are to be provided, which are to be capable of being remotely controlled by the remote control station and controlled by the navigation control station after the control is granted.

9.2.1.1.3 The ship is to satisfy the requirements for situation awareness in 8.4.1.1.4, Chapter 8 of the Rules.

9.2.1.2 Design requirements

9.2.1.2.1 The design of A1 ship is to satisfy the requirements in 8.5.1.2.1 to 8.5.1.2.4, Chapter 8 of the Rules.

9.2.1.2.2 The autonomous navigation system is to be connected to the situation awareness system, communication and signal system, machinery installations, anchoring and mooring system, electrical system, hull safety system, fire safety system, environmental protection system and security system through a redundant network (or equivalent measure).

9.2.1.2.3 When redundant system and equipment are connected to the autonomous navigation system, the interfaces are to be independent from each other.

9.2.1.2.4 The autonomous navigation system is to obtain the information on the failure of a connected system. Upon receiving the failure, it is to evaluate the seaworthiness of the ship to decide the control strategy at the next step.

9.2.1.2.5 The ship is to have a fail-safe mode. If the seaworthiness of the ship is severely affected due to equipment failure and it is impossible to carry out remote control or autonomous navigation, it is to adopt an appropriate safe mode to ensure the safety of the ship and prevent pollution as far as possible. Analysis and assessment of the fail-safe mode suitable for the ship are to be carried out taking into account factors such as the failure mode of ship, the intended function, manning, location, surroundings, weather and sea condition, depth of water and residual navigation capacity of the ship.

9.2.1.2.6 The autonomous navigation system is to have self-checking and alarm functions, which can provide continuous monitoring during normal operation of the equipment. When equipment failure is detected, an alarm and failure information is to be sent to the remote operation station and records are generated.

9.2.1.2.7 The equipment and components of the autonomous navigation system are to have sufficient reliability to minimize the probability of occurrence of failure. The equipment is to be provided and arranged to ensure that in the event of a single failure of the equipment, the ship's perception, communication and navigation control capacity is not affected or can be restored as soon as possible.

9.2.2 Hull safety

9.2.2.1 General requirements

9.2.2.1.1 Hull safety system is to satisfy the requirements of 8.5.7.1.1 of Chapter 8 of the Rules.

9.2.2.1.2 Loadline, subdivision and stability are to satisfy the requirements of 8.5.7.2 of Chapter 8 of the Rules.

9.2.2.1.3 Hull structure is to satisfy the requirements of 8.5.7.3 of Chapter 8 of the Rules.

9.2.2.1.4 Monitoring of parameters is, in addition to the requirements of 8.5.7.4 of Chapter 8 of the Rules, to satisfy the following requirements:

(1) ship motion and acceleration in six degrees of freedom;

(2) relevant data may be added according to the actual conditions and safety needs of the ship.

9.2.2.2 Autonomous decision control

9.2.2.2.1 The autonomous decision control is to comply with the following provisions:

(1) data related to calculations and criteria of stability and structural strength are to be included, such as the Loading Manual (including stability information), the loading instrument, loading and unloading sequence, sequential ballast water exchange, to realize the functions of the information;

(2) the damage control function specified in SOLAS regulation II-1/19 is to be realized;

(3) sending the loading and unloading sequence (self-developed or provided by the remote control station) to the dock and sending ballast water instruction orders to the navigation control system according to the loading and unloading sequence to carry out the corresponding ballast water adjustment so that the ship's stability, floating condition and longitudinal strength are maintained in the normal range;

(4) before the ship leaves the port, the autonomous decision control is to be able to:

① carry out self-inspection of the whole system;

② check the opening/closing condition of all cargo hold hatch covers (where applicable), watertight doors, watertight small hatch covers to ensure that they are closed before the ship leaves the port;

③ check whether the hatch trackway (where applicable) is in order;

④ give an alarm to the navigation control system and remote control station in case of malfunction or abnormality;

(5) during navigation, ballast water exchange, anchoring and cargo loading and unloading, in case of anomaly of monitored parameters, autonomous decision control is carried out and a warning message is to be sent to the remote control station and a control plan is to be provided timely. The following are generally considered:

① ship stability;

② flooding of monitored compartment;

③ temperature of monitored structural members (where applicable).

(6) analysis and evaluation based on long-term data;

(7) relevant safety evaluation analysis and decision-making requirements may be added based on the actual conditions and safety needs of the ship.

9.2.2.2.2 The autonomous decision control is to be able to control the following systems and appliances:

(1) the operation mechanism of the cargo hold hatch cover, opening and closing the hatch cover;

(2) the operation mechanism of watertight doors and watertight small hatch covers, opening and closing;

(3) the ballast water system to adjust ballast water volume of ballast tanks;

(4) the bilge system, discharging bilge;

(5) navigation control system;

(6) other related appliances may be added based on the actual conditions and safety needs of the ship.

9.2.2.3 Self-check and failure handling

9.2.2.3.1 Self-check and failure handling are to comply with the following requirements:

(1) auto-check of systems and related equipment;

(2) in case of systematic failure, report to the navigation control system and remote control station.

9.2.3 Machinery installations

9.2.3.1 For ships applying for A1 notation, equipment and systems in the engine room are to be provided with automatic control/remote control system, automatically operated and run in accordance with the instructions of ship navigation, manoeuvring and cargo management or as needed.

9.2.3.2 Machinery installations of autonomous operation ships are to satisfy the requirements of 8.5.2 of Chapter 8 of the Rules.

9.2.4 Electrical installations

9.2.4.1 Electrical installations of autonomous operation ships are to satisfy the requirements of 8.5.3 of Chapter 8 of the Rules.

9.2.5 Fire-fighting

9.2.5.1 The fire-fighting of autonomous operation ships is to satisfy the requirements of 8.5.4 of Chapter 8 of the Rules.

9.2.6 Environmental protection

9.2.6.1 Environmental protection of autonomous operation ships is to satisfy the requirements of 8.5.5 of Chapter 8 of the Rules.

9.2.7 Anchoring

9.2.7.1 The operation and control of anchoring equipment may be completed by personnel on board or designed for remote control or autonomous control. If remote control or autonomous control is adopted, the applicable requirements of 8.5.6, Chapter 8 of the Rules are to be complied with, and personnel onboard are to be able to override the operation.

9.2.8 Cargo management

9.2.8.1 Cargo management is to satisfy the requirements of 6.3 and 6.5 of Chapter 6 of the Rules.

9.2.8.2 In case early warning/alarm is given by the cargo management system, autonomous decision control is to be carried out and the early warning/alarm information is to be sent to the remote control station, reminding the relevant personnel of the remote control station to pay attention.

9.2.8.3 Autonomous decision-making is to be able to control the following cargo-related systems and appliances, generally including:

(1) the operation mechanism of the cargo hold hatch cover, opening and closing the hatch cover;

(2) the ballast water system to adjust ballast water volume of ballast tanks;

(3) other related systems or appliances may be added based on the actual conditions and safety needs of the ship.

9.3 Additional requirements for A2 functional notation

9.3.1 General requirements

9.3.1.1 Ships assigned A2 functional notation are to satisfy the following requirements:

(1) navigation is to comply with the requirements of 9.2.1.1.1(1) to (6) and 9.2.1.2 of this Chapter;

(2) hull safety and cargo management are to comply with the requirements of 9.2.2 and 9.2.8 of this Chapter respectively;

(3) machinery installations, electrical installations, fire-fighting and environmental protection are to comply with the requirements of 8.5.2, 8.5.3, 8.5.4 and 8.5.5 of Chapter 8 of the Rules.

(4) The operation and control of anchoring equipment may be designed for remote control or autonomous control. Remote control or autonomous control is to meet the applicable requirements of 8.5.6, Chapter 8 of the Rules.

9.3.2 Additional requirements for navigation

9.3.2.1 During navigation, the ship may be monitored by the remote control station and remotely controlled as necessary. In complex operation scenarios such as entering and leaving ports, narrow waterways, and berthing and unberthing, the operation is achieved by remote control via the remote control station.

9.3.2.2 The ship is to satisfy situation awareness requirements of 8.4.1.1.3 and 8.4.1.1.4 of the Rules.

9.4 Additional requirements for A3 functional notation

9.4.1 General requirements

9.4.1.1 Ships assigned A3 functional notation are to satisfy the following requirements:

(1) navigation is to comply with the requirements of 9.2.1.1.1(1), 9.2.1.1.1(3) to (6), 9.2.1.2 and 9.3.2.2 of this Chapter;

(2) hull safety and cargo management are to comply with the requirements of 9.2.2 and 9.2.8 of this Chapter;

(3) machinery installations, electrical installations, fire-fighting and environmental protection are to comply with the requirements of 8.5.2, 8.5.3, 8.5.4 and 8.5.5 of Chapter 8 of the Rules.

9.4.2 Additional requirements for navigation

9.4.2.1 The ship carries out comprehensive analysis and decision-making using information of situation awareness, carrying out control of the propulsion and manoeuvring system, communication and signal system in accordance with pre-determined route and achieving autonomous navigation from berth to berth, including open water, entering and leaving ports, narrow waterways, and berthing and unberthing.

9.4.2.2 During navigation, the ship can be monitored by the remote control station and has the function of remote control. The remote control station may take over control of the ship to carry out remote operation as necessary.

9.4.3 Anchoring

9.4.3.1 General requirements

9.4.3.1.1 The provision of anchoring equipment and the design and construction of its supporting structure are to comply with the applicable provisions of Chapter 3, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

9.4.3.1.2 The operation and control of anchoring equipment are to be designed for autonomous control. Autonomous control is to meet the applicable requirements of 8.5.6, Chapter 8 of the Rules.

9.5 Requirements for provision and performance of equipment

9.5.1 For ships applying for A_x functional notation:

9.5.1.1 Requirements for provision and performance of equipment of R2 ship in 8.5.1.3 of the Rules are to be satisfied.

9.5.1.2 At least two autonomous navigation systems are to be provided to meet 100% redundancy requirements. The two autonomous navigation systems are to be hot backups of each other.

9.5.1.3 The autonomous navigation systems are to be supplied by two independent sources of electrical power. In case of failure of one of the sources of electrical power, automatic change-over is to be realized.

9.5.1.4 For A1 ship, close range detection equipment may be omitted.

9.6 Survey and test

9.6.1 For ships applying for A_x class notation, the following drawings and documents are to be submitted to CCS for approval/information:

(1) diagram of route and speed design and optimization system (including the list of meteorological data);

(2) arrangement of route and speed design and optimization system;

(3) diagram of perception equipment;

(4) arrangement of perception system equipment;

(5) diagram of communication equipment system;

(6) diagram of signal equipment system;

(7) communication equipment arrangement plan;

(8) signal equipment arrangement plan;

(9) diagram of navigation control system;

(10) arrangement of navigation control system;

(11) diagram of navigation control station equipment (A1 ship);

(12) arrangement of navigation control station equipment (A1 ship);

(13) plan to achieve ship's autonomous navigation and remote control function, including design plan of perception system, radiocommunication and signal system, remote control and autonomous navigation;

(14) emergency response procedure for remote control and autonomous navigation failure (for information);

(15) risk assessment report of ship's remote control and autonomous navigation. The report is to cover all remote control and autonomous navigation scenarios in accordance with the degree of autonomy(for information);

(16) equipment installation techniques(for information);

(17) equipment maintenance plan(for information);

(18) mooring and sea trial programmes;

(19) product instructions of relevant systems of remote control and autonomous navigation of ship (for information);

(20) relevant plans and documents of remote control station required by 8.2.10.1, Chapter 8 of the Rules;

(21) additional plans and documents found necessary to be submitted during the plan approval process

9.6.2 Drawings and documents of hull safety and cargo management are to satisfy the requirements of 8.6.2 and 8.6.3 of the Rules.

9.6.3 Initial survey

9.6.3.1 Confirm that relevant plans have been approved.

9.6.3.2 Confirm that systems and products are furnished with corresponding certificates.

9.6.3.3 Confirm that the crews on board and at the remote control station are familiar with ship's performance and operation.

9.6.3.4 Conduct real ship test in accordance with approved mooring and sea trial programme to fully verify functions of autonomous operation, remote control, onboard operation (A1 ship), transfer of control etc.

9.6.4 Survey after construction

9.6.4.1 For ships assigned the functional notation for autonomy, the previous service condition of the systems is to be reviewed in conjunction with annual surveys, intermediate surveys and special surveys to confirm that they are in a normal state; the normal function of ship's autonomous navigation and remote control is to be examined.

9.6.4.2 When equipment and systems are repaired and renewed, the function is to be re-verified. After repairing or renewing the system and equipment of the ship or remote control station related to autonomous navigation function, the sea trial needs to be carried out again as necessary.

CHAPTER 10 ADDITIONAL REQUIREMENTS

10.1 Condition monitoring of waterjet propulsion units

10.1.1 Waterjet propulsion units are to comply with the provisions of Table 10.1.1.

List of monitoring equipment and systems for waterjet propulsion units

Table 10.1.1

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Waterjet propulsion pump		Water jet propulsion performance
1.1		Impeller	Impeller working state, such as impeller balance state, wear state, corrosion state, etc
1.2		Impeller shaft and bearing	Wear
1.3		Thrust bearing	Wear, sealing performance
2	Inlet duct system		
2.1		Inlet duct	Through flow state
2.2		Grating/intake screen	Filtering of impurities
3	Auxiliary system		
3.1	Hydraulic system		
3.1.1		Hydraulic oil pump	Oil supply capacity
3.1.2		Heat exchanger, if fitted	Heat exchanging performance
3.1.3		Filter	Filtering of impurities
3.2	Lubricating oil system		
3.2.1		Lubricating oil pump	Oil supply capacity
3.2.2		Heat exchanger, if fitted	Heat exchanging performance
3.2.3		Filter	Filtering of impurities
3.3	Control system power source (electric, pneumatic, hydraulic)		Power supply capacity

10.2 Intelligent dredging operations

10.2.1 General requirements

10.2.1.1 This Section is applicable to ships applying for CCS intelligent dredging notation.

10.2.1.2 Intelligent dredging can comprehensively utilize all kinds of information and data obtained to analyze and evaluate the operating status, health status and energy efficiency level of dredging operations and related equipment and systems, and provide decision support for the operation and control, overhaul, maintenance and management of dredging operations and related equipment and systems.

10.2.1.3 Intelligent dredging is to be equipped with the following basic functions:

(1) Automatic control of the main equipment/system of dredging operation;

(2) Data monitoring, collection, analysis and evaluation of the operating status and health status of relevant dredging equipment, and providing decision support;

(3) Energy efficiency management realizes data monitoring, collection, analysis and evaluation of energy efficiency and energy consumption of dredging operations, and provides decision support.

10.2.1.4 Intelligent dredging is also to be equipped with the following additional functions in addition to basic functions specified in 10.2.1.3 above:

(1) The dredging equipment/system can automatically run according to the established procedures to achieve one-click dredging operations;

(2) Based on the analysis and evaluation results of the operating status and health status of the dredging equipment and systems, formulate the corresponding maintenance plan according to the situation;

(3) Based on the analysis and evaluation results of dredging operation status, the optimization and automatic control of dredging operation parameters are realized.

10.2.1.5 Intelligent dredging systems equipped with basic functions in 10.2.1.3(2), (3) are to comply with the requirements for category II computer systems. Intelligent dredging systems equipped with basic function in 10.2.1.3(1) and additional functions in 10.2.1.4 are to comply with the requirements for category III computer systems.

10.2.2 Plans and documents

10.2.2.1 For ships applying for intelligent dredging notation, the plans and documents are to comply with the applicable requirements in Chapters 4 and 5 of the Rules.

10.2.2.2 In addition to the plans and documents required in 10.2.2.1, the following plans and documents of intelligent dredging systems are also to be submitted for approval:

(1) The principle, function and operation instructions of the dredging operation parameter optimization system;

(2) The principle, function and operation instructions of the automatic control system;

(3) Other plans and documents as deemed necessary by CCS.

10.2.3 Operation and control

10.2.3.1 For cutter suction dredgers, at least the reamer and its drive system, the mud pump and its drive system, the dredging pipe system and the auxiliary system are to achieve automatic control.

10.2.3.2 When the bridge is lowered/lifted, at least the reamer and its drive system, the mud pump and its drive system, the dredging pipe system and the auxiliary system are to be able to

operate automatically according to the established procedures, and the operating parameters are to be automatically adjusted to the pre-dredging planning parameters.

10.2.3.3 The operating status, working parameters, etc. of the equipment and system of the cutter suction dredging operation are to be displayed in the operation control station, including at least the parameters and status information listed in the following table.

List of monitoring parameters for dredging equipment of cutter suction dredgers

Table 10.2.3.3

No.	Dredging operation systems	Parameters to be monitored
1	Bridge system	● Bridge load ● Dredge depth ● Trunnion draught ● Bridge location
2	Reamer and its drive system	● Reamer rotation speed ● Reamer depth ● Operating torque or power
3	Steel pile positioning system	● Step distance ● Pile trolley speed ● Pile trolley stroke
4	Mud pump and its drive system	● Cabin pump rotation speed and discharge pressure ● Cabin pump power ● Underwater pump rotation speed and discharge pressure ● Underwater vacuum degree ● Vacuum release valve opening degree
5	Dredging piping and auxiliary systems	● Mud concentration, flow rate, density ● Seal water flow and pressure ● Seal water butterfly valve opening degree ● Flush flow and pressure ● Flush valve opening degree ● Mud yield ● Dredging gate valve opening degree
6	Horizontal movement system	● Horizontal movement speed ● Horizontal movement pull force ● Location of the reamer
7	Miscellaneous	● Ship Draught ● Wave compensator stroke ● Hydraulic system pressure, oil temperature ● Lubricating oil temperature, pressure ● Motor speed, current, power ● Wind, wave, surge and other data

10.2.3.4 For rake suction dredgers, at least the digging system, mud pump system, tank loading system, high pressure flushing system are to achieve automatic control.

10.2.3.5 When the rake arm is lowered/lifted, at least the digging system, mud pump system, tank loading system and high pressure flushing system are to be able to operate automatically

according to the established procedures, and the operating parameters are to be automatically adjusted to the pre-dredging planning parameters.

10.2.3.6 The operating status, working parameters, etc. of the equipment and system of the rake suction dredging operation are to be displayed in the operation control station, including at least the parameters and status information listed in the following table.

List of monitoring parameters for dredging equipment of rake suction dredgers

Table 10.2.3.6

No.	Dredging operation systems	Parameters to be monitored
1	Digging system	● Rake pipe angle ● Rake pipe pull force ● Rake head depth ● Movable cover angle ● Rake arm location ● Dynamic display of rake head, body and bending pipe ● Rake head movable cover pressure
2	Mud pump	● Mud pump rotation speed and discharge pressure ● Mud pump power ● Vacuum degree of suction of mud pump of category I ● Seal water flow and pressure ● Seal water butterfly valve opening degree
3	Tank loading system	● Tank loading valve opening degree ● Overflow cylinder height ● Environmental protection valve/low concentration discharge valve ● Loading capacity (dry earth volume)
4	Sludge discharge system	● Hopper door opening degree ● Extraction valve opening degree ● Opening degree of diversion valve of the extraction system ● Tank flushing water flow and pressure ● Tank flushing valve opening degree
5	Suction/discharge pipe system	● Mud concentration, flow rate, density ● Mud yield ● Dredging gate valve opening degree ● Flush flow and pressure ● Flush valve opening degree
6	High pressure flushing system	● High pressure water pressure and flow ● High pressure flush pump power ● High pressure flush valve opening degree
7	Miscellaneous	● Dredger speed ● Ship Draught ● Wave compensator stroke ● Ship positioning and orientation ● Hydraulic system pressure, oil temperature

No.	Dredging operation systems	Parameters to be monitored
		● Lubricating oil temperature, pressure ● Motor speed, current, power ● Wind, wave, surge and other data

10.2.3.7 If necessary, the dredging equipment and system may be taken over by the operator on board, and the change of control is not to cause serious changes in the operating status of the ship and its equipment.

10.2.4 Condition monitoring of dredging equipment

10.2.4.1 The condition monitoring, health assessment and aided decision-making of dredging equipment are to meet the applicable requirements of Chapter 4 of the Rules.

10.2.4.2 For cutter suction dredgers, when applying for intelligent dredging notation D, the condition monitoring of the equipment and systems listed in Table 10.2.4.2 is to be carried out as a minimum.

List of condition monitoring of dredging equipment of cutter suction dredgers

Table 10.2.4.2

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Reamer and its drive system	Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
		Reamer shaft bearing	Wear, sealing performance
2	Mud pump and its drive system	Mud pump	Mud transfer capacity
		Impeller, liner, inner liner	Wear
		Mud pump bearing	Wear, sealing performance
		Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
3	Hydraulic system	Hydraulic oil pump	Oil supply capacity
		Filter	Filtering of impurities
4	Water seal system	Water seal pump	Supply capacity
		Filter	Filtering of impurities
5	Flushing system	Flushing pump	Supply capacity
		Filter	Filtering of impurities
6	Lubricating oil system	Lubricating oil pump	Oil supply capacity
		Filter	Filtering of impurities
		Heat exchanger	Heat exchanging performance
7	Cooling system	Pump	Cooling medium supply capacity
		Heat exchanger	Heat exchanging performance
		Filter	Filtering of impurities
8	Compressed air system		Air supply capacity

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
9	Electric motor	Stator	Stator condition
		Rotor	Rotor working condition, such as inter-turn condition (synchronous motor), balance condition, eccentricity condition, rotor broken bar condition (asynchronous motor)
		Bearing	Wear
10	Winch	Bearing	Wear

10.2.4.3 For rake suction dredgers, when applying for intelligent dredging notation D, the condition monitoring of the equipment and systems listed in Table 10.2.4.3 is to be carried out as a minimum.

List of condition monitoring of dredging equipment of rake suction dredgers

Table 10.2.4.3

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Mud pump and its drive system	Mud pump	Mud transfer capacity
		Impeller, liner, inner liner	Wear
		Mud pump bearing	Wear, sealing performance
		Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
2	Hydraulic system	Hydraulic oil pump	Oil supply capacity
		Filter	Filtering of impurities
3	Water seal system	Water seal pump	Supply capacity
		Filter	Filtering of impurities
4	Flushing system	Flushing pump	Supply capacity
		Filter	Filtering of impurities
5	Lubricating oil system	Lubricating oil pump	Oil supply capacity
		Filter	Filtering of impurities
		Heat exchanger	Heat exchanging performance
6	Cooling system	Pump	Cooling medium supply capacity
		Heat exchanger	Heat exchanging performance
		Filter	Filtering of impurities
7	Compressed air system		Air supply capacity
8	Electric motor	Stator	Stator condition
		Rotor	Rotor working condition, such as inter-turn condition (synchronous motor), balance condition, eccentricity condition, rotor broken

			bar condition (asynchronous motor)
		Bearing	Wear
9	Winch	Bearing	Wear

10.2.5 Energy efficiency management

10.2.5.1 The energy efficiency management of dredging operation is to meet the applicable requirements of Chapter 5 of the Rules.

10.2.5.2 An online energy efficiency monitoring function is to be provided to obtain real-time operation status, dredging output and energy consumption data, and to evaluate, report and sound the alarm for the energy efficiency and energy consumption of dredging operations.

10.2.5.3 The parameters of major energy-consuming equipment, dredging equipment and systems (such as reamer and mud pump) during dredging operations are to be collected in real time, including but not limited to:

(1) the power, pressure and temperature parameters of the main energy-consuming equipment;

(2) fuel consumption parameters of major energy-consuming equipment;

(3) engine shaft power or equivalent output power;

(4) motor output power;

(5) parameters listed in 10.2.3.3 of this Section (applicable to cutter suction dredgers);

(6) parameters listed in 10.2.3.6 of this Section (applicable to rake suction dredgers).

10.2.5.4 The following energy consumption and efficiency indicators are to be calculated automatically:

(1) fuel consumption per unit hour;

(2) fuel consumption per 10,000 cubic feet.

10.2.5.5 It is to be possible to use real-time data of the ship's energy consumption/energy efficiency, perform comparative analysis according to predetermined evaluation methods and criteria, automatically assess energy consumption/energy efficiency status, and output assessment conclusions.

10.2.5.6 It is to be possible to make auxiliary decision suggestions for energy efficiency optimization and improvement based on the energy consumption/energy efficiency assessment results.

10.2.5.7 It is to be possible to automatically generate relevant indicator data reports for any time period and query them as required.

10.2.6 One-click dredging

10.2.6.1 One-click dredging function is to comply with the relevant requirements of 10.2.3 of

this Chapter in addition to the provisions of this Section.

10.2.6.2 The operation and control of the cutter suction dredging equipment are to meet the following requirements:

(1) The automatic operation function of dredging equipment is to be provided, and the related equipment/system can automatically operate according to the established procedures within a single anchor shift cycle, so as to realize the automatic operation of dredging operations with one click.

(2) Dredging operation related equipment/systems are to include the followings as a minimum: bridge system, including reamer and its drive system, mud pump and its drive system, dredging pipe system and auxiliary system, horizontal movement system, steel pile positioning system/three-cable positioning system, etc.

(3) The established procedures are to consider the control process and logical sequence of dredging preparation, bridge lowering and mud digging, ship shifting, pile changing, anchor shifting, bridge lift, etc.

(4) The operating status and working parameters of the dredging equipment and system are to be displayed in the operation control station, including at least the parameters and status information listed in 10.2.3.3.

10.2.6.3 The operation and control of the rake suction dredging equipment are to meet the following requirements:

(1) The automatic operation function of dredging equipment is to be provided, and the related equipment/system can automatically operate according to the established procedures, and one-click automatic operation for digging and loading, chamber-emptying and dumping is to be realized separately.

(2) Dredging operation related equipment/systems are to include the followings as a minimum: digging system, mud pump, loading system, unloading system, discharging pipe system, high pressure flushing system, etc.

(3) The dredging procedures are to consider the control process and logical sequence of dredging preparation, rake laying, rake lifting, etc.

(4) The dumping procedures are to consider the control process and logical sequence of automatic operation preparation, dumping, flushing, ballasting, end of dumping, etc.

(5) The chamber-emptying procedures are to consider the control process and logical sequence of automatic operation preparation, start of chamber-emptying, end of chamber-emptying, etc.

(6) The operating status and working parameters of the dredging equipment and system are to be displayed in the operation control station, including at least the parameters and status information listed in 10.2.3.6.

10.2.6.4 The relevant operation parameters of dredging operation related equipment/system are to be automatically adjusted to pre-dredging planned parameters.

10.2.6.5 Necessary safety measures are to be set up to deal with abnormal dredging operations, such as smothering pump, pressure rake, pipe blocking, cavitation, etc., to ensure the safety of personnel and equipment.

10.2.6.6 A necessary recording system is to be provided so as to automatically record the abnormal response measures of dredging equipment and systems according to the specified procedures and plans.

10.2.7 Condition-based maintenance

10.2.7.1 Condition-based maintenance for dredging equipment is to comply with the applicable requirements of Chapter 4 of the Rules.

10.2.8 Optimization of operation parameters

10.2.8.1 The operation parameter optimization function is to be provided to realize the initialization and optimization of operation parameters.

10.2.8.2 The operation parameter initialization function is to be able to give the initial value of the dredging operation parameters according to the project plan, the ship's own condition, soil conditions, environmental conditions and other factors.

10.2.8.3 The operation parameters of cutter suction dredgers include at least cabin pump speed, underwater pump speed, reamer depth, reamer speed, reamer power, transverse speed, transverse tension, stepping distance, digging depth, etc.

10.2.8.4 The operation parameters of rake suction dredgers include at least:

(1) The dredging operation includes the speed of the mud pump, the speed of the high-pressure flushing pump, the angle of the movable cover of the rake head to the ground, the speed of the ship, the height of the overflow cylinder, the stroke of the wave compensator, etc.

(2) Dumping operation, including dumping time/rate, mud door stroke, high-pressure flushing flow and velocity, etc.

(3) The chamber-emptying operation includes the speed of the mud pump, the speed of the high pressure flushing pump, the opening sequence of the pumping hatch door, the opening proportion of the pumping hatch door, the opening degree of the pumping hatch water inlet valve, the pressure flow rate of the high pressure flushing pump and the flushing strategy.

10.2.8.5 The operation parameter optimization function is to be able to evaluate the optimal mud concentration and flow rate of dredging transport, and give the optimization plan of dredging operation parameters to achieve the economic yield or maximum yield target.

10.2.8.6 The operation parameter optimization function is at to least consider the following aspects:

(1) project plan;

(2) environmental conditions;

(3) soil condition;

(4) status of ship power system;

(5) dredging equipment status;

(6) matching of soil quality and reamer;

(7) matching of dredging equipment;

(8) dumping scheme.

10.2.9 Survey and test

10.2.9.1 Survey and test are to comply with the applicable requirements of Chapters 4 and 5 of the Rules.

10.3 Intelligent scientific research

10.3.1 General requirements

10.3.1.1 This Chapter applies to scientific research ships applying for CCS intelligent scientific research notation.

10.3.1.2 Scientific research ship refers to a ship specially used for marine scientific research, surveying and exploration and other scientific operations.

10.3.1.3 Intelligent scientific research means that in the process of voyage preparation, operation and summary, the scientific research ship can provide support for voyage planning, operation management, operation scheduling and data management based on the characteristics of the water area.

10.3.1.4 Intelligent scientific research is to be able to meet the management and monitoring needs of various scientific research operations on board, generally including but not limited to the following types of scientific research operations:

(1) CTD operation refers to the use of temperature and salt depth meter operation mode, where: C refers to conductance, T refers to temperature, D refers to depth.

(2) Multi-tube, box, gravity column operation, refers to the use of multi-tube, box, gravity column sampling operation.

(3) Horizontal trawl operation refers to the use of horizontal trawl sampling operations.

(4) Vertical trawl operation refers to the use of vertical trawl sampling operation.

10.3.1.5 Scientific research systems are to comply with the requirements for category I computer systems.

10.3.2 Plans and documents

10.3.2.1 The following plans and documents of intelligent scientific research systems are to be submitted for approval:

(1) Detailed documents related to intelligent scientific research systems, generally including:

① system block diagram, principle, function and operation and maintenance instructions;

② system hardware description, such as sensors, scientific research equipment, test equipment, etc.;

③ software description, such as scientific research management, scientific research coordination, scientific research monitoring, etc.;

④ type and content of output data/information;

(2) Scientific research operation monitoring system (for SRc supplementary notation);

(3) Type test program;

(4) Other plans and documents as deemed necessary by CCS.

10.3.2.2 The following plans and documents of intelligent scientific research systems are to be submitted for information:

(1) Operation manual (according to the provisions of 1.9, Chapter 1 of the Rules).

10.3.2.3 For ships applying for the intelligent scientific research notation, the following plans and documents are to be submitted for approval:

(1) Intelligent scientific research system diagram;

(2) Other plans and documents as deemed necessary by CCS.

10.3.2.4 For ships applying for the intelligent scientific research notation, the following plans and documents are to be submitted for information:

(1) Arrangement of intelligent scientific research system main equipment on board;

(2) Intelligent scientific research system specifications, including system functions, software and hardware, installation requirements, etc.

10.3.3 Functional requirements

10.3.3.1 Intelligent scientific research is to be provided with the following basic functions:

(1) Intelligent scientific research is to be provided with the process management function, to provide task decomposition and task process management and other functions according to the investigation objectives and investigation contents and methods, including the following:

① Division of scientific research stages, such as initialization stage, planning stage,

collaborative operation stage, summary of results stage;

② scientific research task decomposition, such as route determination in the initialization phase, division of scientific research projects, personnel arrangement, equipment use, etc.

③ User role management function, such as personnel management, role management, function management, and service approval management.

④ Information sharing function, such as the timely release of the arrival information, navigation information.

(2) The intelligent scientific research is to be provided with the functions of voyage and operation management. According to the disciplines and projects of the scientific experiment, the navigation planning and station layout of the ship are given, and the overall management of the research team members, research equipment and research methods is carried out. Suggestions are given on the basis of comprehensive decision-making.

(3) Intelligent scientific research is to be provided with the functions of scientific research test management, such as project tracking, process management, requirement management and equipment management.

(4) Intelligent scientific research is to be able to manage the samples and results of scientific research tests, and the management of samples is at least to include identification management, pre-treatment management, storage and inventory management, use management, analysis results data management and other aspects. If there are dangerous goods, the dangerous goods are to be managed when being used, in and out of the warehouse and during storage.

10.3.3.2 In addition to the basic functions specified in 10.3.3.1, intelligent scientific research can also monitor the layout, recovery and sampling process of scientific research sampling instruments, such as whether the layout of sampling instruments is monitored, whether the sampling requirements are met, the sampling process is recorded offline or online, and the warning message can be issued when anomalies occur.

10.3.4 System requirements

10.3.4.1 Intelligent scientific research system is to meet the following open requirements:

(1) the technical framework is to be open;

(2) the business framework is to be open and satisfy the integration of existing and new businesses.

10.3.4.2 Scientific research data management is to meet the requirements of integrity and compliance, and meet the data quality requirements of scientific research experiments.

10.3.4.3 The intelligent scientific research system is to have the ability of data integration, that is, the necessary data is screened according to the data quality of each system and the functional requirements of the integration platform.

10.3.4.4 The requirements for ship-shore coordination are to include at least the following aspects:

(1) voyage planning coordination;

(2) coordination of site operation implementation plan;

(3) task supervision and coordination;

(4) centralized management and coordination of results;

(5) voyage task and operation task supervision;

(6) operation video and information supervision.

10.3.5 Survey and test

10.3.5.1 The initial survey items include:

(1) confirming that the plans have been reviewed;

(2) confirming that the intelligent research system has the corresponding product certificate;

(3) ships applying for intelligent research notation is subject to initial survey to verify the following items:

① confirming that the data acquisition, storage, transmission, display, application and other processes of the intelligent scientific research system meet the expected design requirements;

② checking functions related to survey according to the functional requirements of intelligent scientific research.

10.3.5.2 Survey after construction includes annual survey, intermediate survey, and special survey. Survey items include:

(1) checking the previous operation records of the scientific research system to confirm that the scientific research system is operating normally;

(2) system data can normally interact between ship and shore, and confirm the history of data interaction;

(3) spot checking system backup records to confirm that the system has implemented effective backup;

(4) testing the relevant functions according to the requirements of each scientific research operation system.

10.4 Tugs

10.4.1 General requirements

10.4.1.1 This Section is applicable to harbor towage tugs applying for CCS intelligent ship notation. Tugs of other purposes applying for CCS intelligent ship notation may refer to the requirements of this Section for implementation. The designer may discuss with CCS to determine

the applicable intelligent functions and requirements.

10.4.1.2 In view of the features and intelligent demands of harbor towage tug operation, this Section supplements the technical requirements for harbor towage tugs in intelligent navigation, intelligent energy efficiency, intelligent towing operation, and remote control. For the parts not covered in this Section, the relevant provisions of other sections of the Rules are also to be complied with.

10.4.1.3 In this Section, a harbor towage tug (hereinafter referred to as "tug") generally means a tug that assists large ships in entering and leaving the port, berthing and unberthing, shifting berths, turning around, entering and leaving the dry-dock, etc.

10.4.2 Plans and documents

10.4.2.1 The following plans and documents of intelligent towing operation systems are to be submitted for approval:

(1) System design and detailed documents, generally including:

① system composition, function, principle description;

② monitoring parameters;

③ system hardware description, such as sensors, data acquisition devices, data storage/backup devices, etc.;

④ software description, such as data processing, data analysis, security status assessment, etc.;

⑤ types and contents of output data/information.

(2) Detailed plan for measuring/obtaining safety assessment criteria;

(3) Type test program;

(4) Other plans and documents as deemed necessary by CCS.

10.4.2.2 The following plans and documents of intelligent towing operation systems are to be submitted for information:

(1) Operation manual.

10.4.2.3 For tugs applying for intelligent towing operation notation Tx, the following plans and documents are to be submitted for approval:

(1) System diagram;

(2) List of real ship monitoring parameters;

(3) Test program;

(4) Procedures and plans, including:

① procedures and plans for data acquisition/storage;

② procedures and plans for evaluating results/reporting outputs;

③ calibration plans for monitoring device.

(5) Other plans and documents as deemed necessary by CCS.

10.4.2.4 For tugs applying for intelligent towing operation notation Tx, the following plans and documents are to be submitted for information:

(1) Shipboard arrangement of major equipment;

(2) System specification.

10.4.3 List of product certification

10.4.3.1 Product certification of tug intelligent systems and components is to comply with the requirements of Table 10.4.3.1 in addition to the provisions of 1.10, Chapter 1 of the Rules, where the symbols are explained as follows:

(1) C – Marine Products Certificate; E – Equivalent document; W – Manufacturer's document; X – Applicable; O – Optional;
(2) DA – Design approval; TA-B – Type approval B; TA-A – Type approval A; WA – Works approval; PA – Plan approval;
(3) X[3]: If certification requirements for purchased parts can not be satisfied, complete type test is to be carried out with relevant intelligent system;
(4) Note ①: referring to marine data relay components, such as serial servers, protocol converters, aggregation switches, core switches, routers and other devices.

List of Certification Requirements for Tug Intelligent Systems and Components **Table 10.4.3.1**

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
1	Intelligent towing operation								
1.1	Condition monitoring and health assessment system	X	—	—	X	—	—	X	Applicable to tugs applying for the basic notation T
.1	Computer/server	—	X	—	X[3]	—	—	X	
.2	Display	—	X	—	X[3]	—	—	X	
.3	Uninterruptible Power Supply (UPS)	—	X	—	X[3]	—	—	X	
.4	Programmable controller	—	X	—	X	—	—	X	
.5	Sensor/monitoring device	O	X	—	X[3]	—	—	X	
.6	Data relay components①	O	X	—	X[3]	—	—	X	

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
1.2	Aided towing operation system	X	—	—	X	O	—	X	Applicable to tugs applying for the basic notation T
.1	Computer/server	—	X	—	X[3]	—	—	X	
.2	Display	—	X	—	X[3]	—	—	X	
.3	Uninterruptible Power Supply (UPS)	—	X	—	X[3]	—	—	X	
.4	Programmable controller	—	X	—	X	—	—	X	
.5	Data relay components①	O	X	—	X[3]	—	—	X	
.6	Video monitoring system for towing operation	—	X	—	X[3]	—	—	X	
1.3	Condition-based maintenance system	X	—	—	X	—	—	X	Applicable to tugs applying for the additional notation Tm
.1	Computer/server	—	X	—	X[3]	—	—	X	
.2	Display	—	X	—	X[3]	—	—	X	
.3	Uninterruptible Power Supply (UPS)	—	X	—	X[3]	—	—	X	
.4	Programmable controller	—	X	—	X	—	—	X	
.5	Sensor/monitoring device	O	X	—	X[3]	—	—	X	
.6	Data relay components①	O	X	—	X[3]	—	—	X	
1.4	Towing operation coordination system	X	—	—	X	O	—	X	Applicable to tugs applying for the additional notation Ts
.1	Computer/server	—	X	—	X[3]	—	—	X	
.2	Display	—	X	—	X[3]	—	—	X	
.3	Uninterruptible Power Supply (UPS)	—	X	—	X[3]	—	—	X	
.4	Programmable controller	—	X	—	X	—	—	X	

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
.5	Sensor/monitoring device	O	X	—	X[3]	—	—	X	
.6	Data relay components①	O	X	—	X[3]	—	—	X	

10.4.4 Intelligent navigation

10.4.4.1 Tugs applying for CCS intelligent navigation notation are also to comply with the relevant requirements in Chapter 2 of the Rules in addition to the following provisions.

10.4.4.2 In addition to meeting the relevant requirements of Chapter 2 of the Rules, the collision early warning function is also to be equipped with a short range detection system to sense the distance and relative position between the tug and other ships, and between the tug and the shore in real time. The detection range is to cover the left and right sides of the tug, superstructure, mast and areas prone to collision during the operation of the tug. The detection is to be three-dimensional, and the detection distance of the side is not to be less than 50 m.

10.4.4.3 The route and speed design and optimization function is also to comply with the applicable requirements in Chapter 2 of the Rules in addition to the following provisions:

(1) The objectives, monitoring or acquisition parameters, equipment equipment, etc. of the route and speed design and optimization can be adjusted according to the tasks of the tug (such as mooring assistance, pilot pick-up, maritime rescue, etc.), navigation waters, design and other characteristics;

(2) When designing and optimizing the route and speed of tugs, factors such as port traffic rules, safety navigation management regulations, navigational notice, speed limit, etc. are to be comprehensively considered, and statistical data such as typical speed, main engine speed and fuel consumption of previous routes are to be considered to plan route and optimize speed.

10.4.4.4 The open water autonomous navigation notation specified in Chapter 2 of the Rules is not applicable to harbor towage tugs.

10.4.5 Intelligent energy efficiency management

10.4.5.1 Tugs applying for CCS intelligent energy efficiency management notation are also to comply with the relevant requirements in Chapter 5 of the Rules in addition to the following provisions.

10.4.5.2 In addition to meeting the applicable requirements for monitoring and measurement in 5.4.2, Chapter 5 of the Rules, the following provisions are to be complied with:

(1) The draught value can be monitored by the draught measuring equipment directly, or can be measured or obtained by other means and manually entered into the intelligent energy efficiency

management system.

(2) The tilt angle can be monitored by an electronic inclinometer directly, or can be measured or obtained by other means and manually entered into the intelligent energy efficiency management system after obtaining it.

(3) Towing equipment energy consumption and related parameters are to be monitored, generally including:

① Current, voltage and electric power of the hydraulic pump;

② Working pressure, working temperature of the hydraulic system;

③ Current, voltage and electric power of the driving motor (when the towing equipment is driven by a motor).

10.4.5.3 The calculation of the energy efficiency and energy consumption index of the tug is to meet the following requirements:

(1) The following energy efficiency and energy consumption index is to be calculated automatically:

① fuel consumption per hour;

② fuel consumption per day;

③ fuel consumption per voyage (leg).

(2) The designer may adjust the energy efficiency and energy consumption index specified in 10.4.5.3(1) according to the operation purposes, propulsion types, navigation waters and other characteristics of the tug.

10.4.5.4 The energy efficiency level of the tug is to be evaluated comprehensively considering the influencing factors such as towing operation process, berth characteristics, water area characteristics and port management regulations, and suggestions for energy efficiency optimization and improvement are to be put forward according to the evaluation results.

10.4.6 Intelligent towing operation

10.4.6.1 Tugs applying for CCS intelligent towing operation notation are to comply with the following requirements.

10.4.6.2 Intelligent towing operation refers to the comprehensive use of various information and data obtained to analyze and evaluate the safety state, operation status and health status of the towing operation and related equipment and systems, and provide decision support for the operation and control, overhaul, maintenance and other aspects of the towing operation and related equipment and systems.

10.4.6.3 Intelligent towing operation is to have following basic functions:

(1) Condition monitoring and health management of towing equipment and systems;

(2) Aided towing operation.

10.4.6.4 In addition to the basic functions specified in 10.4.6.3 above, the following additional functions can be achieved according to the needs:

(1) Condition-based maintenance of towing equipment and system;

(2) Towing operation coordination.

10.4.6.5 For application and assignment of the functional notation for intelligent towing operation Tx, see the provisions of 1.4.6, Chapter 1 of the Rules.

10.4.6.6 Plans and documents related to intelligent towing operation are to comply with the requirements of 10.4.2 of this Chapter.

10.4.6.7 Condition monitoring and health management of towing equipment and systems are to comply with the following requirements:

(1) Hydraulically driven towing winch is to be monitored as specified in Table 10.4.6.7(1).

List for condition monitoring of hydraulic driven towing equipment

Table 10.4.6.7(1)

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Towing winch		
1.1		Hydraulic motor	Wear
1.2		Gear box	Wear
1.3		Winch drum shaft and bearing	Wear
2	Hydraulic system		
2.1		Hydraulic pump	Oil supply capacity
2.2		Heat exchanger	Heat exchanging performance
2.3		Filter	Filtering of impurities
3	Control system		
3.1		Power source (electric, pneumatic, hydraulic)	Energy Supply capacity
4	Towline		Force state, service status

(2) For motor-driven towing winch, in addition to monitoring the towing winch, control system and towline as specified in Table 10.4.6.7(1), the condition monitoring of the equipment specified in Table 10.4.6.7(2) is also to be carried out.

List for condition monitoring of motor-driven towing equipment

Table 10.4.6.7(2)

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Power transformer		
1.1		Winding	Working state of winding
2	frequency converter		
2.1		Power device module	Working state
2.2		Brake resistance(if applicable)	Brake resistance overload
3	Electric motor		
3.1		Stator	Stator status such as winding inter-turn insulation
3.2		Rotor	Rotor working state, such as inter-turn state (synchronous motor), balance state, eccentricity state, broken rotor (asynchronous motor), loss of excitation (permanent magnet motor)
3.3		Bearing	Wear
4	Auxiliary system		
4.1		Cooling system (water cooling, air cooling)	Cooling performance

(3) The condition monitoring, health assessment and aided decision-making of towing equipment and system are to meet the applicable requirements of Chapter 4 of the Rules.

10.4.6.8 The aided towing operation function is to comply with the following requirements:

(1) Real-time monitoring or access to the following operation status and information:

① Relative state between the tug and the towed ship, such as relative position, relative angle, relative speed, relative distance, etc.;

② The connection status between the tug and the towed ship, such as the pull of the bollard, the length and angle of the towline, etc.;

③ Tug stability state, such as trim, list, roll, pitch, yaw, watertight door state, etc.;

④ Tug's own state, such as speed, heading, power and rotation speed of main engine, etc.

(2) Equipped with video monitoring system for towing operation, which can obtain real-time picture of the surrounding environment of the tug and the working area of the fore-and-aft deck. The scope of video surveillance is to consider the needs of tug navigation, towing operation, towing equipment operation, etc.

(3) Capable of comprehensively considering the manoeuvring performance of the tug, the relative state between the tug and the towed ship, the towline connection state, the stability state, its own state, the operation restrictions and other information, evaluating the safety state of the towing

operation, predicting the possible risks (such as capsizing), giving warning and operational suggestions in time, and helping the operator take appropriate measures to avoid the tug falling into dangerous situation.

10.4.6.9 The condition-based maintenance function for towing equipment and system is to comply with the following requirements:

(1) It is to be possible to develop the condition-based maintenance plan for towing equipment and system basing on the results of condition monitoring and health assessment.

(2) The condition monitoring, health assessment and condition-based maintenance are to meet the applicable requirements of Chapter 4 of the Rules.

10.4.6.10 The aided coordination operation function is to comply with the following requirements:

(1) It is to be possible to compile a list of tug operating status information based on monitored or acquired data and information, which generally includes:

① Navigation information, such as ship position, heading, speed, etc.;

② Ship attitude, such as fore and stern draught, heeling and triming angle, etc.;

③ The working condition of the main machine, such as the main engine speed, power, fuel consumption, etc.;

④ Environmental information of the navigation sea area, such as wind direction, wind speed, water depth, relative velocity, etc.;

⑤ Towing equipment status, such as bollard pull, towline length, angle, etc.;

⑥ Navigation and operation information, such as voyage operation time, estimated completion time of the task, remaining fuel on board, endurance, etc.

(2) The navigation operation status information specified in (1) above is to be timely transferred to shore-based and/or towed large ships and/or other formation tugs through taking appropriate means according to the needs of towing task arrangement and operation;

(3) It is to be possible to adjust the tug navigation and operation plan/operation according to the operation plan, assignment, instruction or information of shore-based and/or towed large ships and/or other formation tugs.

10.4.7 Remote control

10.4.7.1 Tugs applying for CCS remote control notation are also to comply with the relevant requirements in Chapter 8 of the Rules in addition to the following provisions.

10.4.7.2 For a tug electrically propelled with azimuth thruster(s), at least the following status and/or parameters are to be displayed at the remote control station in order to operate and control of the main propulsion and steering devices from remote control station:

(1) Operation mode selected (if any);

(2) Propeller speed and rotation direction;

(3) The direction of thrust;

(4) Gear (if any)engaged/disengaged status;

(5) The state of the clutch (if any);

(6) The control station carrying out control;

(7) Other parameters necessary for remote control.

10.4.7.3 The remote control station is to be equipped with emergency shutoff devices.

10.4.7.4 If towing equipment is to be operated and controlled from a remote control station, the status and/or parameters of at least the following towing equipment are to be displayed at the remote control station:

(1) Connection state, length and stress state of the towline;

(2) Gear (if any) engaged/disengaging status;

(3) Clutch (if any) status;

(4) Brake status;

(5) Winch drum rotation speed and direction;

(6) Hydraulic pump (if any) working state;

(7) Other parameters necessary for remote control.

10.5 Inland waterway ships

10.5.1 General requirements

10.5.1.1 This Section is applicable to inland waterway ships applying for CCS intelligent ship notation. Inland waterway ships less than 20 m in length may refer to the requirements of this Section for implementation. The designer may discuss with CCS to determine the applicable intelligent functions and requirements.

10.5.1.2 In view of the navigation waterways, channels, operation characteristics and intelligent demands of inland waterway ships, this Section supplements the requirements for inland waterway ships in intelligent navigation, intelligent machinery, intelligent energy efficiency, remote control and autonomous operation when applying the Rules. For the parts not covered in this Section, the relevant provisions of other sections of the Rules are also to be complied with.

10.5.1.3 The hardware and software of the inland waterway ship intelligent system are to meet the relevant requirements for the electronic computer in Chapter 2, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships.

10.5.1.4 Inland waterway ships applying for CCS intelligent ship notation are also to comply with the applicable rules and regulations for inland waterway ships in addition to the requirements of the Rules.

10.5.2 Intelligent navigation

10.5.2.1 Inland waterway ships applying for CCS intelligent navigation notation are also to comply the relevant provisions in Chapter 2 of the Rules in addition to the following provisions.

10.5.2.2 Intelligent navigation of inland waterway ships is to have aided navigation functions specified in 2.1.3, Chapter 2 of the Rules, i.e. vision enhancement, collision warning, grounding warning, integrated information display. The designer may discuss with CCS to determine the functional requirements for route and speed design and optimization.

10.5.2.3 Aided navigation of inland waterway ships are to comply with the following provisions:

(1) The designer may discuss with CCS to determine the technical requirements for route and speed design and optimization specified in 2.3.1, Chapter 2 of the Rules.

(2) Vision enhancement is to comply with the requirements in 2.3.2, Chapter 2 of the Rules and can accurately display the surface objects within 1500 m of the ship's current position.

(3) It is to be possible to monitor or obtain the following parameters and information:

① Real-time perception of environmental and meteorological data during navigation, including:

(a) wind speed and direction;

(b) current flow velocity (historical data may be accepted instead).

② Real-time perception of the information on the ship itself:

(a) information on ship position, speed, heading and draught;

(b) main engine and/or propeller rotation speed and direction, pitch (if applicable), rudder angle, etc.

③ AIS data of surface objects;

④ Waterway data and updates;

⑤ Real time information on other surface objects within the range of radar as follows:

(a) other ships, including position, motion direction, motion speed, size, actual distance , intersection angle with the ship itself and navigation status;

(b) information on other fixed obstacles and mobile objects on surface.

⑥ Measured water depth of ship’s position.

(4) It is to be possible to evaluate whether the ship is in a safe and controllable state through the ship's track, heading, speed, main engine speed, rudder angle and other information, and put

forward operational recommendations according to the evaluation results.

(5) Inland waterway ships applying for CCS intelligent navigation notation N are to be provided with the following equipment or adopt equivalent measures to obtain the parameters and information specified in (3) of this paragraph:

① Aided navigation system (including display system);

② Situation awareness equipment, including:

(a) Marine radar with ARPA function;

(b) Automatic Identification System (AIS of level A or B);

(c) Position, navigation and timing (PNT) systems;

(d) Chart display system applicable to the navigation waters;

(e) Echo sounder;

(f) Speed and distance measuring device;

(g) Anemorumbometer;

(h) Current flow velocity sensor;

(i) Ship communication devices;

(j) Other necessary equipment and systems.

10.5.2.4 Autonomous navigation in open waters[①] is to comply with the following provisions:

(1) Complying with the functional requirements for aided navigation specified in 10.5.2.2 and 10.5.2.3 of this Section;

(2) In the open water navigation scenario, the ship is to be able to analyze and make decisions based on the perceived and obtained navigation scenario information, control the propulsion and steering systems according to the intended route, realize autonomous navigation, and implement collision avoidance decisions and operations in accordance with the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways.

(3) In addition to complying with the monitored parameters specified in 10.5.2.3(3) above, ship motion response, at least including pitch, roll and yaw, are to be obtained for the decision-making of autonomous navigation.

(4) In addition to the equipment required in 10.5.2.4(5), the followings are to be provided:

① autonomous navigation system;

② redundant gyro compasses or other ship heading system;

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① Open inland waters refer to the waters without any adverse conditions such as obstructing navigation facilities/buildings, islands/shoals, torrent currents, sharp bends, heavy traffic, etc., except for complex situations such as narrow waterways, access to ports/wharves, etc. For waters such as artificial canals, the design unit may consult with CCS to determine the impact of navigational environmental conditions such as obstructing navigation facilities/buildings and traffic flows on the application of the functional notation.

③ ship motion sensors.

10.5.2.5 Autonomous navigation during entire voyage is to comply with the following provisions:

(1) Autonomous navigation during entire voyage is to comply with the relevant requirements for autonomous navigation in open waters specified in 10.5.2.4.

(2) In all navigation scenarios, the ship is to be able to analyze and make decisions based on the perceived and obtained navigation scenario information, control the propulsion and steering systems according to the intended route, realize autonomous navigation and berthing/unberthing operations, and implement collision avoidance decisions and operations in accordance with the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways.

(3) In addition to complying with the situation awareness requirements in 10.5.2.4(3), the following situation information is to be obtained for navigational decision-making:

① real-time perception of the distance between the bow/stern and the shore, the angle between the ship and the shore;

② obtaining water level, depth, velocity, flow direction change information and other relevant environmental information of ports/wharves and waterways.

(4) In addition to the equipment required in 10.5.2.4(4), short range detection equipment, e.g. laser radar, is also to be provided.

(5) The measurement range, accuracy and delay of short range detection equipment are to satisfy the decision-making requirements for berthing/unberthing and realize continuous monitoring.

10.5.3 Intelligent machinery

10.5.3.1 Inland waterway ships applying for CCS intelligent machinery notation are also to comply the relevant provisions in Chapter 4 of the Rules in addition to the following provisions.

10.5.3.2 Intelligent machinery is to have the following basic functions:

(1) Carrying out monitoring of the operating condition of the equipment and systems related to main propulsion in machinery space;

(2) Carrying out analysis and assessment of the operating condition and health condition of the equipment and systems based on the condition monitoring data;

(3) Providing reasonable suggestions based on the result of analysis and assessment, in order to provide support for decision-making on the usage, operation and control, servicing and repair, and management, etc. of the equipment and systems;

(4) Main propulsion machinery is to be capable of being remotely controlled from bridge control station, and machinery space including machinery centralized control station is attended by only one person.

(5) During the one-man on-duty period, the equipment and systems in machinery space are to be

capable of continuous and normal operation.

10.5.3.3 Inland waterway ships applying for CCS intelligent machinery basic function notation M are to comply with the automation requirements in Chapter 6, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships.

10.5.3.4 Inland waterway ships applying for CCS intelligent machinery additional function notation Mx are to comply with relevant requirements in Section 6, Chapter 7 of CCS Regulations for Classification of Inland Waterway Ships on survey of Planned Maintenance Scheme (PMS) for machinery.

10.5.3.5 For Inland waterway ships, monitoring items, monitoring parameters or status are generally to comply with the provisions in Appendix 5 in CCS Guidelines for Surveys of Intelligent Machinery of Ships.

10.5.4 Intelligent energy efficiency management

10.5.4.1 Inland waterway ships applying for CCS intelligent energy efficiency management notation are also to comply the relevant provisions in Chapter 5 of the Rules in addition to the following provisions.

10.5.4.2 The draught value can be monitored by the draught measuring equipment directly, or can be measured or obtained by other means and manually entered into the intelligent energy efficiency management system according to the loading conditions. The relevant operational requirements are to be specified in the data acquisition procedure and plan.

10.5.4.3 The tilt angle can be monitored by an electronic inclinometer directly, or can be measured or obtained by other means and manually entered into the intelligent energy efficiency management system. The relevant operational requirements are to be specified in the data acquisition procedure and plan.

10.5.5 Remote control of ships

10.5.5.1 Inland waterway ships applying for CCS remote control notation are also to comply with the relevant requirements in Chapter 8 of the Rules in addition to the following provisions.

10.5.5.2 The display system, alarm system, control system and computer system of the remote control station are designed to comply with the applicable requirements in Sections 3, 4, 5 and 8, Chapter 2, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships.

10.5.5.3 Radio communication and signal equipment are to comply with the following provisions:

(1) The signal equipment of the ship shall be able to be controlled automatically or remotely at the remote control station, and send sound, light and shape signals in accordance with the requirements of the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways.

(2) The performance of radio communication and signal equipment are to comply with the relevant provisions of the Technical Regulations for Statutory Survey of Inland Waterway Ships.

(3) The operation of radio communication and signal equipment may adopt equivalent scheme subject to agreement of CCS.

(4) The provisions of and requirements for communication equipment are as follows:

① communication equipment suitable for navigation is to be provided as a minimum, and the corresponding communication equipment is to be configured according to the functions required by the ship, including but not limited to: 1 set of ship station/system or equivalent equipment/system with audio communication, video communication and Internet data communication, and the communication mode is not limited to satellite, VHF, 4G/5G, etc.;

② the installation and arrangement of communication equipment are to comply with the relevant provisions of the Technical Regulations for Statutory Survey of Inland Waterway Ships.

(5) The provisions of and requirements for signal equipment are as follows:

① the provision of signal equipment is to comply with the relevant provisions of the Technical Regulations for Statutory Survey of Inland Waterway Ships;

② the mast light, port and starboard lights and tail light are to be powered by two power sources, and comply with the relevant provisions in Chapter 9, PART THREE of CCS Rules for the Construction of Inland Waterway Steel Ships;

③ the whistle is to be realized by electronic means, and the whistle signal can be electrically controlled;

④ the states of all lights and whistles are to be transmitted to the remote control station, and all lights and whistles can work independently or be controlled remotely through the remote control station according to the functions of the ship;

⑤ the bell, gong, shape and flag can be operated by the crew on board in a conventional manner. The states of the bell, gong, shape and flag may be transmitted to the remote control station according to the actual situation and safety needs;

⑥ when a ship passes through a canal or other special waterway, it is to be equipped with the prescribed signal equipment as required by the canal authority;

⑦ the arrangement of signal lights is to comply with the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways and applicable requirements of the Administration;

⑧ the installation and arrangement of signal equipment are to comply with the relevant provisions of the Technical Regulations for Statutory Survey of Inland Waterway Ships.

10.5.5.4 For remotely controlled inland waterway ships, the navigation, machinery installations, electrical installations, fire-fighting, environmental protection, anchoring and hull safety are to comply with the following provisions in addition to the relevant requirements in Chapter 8 of the

Rules:

(1) Navigation perception equipment is to be provided according to the applicable requirements in 10.5.2.4 and 10.5.2.5 of this Section. Visual enhancement system is also to be provided.

(2) Machinery installations are to comply with the following provisions:

① the machinery installations and their automation are to comply with the relevant requirements in PART TWO and Chapters 1, 2 and 6, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships;

② the control transfer between control stations are to comply with the applicable requirements in Chapter 2, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships;

③ the alarm and display requirements for bridge control station in Chapter 6, PART FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships are also applicable to remote control stations;

④ Condition monitoring, health assessment and assisted decision-making (including condition-based maintenance) of machine and systems are to comply with the provisions in 10.5.3 of this Section.

(3) the electrical installations and their automation are to comply the applicable requirements in PARTs THREE and FOUR of CCS Rules for the Construction of Inland Waterway Steel Ships.

(4) The fire-fighting design and arrangement of the ship is also to comply with PART SIX of CCS Rules for the Construction of Inland Waterway Steel Ships and applicable provisions of the Administration.

(5) The environmental protection of the ship is to comply with the relevant requirements of the Technical Regulations for Statutory Survey of Inland Waterway Ships.

(6) The provision of the anchoring equipment as well as the design and construction of the hull supporting structure are to comply with the applicable provisions in Chapter 3, PART ONE of CCS Rules for the Construction of Inland Waterway Steel Ships.

(7) The hull safety is to comply with the following provisions:

① the loadlines, subdivision and stability are to comply with the relevant requirements in PART FOUR and Chapters 2 and 8, PART FIVE of the Technical Regulations for Statutory Survey of Inland Waterway Ships;

② the damage control of the ship is to comply with the relevant requirements in PART FIVE of the Technical Regulations for Statutory Survey of Inland Waterway Ships.

10.5.6 Autonomous operation ships

10.5.6.1 Inland waterway ships applying for CCS autonomous operation notation are also to comply with the relevant requirements in Chapter 9 of the Rules in addition to the following

provisions.

10.5.6.2 Autonomous operation ships are to comply with the requirements in 10.5.5.2 and 10.5.5.3 of this Section.

10.5.6.3 Autonomous operation ships are to comply with the following provisions:

(1) During autonomous navigation, the ship is to be able to analyze and make decisions based on the perceived and obtained navigation scenario information, and implement collision avoidance decisions and operations in accordance with the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways.

(2) The signal equipment of the ship is to be able to send sound, light and shape signals automatically in accordance with the Regulations of the People's Republic of China for Preventing Collisions at Inland Waterways.

(3) The machinery installations of the ship are to comply with the requirement in 10.5.5.4(2) of this Section.

(4) The electrical installations of the ship are to comply with the requirement in 10.5.5.4(3) of this Section.

(5) The fire-fighting of the ship is to comply the requirement in 10.5.5.4(4) of this Section.

(6) The environmental protection of the ship is to comply the requirement in 10.5.5.4(5) of this Section.

(7) Anchoring is to comply the requirement in 10.5.5.4(6) of this Section.

(8) Hull safety is to comply the requirement in 10.5.5.4(7) of this Section.

10.6 Polar ships

10.6.1 General requirements

10.6.1.1 This Section is applicable to polar ships applying for CCS intelligent ship notation.

10.6.1.2 This Section supplements the technical requirements for intelligent navigation, intelligent machinery and intelligent hull of polar ships in accordance with the characteristics of polar ships' design, navigation waters, environment, operation management and intelligent demands. For the parts not covered in this Section, the relevant provisions of other sections of the Rules are also to be complied with.

10.6.2 Intelligent navigation

10.6.2.1 Polar ships applying for CCS intelligent navigation notation are also to comply the relevant provisions in Chapter 2 of the Rules in addition to the following provisions.

10.6.2.2 Intelligent navigation of polar ships is also to have the following functions:

(1) polar route planning;

(2) polar fleet navigation and escort.

The polar route planning function is applicable to polar ships operating independently in the ice area, and the fleet navigation and escort function is applicable to ships carrying out polar ice breaking escort.

10.6.2.3 Polar route planning is to comply with the following requirements:

(1) Polar route planning means that the ship plans the route and speed of navigation in polar waters before sailing according to its own technical conditions and performance (design ice class, ice breaking capacity, polar service temperature, speed limit, etc.), polar scientific expedition/navigation tasks, ship draught, etc., and takes into account the ice conditions of the navigation waters and environmental factors such as wind, wave, current, surge, etc. The ship can adjust the route planning in time according to changes in external conditions, avoid icebergs, large floating ice and other fixed obstacles encountered during navigation, and ensure the safety of the ship and the personnel on board.

(2) The polar route planning function may consist of shipborne systems and/or shore-based support systems, which can be realized in the following ways:

① independently realized by shipborne systems;

② realized by shipborne systems and shore-based support systems in coordination.

(3) During navigation, the ship is to have the ability to adjust the routes of long and short distances, including at least:

① dynamically updating routes according to regular updates of ice conditions, meteorological data and changes in voyage tasks;

② Based on the surrounding sea ice, iceberg data and other environmental information obtained by real-time perception and observation, the short-distance route and speed are adjusted, and the recommended scheme is given to avoid icebergs, large floating ice and other fixed obstacles, so as to avoid the occurrence of dangerous conditions such as collision and ice trapping.

(4) A performance calculation model is to be built based on operational constraints in ice areas such as ship design parameters, icebreaking capacity, and service temperature. The construction of the model is to take into account the requirements specified in the Polar Water Operational Manual.

(5) Route planning is to take into account meteorological and ice condition data of the navigation waters, the latter of which is to include at least the following information:

① sea ice density, especially dense ice (7/10~8/10), fast ice (10/10), sparse ice (4/10~6/10) information;

② sea ice development stage/sea ice thickness;

③ ice type/floating ice width;

④ historical status, limits and amount of ice;

⑤ floating block ice, multi-year ice, iceberg information.

(6) Meteorological and sea ice data are to be from reliable sources that are real-time and accurate.

(7) Ships are to be able to perceive the following environmental information throughout the day for route planning decision-making:

① wind speed and direction;

② sea visibility;

③ ambient temperature;

④ measured water depth of the ship's position;

⑤ ice thickness and ice density of the surrounding waters;

⑥ icebergs, large floating ice and other fixed obstacles in the surrounding waters.

(8) During polar navigation, automatic updates of ice conditions and meteorological data are to be maintained, and relevant data is to be available at any time for meteorological elements such as polar cyclones that have a great impact on navigation safety.

(9) Areas with ice pressure or potential ice pressure are to be avoided and ecologically sensitive areas are to be avoided.

(10) Polar ships are to be able to avoid dangerous areas such as icebergs, large floating ice, and shoals during navigation.

(11) The operational requirements and limitations specified in the Polar Water Operational Manual (PWOM), such as maximum ice condition, minimum temperature, maximum latitude, etc., are to be complied with.

(12) The ship is to be planned to navigate in low risk sea areas as far as possible, and the output route is to be evaluated in accordance with the IMO Guidance on Methodologies for Assessing Operational Capabilities and Limitations in Ice, and the route’s Risk Index Outcome (RIO) after assessment is to be greater than or equal to 0. If the assessment result is less than 0, the operator on board is to give special consideration to the operational decision.

10.6.2.4 Polar fleet navigation and escort are to comply with the following requirements:

(1) This function is applicable to escort ships that are engaged in ice-breaking operations during polar fleet navigation. It is to be possible to determine the navigation order of the fleet according to the ship breadth, dynamic performance, ice class, draught and other factors, so as to ensure the maximum navigation safety and efficiency of the fleet navigation.

(2) During the fleet navigation, escort ships are to be able to continuously obtain the real-time navigation status of other ships following in the fleet, including: the speed, heading, distance from and relative position to the preceding ship, and taking into account the ship's ice-breaking ability, maneuvering performance, size and speed, current navigation ice conditions, etc., and put forward suggestions to adjust the speed and heading of each following ship after analysis and assessment,

so as to maintain the safe distance between ships in the fleet and ensure the safety and efficiency of the fleet navigation.

(3) Escort ships are to receive the following information from the following ships in the fleet:

① ship breadth;

② dynamic performance;

③ design ice class;

④ ship's draught;

⑤ real-time speed;

⑥ real-time heading;

⑦ distance between the ship and the escort;

⑧ relative position to the escort ship;

⑨ distance from the preceding ship;

⑩ relative position to the preceding ship.

(4) The escort ships are to obtain the ice condition data specified in 10.6.2.3(5) of this Section, and be equipped with the perception capabilities specified in 10.6.2.3(7).

(5) The escort ships summarize the data provided by each following ship in the fleet, and form the speed and heading suggestions of each following ship in the fleet after comprehensive analysis.

(6) The escort ships are to be able to store the decision results of intelligent fleet navigation for the subsequent analysis and evaluation of escort decisions.

10.6.2.5 The design of the intelligent navigation system is to comply with the following requirements:

(1) The system is to have a chart database of polar waters, and the chart database is to be updated regularly.

(2) Charts are to have the option of different display modes such as Mercator projection and polar spherical projection.

(3) Sea ice data is to be available in at least the following ways:

① egg-shaped ice map;

② remote sensing satellites equipped with microwave radiometers (such as AMSR2);

③ marine radar;

④ ice detection radar.

(4) The system is to include the ship’s operational capabilities and limitations specified in the Polar Water Operational Manual (PWOM) as a minimum.

(5) The design of the intelligent polar navigation system is to contain the Polar Operational Limit Assessment Risk Indexing System (POLARIS) and comply with the requirements of MSC.1/Circ.1519. The operation decisions are to be assessed by the POLARIS, and be output when the RIO is greater than or equal to 0.

(6) The system is to have the function of pushing the planned route to the navigation equipment such as electronic chart/integrated navigation system.

(7) The output route suggestion is to be able to maintain an appropriate safe distance from icebergs and large floating ice based on the ship's own situation (ship size, draught, etc.).

(8) The output following operation suggestion is comply with the operational requirements and limitations specified in the Polar Water Operational Manual (PWOM).

(9) The navigation sequence of the intelligent fleet and the heading and speed suggestions for the following ships are to be clearly displayed at the steering position of the escort ships.

10.6.2.6 The provision of the intelligent navigation system is to comply with the following requirements:

(1) The systems and equipment related to intelligent polar navigation are subject to CCS type tests and product inspection.

(2) The equipment required for intelligent navigation is to comply with the relevant requirements for navigation in high latitude in IMO International Code for Ships Operating in Polar Waters (resolution MSC.385(94)).

(3) Ships equipped with polar route planning function are to be provided with the following equipment:

① data communication device;

② electronic chart display and information system;

③ electronic positioning instrument;

④ anemorumbometer;

⑤ gyro compass or other ship heading system;

⑥ GNSS compass;

⑦ speed and distance measuring device;

⑧ echo sounder;

⑨ visibility sensor;

⑩ marine radar;

⑪ ice detection radar;

⑫ polar intelligent route planning system.

(4) Ships with polar fleet navigation function are also to be provided with the followings in addition to the equipment specified in 10.6.2.6(3):

① Polar Escort operating system;

② Close detection equipment, such as laser radar.

10.6.3 Intelligent hull

10.6.3.1 Polar ships applying for CCS intelligent hull notation are also to comply the relevant provisions in Chapter 3 of the Rules in addition to the following provisions.

10.6.3.2 For hull maintenance (Hh) function, the following requirements are to be complied with:

(1) The three-dimensional hull structural model is to fully describe the actual hull structure and coating condition, including only only structural elements such as plates, stiffeners and large brackets, etc but also coating (including properties such as type and application range).

(2) For hull inspection and maintenance scheme, general inspection items, critical area (including ice belt regions and strengthened extension areas) and typical defect diagram are to be developed in accordance with the characteristics of hull structures, ice class and the environment of ice area navigation.

(3) For deck machinery inspection and maintenance scheme, in addition to the characteristics of deck machinery, the low temperature operation requirements in the ice environment (such as the deck anchoring areas are to be kept ice-free) are to be considered, to develop operational measures to prevent or mitigate icing, heating and anti-freezing, and to ensure the operational conditions of deck machinery.

(4) Recording and assessment of hull structural conditions are to include:

① for recording and assessment of hull structural conditions, when predicting the corrosion trend of hull structure, in addition to the thickness change of hull structure members, the influence of ice environment is also to be considered (mainly considering the wear caused by ice layer);

② for recording of the coating condition, the data of structural thickness is recorded within the in-service period of ship from completion of construction to decommissioning based on the three-dimensional hull structural model.

(5) The development of the structural renewal plan is to include the structural renewal and coating, among which the coating plan is to be developed based on the structural renewal demand and the hull coating maintenance scheme.

10.6.3.3 For hull monitoring and assisted decision-making (Hm) function, the following requirements are to be complied with:

(1) It is to be possible to obtain information about the environment of the ice area, such as air temperature, sea water temperature, sea ice type and its corresponding thickness, and sea ice

density.

(2) Parameters of hull structure monitoring are to include the structural stress of the ice belt region of the ice-strengthened ship, the response of the hull structure is to be monitored by placing strain sensors on the hull members near the waterline, and the installation position of the sensors are to be selected based on the distribution trend of the ice load, as shown in Figure 10.6.3.3 and Table 10.6.3.3.

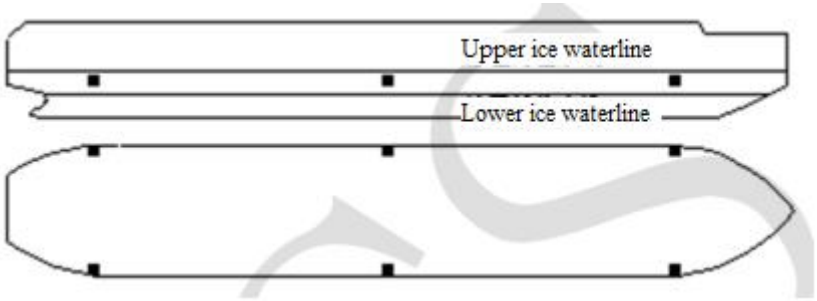

Figure 10.6.3.3 Arrangement of sensors of an ice-strengthened ship

Arrangement of sensors of an ice-strengthened ship Table 10.6.3.3

Arrangement area	The distribution area between upper ice waterline (UIWL) and lower ice water line (IWL) is selected according to the hull zoning requirements in the Rules for Ice Class. The location can be determined by ice load numerical prediction, ice load model test and finite element analysis of structural stress.
Means of arrangement	Select the corresponding sensor placement mode according to different members to be monitored: (1) 45° bi-directional strain sensor or three-directional strain sensor is placed on the web; (2) A uni-directional strain sensor is placed on the panel or folding edge; (3) Three-directional strain sensors are arranged on the shell plating.
Type of sensors	Fiber grating sensor or resistance strain sensor
Notes	(1) When sensors are placed, short strain sensors are generally used to measure the local stress of the structure caused by ice excitation, and they are to be arranged in the position of the greatest strain. (2) The appropriate means of sensor installation is to be selected according to the functional requirements of tensile/bending positive strain or shear strain measurement, while taking into account the impact of temperature changes on the measurement.

(3) Hull monitoring is to be able to obtain the icing status of the ship.

(4) During navigation, hull monitoring and assisted decision-making system is to be able to carry out ship stability calculation (or obtain it from the loading instrument). In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as adjusting heading and speed, heating and de-icing, etc. so as to ensure that the ship's stability is in safe condition;

(5) During navigation, hull monitoring and assisted decision-making system is to be able to

monitor the hull's local strength (including ice-strengthened areas). In case of an abnormal situation, an alarm is to be timely activated, cause analysis will be carried out and appropriate operational suggestions will be provided, such as lowering speed, adjusting heading, reducing manoeuvring, etc. so as to ensure that the ship's local strength is in safe condition.

10.6.4 Intelligent machinery

10.6.4.1 Polar ships applying for CCS intelligent machinery notation are also to comply the relevant provisions in Chapter 4 of the Rules in addition to the following provisions.

10.6.4.2 Depending on the actual design of the ship, the polar ship is also to meet the applicable monitoring requirements set out in Table 10.6.4.2.

List of condition monitoring equipment and systems Table 10.6.4.2

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Ventilation system		
1.1		Ventilator	Ventilation capacity
1.2		Inverter (if any) power device module	Working state
1.3		Heat exchanger (if any)	Heat transfer performance, such as air inlet temperature being maintained within the specified range
2	Seawater cooling system		
2.1		Pump	Seawater supply capacity
2.2		Heat exchanger	Heat exchanging performance
2.3		Filter	Filtering of impurities
2.4		Sea chest	Seawater flow condition
3	Exhaust gas boiler heating system		
3.1	Exhaust gas boiler		Exhaust gas flow capacity
3.1.1		Boiler tube	Soot accumulation state
3.2	Water supply system		Feedwater quality
3.2.1		Feed pump	Water supply capacity
3.3	Steam system		Gas supply capacity
3.3.1		Steam condenser	Steam condensation capacity
4	Oil fired boiler heating system (if any)		
4.1	Oil fired boiler		
4.1.1		Combustion chamber	Burning state
4.1.2		Burning unit	Fuel supply capacity Combustion air supply capacity

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
4.2	Water supply system		Feedwater quality
4.2.1		Feed pump	Water supply capacity
4.3	Steam system		Gas supply capacity
4.3.1		Steam condenser	Steam condensation capacity
5	Thermal oil heating system (if any)		
5.1	Thermal oil heater		
5.1.1		Combustion chamber	Burning state
5.1.2		Burning unit	Fuel supply capacity Combustion air supply capacity
5.2	Thermal oil system		Heating capacity
5.2.1		Thermal oil circulating pump	Thermal oil circulation capacity
5.2.2		Thermal oil cooler	Heat exchanging performance
6	Ethylene glycol heating system (if any)		Heating capacity
6.1		Ethylene glycol circulating pump	Ethylene glycol supply capacity
6.2		Steam-Ethylene glycol heat exchanger	Heat exchanging performance

10.7 Intelligent geotextiles laying

10.7.1 General requirements

10.7.1.1 This Section is applicable to ships applying for CCS functional notation for intelligent geotextiles laying.

10.7.1.2 Intelligent geotextiles laying comprehensively utilize all kinds of information and data obtained from condition monitoring to analyze and evaluate the operating status and health condition of the geotextiles laying equipment and systems, as well as the geotextiles laying operation status and energy efficiency condition, and provide decision-making support for the usage, operation and control, servicing and management of the geotextiles laying equipment and systems.

10.7.1.3 Intelligent geotextiles laying is to be provided with the following basic functions:

(1) Automatic control of the main equipment and systems of geotextiles laying operation;

(2) Data monitoring and collection of the operating status and health condition of relevant geotextiles laying equipment;

(3) Data monitoring and collection of energy efficiency and energy consumption of geotextiles laying operation.

10.7.1.4 Intelligent geotextiles laying is also to be provided with the following additional functions in addition to basic functions specified in 10.7.1.3 above:

(1) The geotextiles laying equipment and systems can automatically run according to the established procedures to achieve one-click geotextiles laying operation;

(2) Evaluation of the operating status and health condition of the geotextiles laying equipment and systems based on the monitored data, providing decision-making support for the operation and control, servicing, maintenance and management of the geotextiles laying equipment and systems based on the analysis and evaluation results;

(3) Evaluation of the energy efficiency and energy consumption of the ship, providing assisted decision-making recommendations for energy efficiency management based on the analysis and evaluation results;

(4) Based on the analysis and evaluation results of geotextiles laying operation status, the optimization and control of geotextiles laying operation parameters are achieved.

10.7.1.5 Intelligent geotextiles laying systems provided with functions in 10.7.1.3(2), 10.7.1.3(3), 10.7.1.4(2), 10.7.1.4(3) are to comply with the requirements for category II computer systems. Intelligent geotextiles laying systems that can achieve automatic control in 10.7.1.3(1), one-click geotextiles laying in 10.7.1.4(1), optimization and control of geotextiles laying operation parameters in 10.7.1.4(4) are to comply with the requirements for category III computer systems.

10.7.2 Plans and documents

10.7.2.1 The plans and documents for intelligent geotextiles laying operation system are to comply with the applicable requirements in Chapters 4 and 5 of the Rules.

10.7.2.2 The following plans and documents for intelligent geotextiles laying operation system are to be submitted for approval:

(1) Detailed information on intelligent geotextiles laying operation system, generally including the following:

① system diagram, principle, functions, operating and maintenance description;

② system hardware description, e.g. sensor, data acquisition device, data storage/backup device etc.;

③ software description, e.g. data processing and analysis method, fault diagnosis method and condition assessment method, etc.;

④ type and content of output data/information.

(2) The principle, function and operation instructions of the automatic control system;

(3) A list and description of the equipment and systems being monitored:

① monitoring purpose (condition, function, performance, etc.);

② monitoring parameters and their working range, e.g. current and pressure, etc.;

③ monitoring devices/sensors;

④ monitoring procedures;

⑤ condition analysis/assessment method;

⑥ acceptance criteria.

(4) Detailed plan for measuring/acquiring health assessment criteria, including measurement methods, time to establish criteria and method for assessing the effectiveness of criteria, etc.;

(5) The principle, function and operation instructions of intelligent geotextiles laying operation parameter optimization system;

(6) Type test program;

(7) Other plans and documents deemed necessary by CCS.

10.7.2.3 The following plans and documents of intelligent geotextiles laying operation system are to be submitted for information:

(1) Risk analysis report;

(2) Operating manual.

10.7.2.4 For ships applying for the functional notation for intelligent geotextiles laying, the plans and documents are to meet the applicable requirements in Chapters 4 and 5 of the Rules.

10.7.2.5 the following plans and documents for intelligent geotextiles laying system are to be submitted for approval:

(1) Intelligent geotextiles laying system diagram;

(2) List and description of monitored equipment and systems on real ship, at least including the following information of each equipment and part:

① monitoring purpose (condition, function, performance, etc.);

② monitoring parameters and their working range, e.g. current and pressure, etc.;

③ monitoring devices/sensors;

④ monitoring procedures;

⑤ condition analysis/assessment method;

⑥ acceptance criteria.

(3) List of main energy-consuming equipment of geotextiles laying and monitoring parameters;

(4) Test program.

10.7.2.6 The following plans and documents for intelligent geotextiles laying system are to be submitted for information:

(1) Installation and arrangement plan of main equipment of geotextiles laying equipment and systems;

(2) Instructions of intelligent geotextiles laying operation system.

10.7.3 Operation and control

10.7.3.1 For a geotextiles layer, at least the operation equipment such as positioning equipment, turning plate winch, coil drum driven winch, (trussed) crane, etc. are to achieve automatic control.

10.7.3.2 For opening/stopping of the coil drum, at least the positioning equipment and its drive system, turning plate winch and its drive system, (trussed) crane and other operation equipment and their drive systems, and geotextiles laying monitoring system can operate automatically according to the established procedures, and the operating parameters are to be automatically adjusted to the planned parameters before geotextiles laying.

10.7.3.3 The operating status, working parameters, etc. of the geotextiles laying equipment are to be displayed in the operation control station, including at least the parameters and status information listed in the following table.

List of monitoring parameters for geotextiles laying equipment **Table 10.7.3.3**

No.	Equipment name	Parameters to be monitored
1	Mooring positioning winch	● Length of wire rope ● Wire rope rotational speed ● Wire rope load ● Speed of winch motor ● Winch motor power ● Winch motor torque ● Brake status ● Clutch status
2	Turning plate winch	● Winch motor rotational speed ● Winch motor power ● Winch motor torque ● Turning plate angle sensor ● Brake status
3	Coil drum driven winch	● Length of wire rope ● Wire rope speed ● Drum speed ● Winch motor power ● Winch motor torque ● Braking status
4	(Trussed) crane (including truss motor, trolley motor, crab motor and lifting motor).	● Lowering and releasing speed and length ● Traveling speed ● Limit switch ● Motor rotational speed ● Motor power ● Operating frequency ● Output torque

No.	Equipment name	Parameters to be monitored
5	Others	● Ship's draft ● Data such as wind, waves, and swells (which may be obtained through other means) ● Video surveillance footage ● Pressure and oil temperature of the hydraulic system

10.7.3.4 Operators onboard are to monitor the operating status of geotextiles laying related equipment and systems. If necessary, additional video surveillance equipment are to be provided. In emergency situations or when necessary, operators can take over the operation, and such taking over is not to cause serious changes in the operating status of the ship and its equipment.

10.7.3.5 Where video surveillance equipment is fitted, the installation position and number are to meet the requirements of geotextiles laying operation. Independent or grouped video displays may be adopted. If necessary, a joystick for the video surveillance equipment are also to be provided. Video signals are to be displayed in real time at the operation control station and/or other designated places and the presented video pictures are to be clear and stable.

10.7.3.6 A geotextiles layer is to be provided with a geotextiles laying visual system to simulate the forming state during geotextiles laying, and, by comparing the actual edge laying and the theoretical edge laying, judge whether the formation meets the design procedures. When the criterion range is exceeded or there is a tendency of exceeding the criterion range, a warning is to be released.

10.7.3.7 During geotextiles laying operation, the automatic system of the geotextiles laying equipment outputs signals to the audible and visual alarm on the corresponding ship bridge and operation control station to give real-time intermittent indication and alarm during automatic operation of the equipment. If the operation control station is in the bridge, there is no need to set the alarm repeatedly.

10.7.4 Condition monitoring of geotextiles laying equipment

10.7.4.1 The condition monitoring, health assessment and assisted decision-making of geotextiles laying equipment are to meet the applicable requirements of 4.1, 4.3 and 4.4, Chapter 4 of the Rules.

10.7.4.2 When applying for intelligent geotextiles laying notation G, the condition monitoring of the equipment and systems specified in Table 10.7.4.2 is to be carried out as a minimum.

List of condition monitoring of geotextiles laying equipment Table 10.7.4.2

No.	Name of equipment and system	Monitoring Scope (e.g. equipment/parts/performance, etc.)	Monitoring Purpose (e.g. condition, function, performance, etc.)
1	Mooring positioning winch	Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
2	Turning plate winch	Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
3	Coil drum driven winch	Gear case	Wear
		Drive shaft bearing	Wear, sealing performance
4	Motor (mooring positioning winch, turning plate winch, coil drum driven winch, (trussed) crane)	Stator	Stator state
		Rotor	Rotor state, such as turn-to-turn state (synchronous motor), balance state, eccentricity state, rotor bar break (asynchronous motor), loss of excitation (permanent magnet motor)
		Bearing	Wear

10.7.5 Energy efficiency management

10.7.5.1 The energy efficiency management of geotextiles laying operation is to comply with the applicable requirements regarding energy efficiency management of 5.1, 5.3 and 5.4, Chapter 5 of the Rules.

10.7.5.2 An online energy efficiency monitoring function is to be provided to obtain real-time operation status, geotextiles laying length and energy consumption data, and to evaluate, report and alarm for the energy efficiency and energy consumption of geotextiles laying operations.

10.7.5.3 The parameters of major energy-consuming equipment, geotextiles laying equipment and systems (such as coil drum driven winch and crane, etc.) during geotextiles laying operations are to be collected, including but not limited to:

(1) the power, pressure and temperature parameters of the main energy-consuming equipment;

(2) fuel consumption parameters of major energy-consuming equipment;

(3) engine shaft power or equivalent output power;

(4) motor output power;

(5) parameters listed in 10.7.3.3 of the Chapter.

10.7.5.4 The following energy consumption and efficiency indicators are to be calculated automatically:

(1) fuel consumption per single operation;

(2) energy efficiency index of construction process.

Designers can adjust the energy efficiency and energy consumption indicators specified in (1) and (2) above according to geotextiles laying operation environment and process,etc.

10.7.5.5 It is to be possible to use real-time data of the ship's energy consumption/energy efficiency, perform comparative analysis according to predetermined evaluation methods and criteria, automatically assess energy consumption/energy efficiency status, and output assessment conclusions.

10.7.5.6 It is to be possible to make auxiliary decision suggestions for energy efficiency optimization and improvement based on the energy consumption/energy efficiency assessment results.

10.7.5.7 It is to be possible to automatically generate relevant indicator data reports for any time period and query them as required.

10.7.6 One-click geotextiles laying

10.7.6.1 One-click geotextiles laying function is to comply with the relevant requirements of 10.7.3 of this Chapter in addition to the provisions of this Section.

10.7.6.2 The operation and control of the geotextiles laying equipment are to meet the following requirements:

(1) The automatic operation function of geotextiles laying equipment is to be provided, and the related equipment and systems can automatically operate according to the established procedures within a single anchor shift cycle, so as to realize the automatic operation of geotextiles laying with one click;

(2) Geotextiles laying equipment and systems are to include the followings as a minimum: construction positioning equipment, turning plate winch, coil drum driven winch, (trussed) crane, and intelligent geotextiles laying operation system,etc.;

(3) The established procedures are to consider the control process and logical sequence of laying out the geotextiles, etc.;

(4) The operating status and working parameters of the geotextiles laying equipment and systems are to be displayed in the operation control station, including at least the parameters and status information listed in 10.7.3.3 of this Chapter.

10.7.6.3 The relevant operation parameters of geotextiles laying related equipment and systems are to be automatically adjusted to pre-operation planned parameters.

10.7.6.4 An emergency operation plan is to be developed. In the process of automatic control, if the conditions of one-click laying are not met, an alarm signal is to be released and the emergency operation process is to be directly cut into.

10.7.6.5 Necessary safety measures are to provided to deal with abnormal geotextiles laying operations, such as video surveillance, to ensure the safety of personnel and equipment.

10.7.6.6 A necessary recording system is to be provided so as to automatically record the

responses to abnormality of geotextiles laying equipment and systems according to the specified procedures and plans.

10.7.7 Optimization of operation parameters

10.7.7.1 The initialization and optimization of operation parameters are to be achieved based on factors such as project plan, environmental condition, soil condition, ship condition,etc.

10.7.7.2 For the operation parameter initialization function, the initial value of the geotextiles laying operation parameters is to be given by considering the project plan, ship condition, soil conditions, environmental conditions and other factors.

10.7.7.3 The operation parameters of geotextiles laying operation include at least the following:

(1) anchor positioning includes: winch speed, etc.;

(2) lifting operation includes: traveling speed, distance, path, etc.;

(3) laying operation includes: angle of turning plate, laying speed, etc.

10.7.7.4 The operation parameter optimization function is to be able to evaluate the accuracy and speed of geotextiles laying, and provide the optimization plan of geotextiles laying operation parameters to achieve the economic yield or maximum yield target.

10.7.7.5 The operation parameter optimization function is at to least consider the following factors:

(1) geotextiles laying operation plan;

(2) environmental conditions;

(3) soil condition;

(4) condition of ship power system;

(5) condition of geotextiles laying equipment;

(6) matching of the environment, soil type and geotextiles laying process;

(7) matching of geotextiles laying equipment.

10.7.8 Survey and test

10.7.8.1 Initial survey is to include the following items as a minimum:

(1) confirming that plans and documents have been approved;

(2) confirming that the intelligent geotextiles laying operation system has been approved;

(3) confirming the installation integrity of the relevant system and equipment;

(4) carrying out test and survey according to the approved test programme;

(5) for equipment subject to condition-based maintenance, checking the condition-based maintenance plan and implementation procedures (if applicable) to ensure that the contents are consistent with real ship.

(6) confirming that relevant plans and documents, manuals, procedures and relevant records are kept on board the ship.

10.7.8.2 For ships which are assigned the functional notation for intelligent geotextiles laying, the survey is to be carried out in connection with the annual/intermediate/special survey of ship, in order to verify the normal function of systems related to intelligent geotextiles laying.

10.7.8.3 Prior to the annual survey, the owner or ship manager is to submit to CCS survey unit an annual report on systems related to intelligent geotextiles laying, which at least is to include the following items from last annual survey:

(1) general operating condition of systems related to intelligent geotextiles laying;

(2) maintenance records of systems related to intelligent geotextiles laying;

(3) fault/failure conditions and cause analysis of the intelligent geotextiles laying equipment;

(4) repair records and replacement of spare parts of the intelligent geotextiles laying equipment.

10.7.8.4 At annual survey, in addition to examining the annual report submitted by the owner (ship), the surveyor is also to examine the following items on board the ship:

(1) examining whether the systems related to intelligent geotextiles laying operate effectively;

(2) examining detailed working records of the systems related to intelligent geotextiles laying;

(3) examining repair records of the equipment and systems related to intelligent geotextiles laying;

(4) confirming that the historical data, trend analysis data, and monitoring and alarm of systems related to intelligent geotextiles laying are complete and carrying out random examination of report contents;

(5) confirming that operators are familiar with the operation and maintenance of systems related to intelligent geotextiles laying and confirming the implementation condition;

(6) some testing and analysis processes need to be verified if deemed necessary by the surveyor;

(7) examining and confirming that relevant instrumentation have been calibrated in accordance with specified procedures and plans;

(8) the maintenance of equipment included in the condition-based maintenance is to be confirmed.

10.7.8.5 For ships which are assigned the functional notation for intelligent geotextiles laying, in case the monitored equipment is damaged, repaired and replaced, or the means of monitoring is significantly changed, a request for occasional survey is to be made to CCS.