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CHINA CLASSIFICATION SOCIETY

**GUIDELINES FOR SURVEYS OF
INTELLIGENT ENERGY EFFICIENCY
MANAGEMENT OF SHIPS
2018**

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Foreword

As a part of CCS Rules for Intelligent Ships, the Guidelines specify detailed requirements for intelligent energy efficiency management, which supplement relevant rules requirements. Relevant approval and survey are to, in addition to the requirements of the Guidelines, satisfy relevant provisions of CCS Rules for Intelligent Ships.

The Guidelines are developed and updated by CCS and released on <http://www.ccs.org.cn>. Any comment on the Guidelines can be sent to es@ccs.org.cn.

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CHAPTER 1 GENERAL

1.1 Purpose

1.1.1 The Guidelines specify technical and approval requirements for ship energy efficiency on-line intelligent monitoring, speed optimization and optimal stowage based on trim optimization as well as survey requirements for i-Ship(E), i-Ship(Es) and i-Ship(Et) notations in Chapter 5 Intelligent Energy Efficiency Management of the Rules for Intelligent Ships, which may be used as guidance notes for CCS surveyors, ship designers, manufacturers, service suppliers, shipowners and ship management companies when they conduct relevant work.

1.2 Scope of application

1.2.1 The Guidelines apply to ships applying for i-Ship(E), i-Ship(Es) and i-Ship(Et) notations in Chapter 5 Intelligent Energy Efficiency Management of the Rules for Intelligent Ships. Explanations and requirements for such notations are given in 5.1.5 of the Rules for Intelligent Ships.

1.2.2 Functional requirements for the i-Ship(E) notation include requirements for the EOM notation. EOM functions mainly include ship equipment monitoring, energy management, energy efficiency management etc. In addition to EOM functional requirements, i-Ship(E) includes the function of energy efficiency assistant decision-making. Survey requirements for the EOM notation are given in Section 7, Chapter 6, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

1.3 Definitions

1.3.1 Relevant definitions and abbreviations are as follows:

- (1) EEOI means ship's energy efficiency operational indicator, i.e. the ratio of mass of CO₂ emitted per unit of transport work.
- (2) MRV means monitoring, reporting and verification of CO₂ emissions from maritime transport.
- (3) 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. Emission control area mentioned in this Chapter is to include area listed or specified in Regulations 13 and 14 of MARPOL Annex VI.
- (4) Main energy-consuming equipment means main energy-consuming equipment including main engine, auxiliary engine, boiler and inert gas generator, etc.
- (5) Transportation work means product by multiplying the distance travelled with the amount of cargo carried.

CHAPTER 2 SHIP ENERGY EFFICIENCY ON-LINE INTELLIGENT MONITORING

2.1 General requirements

2.1.1 General requirements for ship energy efficiency on-line intelligent monitoring are given in 5.2.1 of the Rules for Intelligent Ships.

2.1.2 Main energy-consuming equipment generally includes main engines, auxiliary engines and boilers. For oil tankers, it also includes fuel oil or fuel gas inert gas generators (where applicable). Ship energy efficiency is directly affected by the condition of such equipment and therefore it is to be monitored. Monitoring parameters are to be used to evaluate equipment condition intuitively.

2.1.3 Ship's navigation equipment (aids to navigation) includes, but not limited to, global positioning system, wind speed and direction indicator, log, electronic clinometer, sounding instrument, ship draft measuring equipment etc. In addition to ensuring the safety of navigation, such equipment helps to track the sailing path of ship, sea condition and weather by monitoring parameters and analyze factors affecting ship energy efficiency.

2.1.4 Comprehensive analysis and evaluation of ship's energy efficiency condition is to be carried out periodically based on the monitoring of navigation and energy consumption data. Assistant decision-making recommendations on energy efficiency optimization and improvement are provided in accordance with evaluation results. Relevant data or analysis and evaluation report is provided according to demand.

2.1.5 Computer system based on energy efficiency on-line intelligent monitoring is to satisfy the requirements for category I computer system of the Guidelines for Assessment of Security and Reliability of Marine Software. Relevant materials are to be prepared in accordance with the list of materials required by the Guidelines above and the application for assessment is to be sent to the Marine Product Management Dept. of CCS.

2.1.6 Requirements for product certification are given in 6.4 of the Guidelines.

2.2 Data collection

2.2.1 Automatic data collection is to be carried out for main energy-consuming equipment, shaft power monitoring equipment, fuel metering device for main energy-consuming equipment, wind speed and direction indicator, global positioning system, log, electronic clinometer (if fitted), sounding instrument and ship draft measuring equipment. Data collection may also be carried out for equipment other than the above equipment in accordance with functional needs of the system.

2.2.2 Data sent by the data transmission port of the hardware equipment may be directly collected, or data may be collected by means of a virtual serial server or from other data integration platforms. The type of interface may be serial port (RS232, RS422, RS485), TCP etc. The format of protocol may be NMEA0183, MODBUS or a manufacturer-defined format which is similar to NMEA0183.

2.2.3 Photoelectric isolation is to be carried out in order to avoid interference during data collection.

2.2.4 Collected parameters are to comply with 9.1 Summary of Parameters of Energy Efficiency Equipment.

2.3 Data collection period and storage

2.3.1 Data collection period is set in accordance with the period of data transmission of equipment and requirements from system function setting. The collection period may be adjusted in accordance with needs and the maximum is not to exceed 1 h.

2.3.2 Automatic backup needs to be carried out for collected data on a periodical basis. Quick recovery is to be provided. Redundant Array of Inexpensive Disks (RAID), multi-disk, CD burning and removable media storage may be used for data backup.

2.4 Energy efficiency/energy consumption and emission data analysis

2.4.1 The system is to be able to calculate energy efficiency and emission index automatically, including the following based on ship type:

- (1) Energy Efficiency Operational Indicator (EEOI);
- (2) fuel consumption per distance;
- (3) fuel consumption per transport work;
- (4) CO₂ emission per distance;
- (5) CO₂ emission per cargo mass.

2.4.2 For the definition and calculation methods of energy efficiency and emission index above, reference may be made to the following:

- (1) MEPC.1/Circ.684 on Guidelines for voluntary use of the Ship Energy Efficiency Operational Indicator (EEOI);
- (2) Regulation (EU) 2015/757 of the European Parliament and of the Council on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC;
- (3) CCS Guidelines for Development of Ship Energy Efficiency Management Plan (SEEMP).

2.4.3 The system is to be able to calculate the following index of main energy-consuming equipment automatically:

- (1) fuel consumption per hour;
- (2) fuel consumption per day;
- (3) summary of fuel consumption per voyage (leg).

2.4.4 Other energy efficiency and energy consumption index can be added in accordance with ship type and system function needs.

2.5 Energy efficiency and energy consumption evaluation

2.5.1 Real-time evaluation of energy consumption of main energy-consuming equipment

- (1) automatically judging ship's navigational status such as mooring, maneuvering navigation and constant speed navigation as well as the operational condition of special purpose ships according to ship's main engine speed, any change of ship position and historical navigational data;
- (2) calculating fuel oil consumption per unit of time according to ship's fuel oil metering devices, evaluating energy consumption in conjunction with ship's historical energy consumption data and current condition, and outputting evaluation conclusion.

2.5.2 Evaluation of ship energy efficiency and emission index

- (1) establishing ship energy efficiency and emission index evaluation criteria through the self-learning function in accordance with ship's historical data (design, sea trial), data of the sister ships or in conjunction with ship's real-time data;

(2) calculating ship energy efficiency and emission index on a real-time basis in accordance with the monitoring data of ship equipment, and comparing with ship energy efficiency and emission index evaluation criteria;

(3) generating evaluation and analysis report of ship energy efficiency and emission as needed.

2.5.3 Ship's energy consumption distribution analysis

(1) obtaining ship's dynamic energy consumption distribution proportion and energy utilization efficiency according to real-time data of ship's energy consumption;

(2) outputting energy consumption distribution and dynamic energy consumption distribution data of the design speed, and the analysis result of energy utilization efficiency;

(3) for analysis and calculation of energy consumption distribution, reference may be made to CCS Guidelines for Ship's Energy Consumption Distribution and Energy Saving.

2.5.4 Reminding that index exceeds limit

(1) a limit value of index is set in accordance with index criteria on ship energy efficiency and energy consumption evaluation;

(2) if real-time value of ship's energy efficiency and energy consumption index exceeds set value, the system is to give an alarm.

2.6 Assistant decision-making on energy efficiency management

2.6.1 General evaluation on ship's energy efficiency and energy consumption condition may be carried out according to voyage and designated period (not exceeding one year).

2.6.2 An energy efficiency and energy consumption evaluation system applicable to the ship may be established in accordance with the requirements of IMO Guidelines for the Development of a Ship Energy Efficiency Management Plan and energy efficiency management requirements of industrial organizations and shipping companies. Assistant decision-making recommendations on optimization and improvement are provided according to evaluation results.

2.7 Assistant management of energy efficiency

2.7.1 Applicable requirements for monitoring and report of energy consumption or emission from IMO and the Administration are to be satisfied.

2.7.2 Emission control area (ECA) early warning: system is able to provide early warning for residual nautical miles and residual time for fuel oil change-over operation in accordance with the design of ship's fuel oil system, operating condition of equipment and in conjunction with comprehensive factors such as ship's course, speed and sea state, in order to ensure that the ship satisfies emission requirements in an ECA.

2.7.3 Fuel information management: information on fuel bunkering and change-over may be recorded automatically in conjunction with bunkering metering devices or fuel oil change-over switch signals or such information may be recorded manually; in the latter case, it is to be recorded timely after completion of fuel bunkering and change-over operations.

CHAPTER 3 SPEED OPTIMIZATION

3.1 General requirements

3.1.1 Factors affecting the speed

Speed optimization covers many factors, including operational method, port condition, charter party, fuel oil price, cargo rate, sail schedule, hydrometeorology, requirements and limitation of the route on the speed, ship condition, machinery installations condition, ship loading, fuel oil quality etc. Comprehensive analysis is needed and reasonable measures are taken to optimize the speed.

3.1.2 Speed optimization

The essence of speed optimization is to find the best speed under the current condition and objective. The decrease of speed reduces fuel consumption of main engines and increases navigation time, thereby reducing the transportation efficiency. In case of a tight sail schedule, a large quantity of freight and high freight charge, the ship will choose the most profitable speed and as a result speed optimization based on different objectives is to be achieved by comprehensively taking into account a number of factors.

3.2 Speed optimization based on voyage plan

3.2.1 The speed is optimized in accordance with the voyage plan. Factors affecting the route, as well as navigation time and navigation distance are estimated. The system is to be capable of providing a speed optimization plan (recommendations on main engine speed or ship speed).

3.2.2 During navigation, the system is to be capable of adjusting the speed optimization plan in accordance with factors such as ship performance, efficiency index, comprehensive weather and sea state and based on historical data (relationship among factors such as speed, cargo capacity, oil consumption as well as weather and sea conditions) and ports.

3.2.3 The system is also to be capable of:

- (1) predicting information such as navigation distance according to ship's port of departure, port of arrival and departure time; automatically calculating navigated distance and navigated time, and forecasting arrival time according to residual voyage and current speed;
- (2) automatically calculating specific fuel consumption under current speed according to parameters such as speed, main propulsion equipment power and fuel consumption, calculating oil consumption according to current speed and residual navigation distance and calculating fuel consumption for navigated miles and fuel necessary for residual miles;
- (3) evaluate effect on speed according to set factors such as ship efficiency index which can reflect ship performance and efficiency during operation as well as weather and sea conditions, and based on historical data analysis (relationship among factors such as speed, cargo capacity, oil consumption as well as weather and sea conditions).

3.3 Speed optimization based on cost effectiveness

3.3.1 Cost involved in ship operation mainly includes freight charge, port charge, fuel price, ship depreciation, material input, crew wages, shore-based personnel wages and management charges. The system may check each cost during ship operation, evaluate voyage benefits and provided a speed optimization plan with the best cost effectiveness.

3.3.2 The system is to be capable of adjusting the optimization plan based on cost change.

CHAPTER 4 OPTIMAL STOWAGE BASED ON TRIM OPTIMIZATION

4.1 General requirements

4.1.1 The hydrodynamic resistance of ship navigation is affected by ship speed, displacement, draft and trim angle. The trim floatation is adjusted and the underwater shape during ship navigation is changed in order to affect wave making, wetted surface, bow incident, wake current and other ship resistance factors. Trim optimization is conducted to effectively reduce the navigation resistance, the power demand of main engine and fuel consumption.

4.1.2 In accordance with the requirements for optimal stowage based on trim optimization, the system can achieve the function of stowage calculation and check based on trim optimization and automatic output of optimized stowage plan.

4.1.3 Other requirements are given in Section 4, Chapter 5 of CCS Rules for Intelligent Ships.

4.2 Requirements for trim optimization and stowage optimization

4.2.1 Trim optimization is to be capable of carrying out optimization calculation by means of inputting ship speed, fore and aft draft and other key navigation parameters, including trim performance basic database or real-time analysis optimization model.

4.2.2 Trim optimization is to be capable of calculating the optimal trim or optimization curve in any ballast condition and loading condition, and indicating optimized main engine power or energy consumption saving percentage.

4.2.3 Trim optimization is to be capable of estimating unit fuel consumption saving of main engine after trim optimization.

4.2.4 Ship particulars related to trim optimization include but not limited to:

- (1) lightship weight;
- (2) length between perpendiculars L_{bp} .

4.2.5 Voyage information (real time or planned) related to trim optimization includes but not limited to:

- (1) voyage number;
- (2) route;
- (3) port of departure;
- (4) port of arrival;
- (5) time of departure;
- (6) time of arrival.

4.2.6 Trim optimization is to ensure that normal users cannot modify ship particulars which have been inputted and trim performance basic database.

4.2.7 Other requirements for trim performance basic database are given in Section 4, Chapter 5 of CCS Rules for Intelligent Ships.

4.2.8 Trim optimization is to be capable of reducing any obvious or illogical input error insofar as practicable. The user is to be alerted by the software in case the inputted draft value exceeds the maximum scantling draft or the draft value is negative.

4.2.9 The calculation efficiency of trim optimization is to be acceptable. The optimal trim plan or the optimized trim range that can be adjusted is to be outputted and saved.

4.2.10 Stowage optimization is at first to satisfy the functional requirements for loading

instruments, i.e. 3 Functional Requirements for Software of Appendix 1, Chapter 2, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

4.2.11 In accordance with the target trim (fore and aft draft difference) outputted by trim optimization, stowage optimization is to be capable of automatically judging whether the value satisfies trim requirements for navigational safety and calculating the optimal stowage plan in compliance with ship safety based on the target optimized trim.

4.2.12 The calculation efficiency of stowage optimization is to be acceptable. The optimization direction is to carry out convergence judgment so as to avoid invalid calculation for a long time.

CHAPTER 5 PLAN APPROVAL

5.1 Plans and documents

5.1.1 For ships applying for the i-Ship(E) notation, the following plans and documents are to be submitted for approval:

(1) Composition and explanation of energy efficiency on-line monitoring system, including the following information:

- ① explanation of equipment composition;
- ② list of monitoring method and parameters;
- ③ special explanation on installation processes 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) Electrical system plan of energy efficiency on-line monitoring system;

(3) Electrical installation arrangement plan of energy efficiency on-line monitoring system;

(4) Electrical system plan of shaft power monitoring equipment;

(5) Arrangement plan of shaft power monitoring equipment;

(6) Fuel oil piping system plan of main energy-consuming equipment;

(7) 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 (the basis for the calibration plan is generally to be provided);

(8) Test program of energy efficiency management system.

5.1.2 For ships applying for the i-Ship(Es) notation, in addition to the plans and documents required in 5.1.1, the following are to be submitted for approval: basic principle, function and instructions of speed optimization system.

5.1.3 For ships applying for the i-Ship(Et) notation, in addition to the plans and documents required in 5.1.1, the following are to be submitted for approval: basic principle, function and instructions of optimal stowage system based on trim optimization

5.1.4 For all ships applying for the intelligent energy efficiency notation, any additional plans and documents deemed necessary during the plan approval process are to be submitted for approval or information.

5.2 Key points of plan approval

5.2.1 Electrical system plan of energy efficiency on-line monitoring system/electrical system plan of shaft power monitoring equipment is to include system power supply, system input and output signal circuit and the system is at least to be supplied by ship's main source of electrical power.

5.2.2 Monitoring parameters of ship's main energy-consuming equipment and metering equipment include, but not limited to:

- (1) parameters of power, pressure and temperature of main energy-consuming equipment;
- (2) parameter of fuel consumption of main energy-consuming equipment;

- (3) parameter of main engine shaft power and rate of revolution;
- (4) parameter of wind speed and direction;
- (5) parameters of ship position, course and speed;
- (6) parameter of speed through the water;
- (7) ship inclination angle;
- (8) water depth value;
- (9) ship draft value;
- (10) surge parameter (when practicable, ship is able to obtain marine meteorological data).

Collected parameters are to comply with 9.1 Summary of Parameters of Energy Efficiency Equipment.

5.2.3 Fuel oil piping system plan of main energy-consuming equipment: the oil supply pipes of main energy-consuming equipment are to be fitted with flowmeters which are to be installed at such position that the fuel oil consumption of main energy-consuming equipment can be measured separately.

5.2.4 Considering the effect of ship deformation and local vibration on performance of shaft power monitoring equipment, the stator installation foundation for shaft power monitoring equipment is to be welded tight, generally welded on ship's strong components, and welding on hull plating is not allowed.

5.2.5 A calibration plan of monitoring devices is to be provided. Equipment calibration depends on calibration interval specified in manufacturer's instructions

5.2.6 For ships applying for i-Ship(E), i-Ship(Es) and i-Ship(Et) notations, the following are to be submitted: basic principle, function and instructions of systems, including software design method, calculation function and principle, data structure, software flowchart and instructions; and meanwhile providing explanations on accurate calculation capability and accuracy control of system functions.

CHAPTER 6 INSPECTION OF PRODUCTS

6.1 Scope of application

6.1.1 It is applicable to product approval and inspection of ship's intelligent energy efficiency management system.

6.2 Approval/inspection basis

6.2.1 Chapter 3 of PART ONE and Chapters 1 and 2 of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

6.2.2 Chapters 1 and 5 of CCS Rules for Intelligent Ships.

6.3 Selection of typical samples

6.3.1 The test sample is to be selected on a technically representative basis and cover the range of products applying for type approval.

6.3.2 In case major components (e.g. computers, displays etc.) of products are from different manufacturers, consideration may be given by CCS to selecting respective samples for type test (marine environmental test, electromagnetic compatibility test).

6.4 Product certification requirements

6.4.1 Products applying for approval/inspection are to satisfy the certification requirements in the Table below.

No.	Product name	Document		Approval mode				Plan approval	Remark
		C/E	W	DA	TA-B	TA-A	WA	PA	
1	Intelligent energy efficiency management system	--	X	--	X	--	--	X	
2	Shaft power meter	--	X	--	X	--	--	X	
3	Flowmeter	--	X	--	X	--	--	X	

Symbols:

- 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.

6.4.2 Where the intelligent energy efficiency management system involves other equipment, the product certification requirements are given in CCS Rules for Classification of Sea-going Steel Ships.

6.5 Type approval

6.5.1 Type test items

The type test of the product is to include the test items listed in Table 6.5.1.

Type test item list

Table 6.5.1

No.	Test item	Requirements for test results	Remarks
1	Appearance identification and integrity check	Confirm that the appearance of the product is to be free of damage, clearly marked, complete with all modules of the product, consistent with the approved plan, and confirm the name and version of the software	
2	Performance test	Refer to 6.5.2 for details	
3	Marine environmental test	CCS Guidelines for Type Approval Test of Electric and Electronic Products	If the product contains hardware
4	Electromagnetic compatibility test	CCS Guidelines for Type Approval Test of Electric and Electronic Products	If the product contains hardware

6.5.2 Performance test

The performance test is to confirm that the system is in compliance with the approved plan/information and the technical requirements for systems of the Guidelines. The product performance test is to include the contents of Table 6.5.2.

The specific test methods are to be developed in conjunction with the contents of the product technical documents (technical conditions, instructions, etc.) approved by CCS. Performance verification can be carried out by means of environmental simulation, and the test scheme is to be confirmed by the surveyor.

Performance test item list

Table 6.5.2

NO.	Test item	Requirements for test results	Remarks
1	Energy efficiency on-line monitoring function		
1.1	Data collection function inspection	The system is to be at least able to monitor parameters in real time: (1) parameters of power, pressure and temperature of main energy-consuming equipment; (2) parameters of fuel consumption of main energy-consuming equipment; (3) parameters of main engine shaft power and rate of revolution; (4) parameters of wind speed and direction; (5) parameters of ship position, course and speed; (6) parameters of speed through the water;	For data input interfaces of the same type, sampling verification can be used if the number is large.

NO.	Test item	Requirements for test results	Remarks
		(7) ship inclination angle; (8) water depth value; (9) ship draft value; (10) surge parameter (if applicable); The data obtained by system is to be consistent with the original input data.	
1.2	Signal loss alarm function	When the collected signal is lost, the system is to be able to give an alarm.	
1.3	Data measurement period inspection	The system is to be able to periodically receive and store the device parameter data, and the receiving period may be adjusted according to the demands, and the maximum period is not to exceed 1 hour.	
1.4	Ship-shore communication function inspection	If the system uses shore-based support to complete data storage or analysis functions, the validity of ship-shore data communication is to be confirmed.	
1.5	Data storage function inspection	The measurement data is to be documented in a standard format and stored periodically; The historical data should be queried from the stored data.	
1.6	Database backup capability inspection	The system is to be provided with the facilities required for database backup, and is verified to be effective.	
2 Energy efficiency/energy consumption and emission data analysis function			
2.1	Energy efficiency and emission index calculation function inspection	Based on the applicable ship type, the system is to be at least able to calculate following energy efficiency and emission index automatically: (1) ship's energy efficiency operational indicator (EEOI); (2) fuel consumption per distance;	

NO.	Test item	Requirements for test results	Remarks
		(3) fuel consumption per transport work; (4) CO ₂ emission per distance; (5) CO ₂ emission per cargo mass.	
2.2	Energy-consuming equipment index calculation function inspection	The system is to be at least able to calculate following index of main energy-consuming equipment automatically: (1) fuel consumption per hour; (2) fuel consumption per day; (3) summary of fuel consumption per voyage (leg).	
2.3	Energy consumption real-time evaluation function inspection	(1) The system is to automatically judge ship's navigational status such as mooring, maneuvering navigation and constant speed navigation according to actual operational condition of ship equipment; (2) The system is to carry out comparison and analysis according to set energy consumption evaluation method and criteria, and use real-time data of ship's energy consumption so as to automatically judge energy-consuming condition and output evaluation conclusion.	
2.4	Energy efficiency and emission index evaluation function inspection	(1) It is to be able to carry out automatic real-time monitoring of energy efficiency and emission evaluation index (including the indexes described in Test item 2.1 in this Table) and carry out comparison and analysis with energy efficiency evaluation criteria; (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.	
2.5	Energy consumption distribution function	(1) The system is to be able to obtain energy consumption	

NO.	Test item	Requirements for test results	Remarks
	inspection	distribution proportion and energy utilization efficiency of main energy-consuming equipment by analysis. (2) The system is to be able to output energy consumption distribution data and analysis result of energy utilization efficiency.	
2.6	Function inspection of reminding that index exceeds limit	The system is to be able to set the limiting values of ship energy efficiency and energy consumption indexes; If real-time value of ship's energy efficiency and energy consumption index exceeds set value, the system is to give alarm.	
3 Function of assistant decision-making on energy efficiency management			
3.1	Inspection of general evaluation on energy efficiency and energy consumption condition	The system is to be able to carry out general evaluation on ship's energy efficiency and energy consumption condition according to voyage and natural period (not exceeding one year) and output evaluation report.	
3.2	Assistant decision-making function inspection	The system is to be able to provide assistant decision-making recommendations on energy efficiency optimization and improvement according to results of general evaluation on ship's energy efficiency and energy consumption.	
4 Function of assistant management of energy efficiency			
4.1	Inspection of the carbon emission report generating function required by MRV	Meeting applicable requirements of IMO, EU and the Administration for monitoring or reporting of energy consumption or emissions.	
4.2	Emission control area (ECA) early warning	The system is to be able to provide Early warning for residual nautical	

NO.	Test item	Requirements for test results	Remarks
	function inspection	miles and residual time within certain area away from ECA according to current ship course and speed.	
4.3	Fuel information management function inspection	The system is to be able to carry out information management for fuel bunkering and fuel change-over during navigation, including information management for fuel bunkering type and fuel information before and after fuel change-over.	
5 Speed optimization function			If applicable
5.1	Function of speed optimization based on voyage plan		
5.1.1	Voyage/leg management function inspection	<p>(1) The system is to be able to predict information such as navigation distance according to ship's departure port, arrival port and departure time;</p> <p>(2) It is to be able to automatically calculate navigated distance and navigated time;</p> <p>(3) It is to be able to forecast arrival time according to residual voyage and current speed.</p>	
5.1.2	Specific fuel consumption calculation function inspection	<p>(1) The system is to automatically calculate specific fuel consumption under current speed according to parameters such as speed, main propulsion equipment power and fuel consumption;</p> <p>(2) It is to be able to calculate fuel consumption for navigated miles and fuel necessary for residual miles.</p>	
5.1.3	Inspection of evaluating effect on speed	The system is to be able to evaluate effect on speed according to set factors such as ship efficiency index which can reflect ship performance and efficiency during operation as well as weather and	

NO.	Test item	Requirements for test results	Remarks
		sea conditions, and based on historical data analysis (relationship among factors such as speed, cargo capacity, oil consumption as well as weather and sea conditions).	
5.1.4	Inspection of speed optimization plan based on voyage plan	The system is to be able to output speed optimization plan based on above evaluation.	
5.2	Speed optimization based on cost effectiveness		
5.2.1	Cost management function inspection	The system is to be able 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.	
5.2.2	Benefit index evaluation function inspection	The system may check each cost during ship operation and evaluate voyage benefits.	
5.2.3	Inspection of speed optimization plan based on cost effectiveness	The system is to be able to output speed optimization plan based on cost effectiveness according to evaluation results of benefit index.	
6 Optimal stowage based on trim optimization			If applicable
6.1	Loading instrument function inspection	It is to satisfy 3 “Functional Requirements for Software”, Appendix 1, Chapter 2, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.	
6.2	Calculation function inspection	1) Overall strength calculation check 2) Intact stability calculation check 3) Check of stability for carriage of grain in bulk (if applicable) 4) Damage stability calculation check (if applicable) 5) Additional requirements for bulk carrier, ore carrier and combination	

NO.	Test item	Requirements for test results	Remarks
		carrier (if applicable) 6) Trim optimization calculation 7) Trim adjustment energy saving estimation 8) Stowage optimization calculation 9) Optimized stowage plan output	
6.3	Inspection of database for trim performance	The system is to establish the database for trim performance. If it is established by means of model tank test or computational fluid dynamics, it is to at least cover conditions included in loading manual, and each condition is to include draft, speed and trim. If it is established by means of collecting ship's real-time navigation data, it is to include operational and navigational condition data such as trim, draft, speed, propulsive power and rotational speed of main propulsion plant, wind speed and wind direction.	
6.4	Optimal trim optimization calculation function inspection	The system is to be at least able to carry out optimal trim calculation under any condition included in loading manual, and output optimized trim range which can be used for adjusting navigational floating condition.	
6.5	Error alert function	The system is to be able to detect illogical input errors (e.g. the input draft value exceeds the actual maximum scantling draft or it is negative) and alert the user.	
6.6	Optimal energy-saving loading plan	The system is to be able to output optimal energy-saving loading plan and the plan is to comply with objective of optimal navigational state and satisfy requirements for hull strength, intact stability, damage stability, grain stability and	

NO.	Test item	Requirements for test results	Remarks
		a series of safety index of initial navigation.	
6.7	Optimal navigational state fitting function inspection	<p>The system is to be able to set several target trim for loading plan optimization according to user demand.</p> <p>The system is to be able to automatically determine whether its value meets the ship's safety trim requirements. If it meets the requirements, the system is to fit the target trim as far as possible. If data exceeds limit and fitting is impossible, the system is to notify the user and output the plan which is nearest to the target.</p> <p>If not, the system is to remind the user to re-select the trim.</p>	

6.5.3 The software is to be assessed as Category I system in accordance with CCS Guidelines for Assessment of Security and Reliability of Marine Software and comply with the requirements of the standard.

6.5.4 The network system of the product is to be assessed in accordance with CCS Guidelines for Requirement and Security Assessment of Ship Cyber System and comply with the requirements of the standard.

CHAPTER 7 INITIAL SURVEY

7.1 Initial survey for new construction

7.1.1 Confirmation of approved plan, approval of installation process and test programme

For ships intended to apply for the class notation for intelligent energy efficiency management at initial survey, the plan and information required in the Guidelines is to be checked for submittal and returning during the construction process and the implementation of the comments of returned plan is to be confirmed.

There are mainly four process documents and test programmes involving the class notation which need to be approved by the attending surveyor:

- (1) Intelligent energy efficiency system mooring test programme;
- (2) Intelligent energy efficiency system sea trial programme;
- (3) Shaft power monitoring equipment installation process document;
- (4) Flow meter installation process document.

The mooring test programme and sea trial programme are to comply with the requirements of commissioning inspection in 7.1.3 of the Guidelines.

When the flowmeter installation process is approved, it is mainly to confirm whether it meets the relevant requirements of Section 7 “Surveys Related to Class Notations for EOM” of Chapter 6, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. The approval of shaft power meter installation process is to meet the corresponding technical requirements of the manufacturer.

7.1.2 Intelligent energy efficiency management system installation inspection

- (1) The attending surveyor is to verify the certification status of the relevant products.
- (2) The installation position of the flowmeter in hardware facilities is to comply with the requirements of approved fuel system plan and the installation is to comply with Appendix 1 “Requirements for Installation of Flowmeter” in Section 7, Chapter 6, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. In addition, the technical requirements of the manufacturer are to be considered. The installation of hardware such as wind speed and direction indicator, sounding instrument, log, global positioning system, clinometer (if used), engine room monitoring system and tank level system is to comply with the requirements of the corresponding approved plan. The installation of shaft power meter is to comply with the requirements of approved shaft power installation process. Considering the effect of ship deformation and local vibration on performance of shaft power monitoring equipment, the stator installation foundation for shaft power monitoring equipment is to be welded tight, generally welded on ship’s strong components, and welding on hull plating is not allowed.
- (3) The cable laying of the intelligent energy efficiency management system is to comply with the relevant requirements of Section 12 “Cables” of Chapter 2, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships. The requirements of the recommended standard CB/T 3908-2007 “Installation Technology for Cables in Ship” are to be taken into account for the specific laying process.

7.1.3 Intelligent energy efficiency management system commissioning inspection

(1) Mooring test stage

During the mooring test, the consistency and accuracy of the equipment output signal are to be confirmed according to the approved monitoring parameter list. Meanwhile, the specific requirements of the approved energy efficiency on-line monitoring electrical system diagram are

to be met, and a record form is to be formed. The surveyor is to sign and confirm the record form and file it.

After the accuracy of all external signals of intelligent energy efficiency management system has been confirmed, whether the signal channel connected to the intelligent energy efficiency management computer system is good is to be confirmed and the integrity and accuracy of the data received by the computer system is to be confirmed before the sea trial begins.

(2) Sea trial stage

During the sea trial, the main functions of the intelligent energy efficiency management system are to be verified, including:

1) For ships applying for the basic class notation for intelligent energy efficiency management (ship energy efficiency on-line intelligent monitoring), the consistency and accuracy of the monitoring data of the intelligent energy efficiency management system on the main energy-consuming equipment and ship navigation conditions are to be checked, and the energy efficiency/energy consumption and emission data analysis, energy efficiency and energy consumption evaluation functions are to be verified during sea trial. See Appendix 1 Ship Energy Efficiency On-line Intelligent Monitoring Function Checklist for details.

2) For ships applying for the class notation for speed optimization, the functions of speed optimization based on voyage plan and speed optimization based on cost effectiveness formed the system are to be confirmed during sea trial. See Appendix 2 Speed Optimization Function Verification Table for details.

3) For ships applying for the class notation for optimal stowage based on trim optimization, the functions of trim optimization and automatic stowage optimization of optimal stowage system are to be confirmed and the function of providing optimal energy-saving stowage plan by adjusting cargo and ballast water with computer simulating automatic iteration is to be provided during sea trial. See Appendix 3 Optimal Stowage Function Verification Table Based on Trim Optimization for specific functions to be verified.

After the system function is confirmed, the report is to be prepared and signed by the surveyor for confirmation.

7.1.4 Documents provided for ship

The approved procedures and plans and signed reports of mooring test and sea trial are to be provided on board, and the system use and maintenance manual and equipment calibration log are to be kept on board.

7.2 Initial survey for existing ships

7.2.1 The existing ships applying for the class notation for intelligent energy efficiency management is to comply with the requirements of 7.1 Initial survey for new construction of the Guidelines. For ships that have been provided with the intelligent energy efficiency management system and have been operating for at least 3 months, the report for the sea trial part can be provided by the applicant according to the system's historical operation record and submitted to the surveyor for review.

7.2.2 For the existing ships which have been assigned the functional notation of EOM, the application for the class notation for i-ship(E) is to be performed as follows:

(1) The following plan are to be submitted for approval:

1) Composition and explanation of energy efficiency on-line monitoring system, including

following information:

- ① explanation of equipment composition;
- ② monitoring method and monitoring parameter list;
- ③ special explanation on installation processes 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) Procedure and plan, including:

- ① Procedures and plans for data collection/storage;
- ② Procedures and plans for relevant evaluation results/report output;
- ③ Plan for calibration of monitoring device. (the basis for the calibration plan is generally to be provided).

(2) Products are to be approved in accordance with the product inspection requirements in Chapter 6 of the Guidelines.

(3) The test programme is to be submitted to the attending surveyor for review. The software function of the energy efficiency on-line monitoring system may be assigned the class notation for i-ship (E) after being verified according to Appendix 1 Ship Energy Efficiency On-line Intelligent Monitoring Function Checklist.

CHAPTER 8 SURVEY AFTER CONSTRUCTION

8.1 Annual survey

8.1.1 The intervals of annual survey are specified in Section 2, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

8.1.2 The purpose of annual survey is to confirm that since the last survey, the ship intelligent energy efficiency management system and related equipment have been well maintained and comply with the functional requirements of Chapter 5 Intelligent Energy efficiency Management of the Rules for Intelligent Ships.

8.1.3 Survey items

(1) Confirming that there are no unapproved changes to the ship intelligent energy efficiency management system or equipment.

(2) Checking the maintenance records of intelligent energy efficiency management system and equipment, and the software upgrade maintenance records to verify that the daily maintenance of the equipment has been normal since the last survey, and to ensure the effective operation of ship intelligent energy efficiency management system.

(3) Checking the detailed failure records and repair records of intelligent energy efficiency management system equipment, and keeping the damaged parts on board as far as possible for inspection. When replacing the parts with certification requirements in the Rules, the relevant certificates are to be provided.

(4) Visually examining shaft power monitoring equipment, flow meter, wind speed and direction indicator, sounding instrument, log, global positioning system, clinometer (if used), engine room monitoring system and tank level system. The monitoring data and operation records are to be checked to confirm the normal operation of the equipment.

(5) For ships assigned the functional notation for intelligent energy efficiency management, previous service condition of system (including but not limited to collected monitoring data records, automatically generated annual/quarterly/monthly/voyage related index data report and output evaluation conclusion) is to be reviewed to confirm that the system functions are in normal condition.

(6) After the system software function is confirmed, the system software function checklist is to be completed and signed by the surveyor for confirmation. For specific reports, see:

Appendix 1 Ship Energy Efficiency On-line Intelligent Monitoring Function Checklist

Appendix 2 Speed Optimization Function Verification Table (where applicable)

Appendix 3 Optimal Stowage Function Verification Table Based on Trim Optimization (where applicable)

(7) confirming that the monitoring equipment is calibrated according to the calibration interval stipulated in the approved procedures and plans.

8.2 Intermediate survey

8.2.1 The intervals of intermediate survey are specified in Section 2, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

8.2.2 The survey items are the same as those of annual survey.

8.3 Special survey

8.3.1 The intervals of special survey are specified in Section 2, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

8.3.2 The survey items are the same as those of annual survey.

CHAPTER 9 ANNEXED TABLE

9.1 Summary of parameters of energy efficiency equipment

9.1.1 The collected parameters are to comply with Appendix 2 Summary of Parameters of Energy Efficiency Equipment, Section 7, Chapter 6, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

Appendix 1 Ship Energy Efficiency On-line Intelligent Monitoring Function Checklist

Verifying the following functions of ship intelligent energy efficiency system online intelligent monitoring:

1 Data monitoring and collection

Verifying the real-time collection of the following parameter data by the software system during the collection cycle:

No.	Survey items	Results
1	Power, pressure and temperature parameters of main engine, auxiliary engine, boiler and other energy-consuming equipment	
2	Flow parameters of fuel flow meter for main engine, auxiliary engine, boiler and other energy-consuming equipment	
3	Shaft speed, torque and shaft power parameters of the main engine shaft power meter	
4	Wind direction and wind speed parameters of wind speed and direction indicator	
5	Parameters of ship position, course and speed of global positioning system	
6	Parameter of speed through the water of log	
7	Ship heeling and trim angle of electronic clinometer	
8	Water depth value of sounding instrument	
9	Ship draft value of draft measuring system	

2 Energy efficiency/energy consumption and emission data analysis:

Verifying the calculation of the following main energy efficiency index parameters by the software system:

No.	Survey items	Results
1	Ship's energy efficiency operational indicator (EEOI)	
2	Fuel consumption per distance	
3	Fuel consumption per transport work	
4	CO ₂ emission per distance	
5	CO ₂ emission per cargo mass.	

Verifying that the software system displays the following energy consumption indexes:

No.	Survey items	Results
1	Fuel consumption per hour	
2	Fuel consumption per day	
3	Summary of fuel consumption per voyage (leg)	

3 Energy efficiency/energy consumption evaluation:

Verifying that the software system displays the following indexes:

No.	Survey items	Results
1	Automatically judging ship's navigational status such as mooring,	

	maneuvering navigation and constant speed navigation	
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	
3	Outputting static and dynamic energy consumption distribution data and analysis result of energy utilization efficiency	
4	If real-time value of ship's energy efficiency and energy consumption index exceeds set value, the system is to give an alarm	

Place of survey:

Operator:

Attending surveyor:

Time of survey:

Appendix 2 Speed Optimization Function Verification Table

Verifying the following functions of ship intelligent energy efficiency system speed optimization:

1 Speed optimization plan based on voyage plan:

No.	Survey items	Results
1	Automatically calculating navigated distance and navigated time, and forecast arrival time according to residual voyage and current speed	
2	Automatically calculating specific fuel consumption under current speed	
3	Calculating fuel consumption for navigated miles and fuel necessary for residual miles	

2 Speed optimization based on cost effectiveness:

No.	Survey items	Results
1	The system is to provide management functions for all cost involved in ship operation	
2	The system may check each cost during ship operation and evaluate voyage benefits	

Place of survey:

Operator:

Attending surveyor:

Time of survey:

Appendix 3 Optimal Stowage Function Verification Table Based on Trim Optimization

Verifying the following functions of the optimal stowage system based on trim optimization

1 Trim optimization and stowage calculation function:

Verifying the calculation of the following main energy efficiency index parameters by the software system:

No.	Survey items	Results
1	Calculating and displaying the optimal trim under any loading and ballast conditions	
2,	Calculating and displaying the corresponding fore and aft drafts for optimal trim under any loading and ballast conditions	
3	Calculating and displaying the still water bending moment and shear force curve under optimization trim condition, and calculating and displaying the maximum still water bending moment and shear force values and their occurrence position	
4	Calculating the still water bending moment and shear force values and permissible values along the ship length under optimization trim condition, and displaying the percentage of the permissible value. If any permissible value is exceeded, an alarm is to be automatically raised	
5	Calculating and displaying the height of the center of gravity and initial stability height of the ship and correcting free surface effects and comparing such values with the permissible values, where applicable	
6	Calculating and displaying GZ curves and correcting free surface effects	
7	Calculating and achieving the criteria for intact stability, and automatically raising an alarm in case of any permissible criterion being exceeded	
9	Inputting and calculating the permissible inclining moment curves	
10	Calculating and achieving the criteria for the stability for the carriage of grain in bulk, and automatically initiating an alarm in case of any permissible criterion being exceeded	

2 Outputting verification displaying:

No.	Survey items	Results
1	Estimated energy saving percentage corresponding to optimization trim	
2	Optimal stowage plan	

Place of survey:

Operator:

Attending surveyor:

Time of survey: