GUIDANCE NOTES
GD011-2026

INTERNATIONAL SHIP CLASSIFICATION

GUIDELINES FOR SURVEYS OF INTELLIGENT ENERGY EFFICIENCY MANAGEMENT OF SHIPS

2026

Effective from 1 June 2026

Foreword

The International Maritime Organization (IMO) has developed the objectives of greenhouse gas emission reduction strategy and greenhouse gas emission control regulations for ships. The increasingly strict emission control regulations have brought unprecedented challenges to ship design and operation management. With the rising market price of marine fuel, the cost of fuel consumption during ship operation also brings great pressure to the operator. The ship industry is urgently seeking effective measures to improve the energy efficiency of ships, reduce energy consumption and reduce greenhouse gas emissions.

International Ship Classification released the first Rules for Intelligent Ships in December 2015, proposing the intelligent ship architecture of “one platform + N applications”, among which the intelligent management of ship energy efficiency is an important direction for the application of intelligent technology. It is intended to conduct big data analysis by obtaining the status information and data of ship navigation, energy consumption, loading, weather and sea state, and ship itself, and evaluate the ship's energy utilization, navigation state, system and equipment operation state, etc., and propose suggestions for energy efficiency optimization according to the evaluation results, so as to continuously improve the level of ship energy efficiency management. The Rules also specify basic functions and additional functions that intelligent energy efficiency management is to have.

In order to ensure the effective implementation and application of the rules requirements for intelligent energy efficiency management, International Ship Classification developed the Guidelines for Surveys of Intelligent Energy Efficiency Management of Ships in combination with the experience of the research and development of intelligent systems in the industry, on-board applications, drawing and document approval, survey etc. The Guidelines are an integral part of the ISC Rules for Intelligent Ships, covering the following additional contents: technical requirements for intelligent energy efficiency management, drawing and document approval, product approval and inspection, survey of intelligent energy efficiency management class notation.

The Guidelines are developed and updated by ISC and released on http://www.isclass.com. Any comment on the Guidelines can be sent to enquiry@isclass.com.

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CHAPTER 1 GENERAL

1.1 Purpose

1.1.1 The Guidelines specify relevant supplementary requirements for ship energy efficiency on-line intelligent monitoring, speed optimization and optimal stowage based on trim optimization, which may be used as guidance notes for classification societies, 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 ISC i-Ship(E), i-Ship(Es) and i-Ship(Et) notations. Explanations and requirements for such notations are given in 5.2.1, Chapter 5 of ISC Rules for Intelligent Ships.

1.2.2 The i-Ship(E) notation include functions and requirements for the EOM notation. The functions of the EOM notation 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 ISC Rules for Classification of Sea-going Steel Ships.

1.3 Definitions

1.3.1 Definitions and abbreviations in 5.1.7 and 5.1.8, Chapter 5 of ISC Rules for Intelligent Ships apply to the Guidelines.

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 5.4.1, Chapter 5 of ISC 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 Energy efficiency on-line intelligent monitoring system is to satisfy the requirements for category I computer system of ISC 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 and the application for assessment is to be sent to the Marine Product Management Dept. of ISC.

2.2 Data collection

2.2.1 Automatic data collection is to be carried out for main energy-consuming equipment, shaft power monitoring equipment(if any), fuel metering device for main energy-consuming equipment, wind speed and direction indicator, global positioning system, log, electronic clinometer, 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.

Note: The equipment above may be adjusted based on ship type, ship propulsion method, etc.

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 Collected parameters are to comply with 9.1, Chapter 9 of the Guidelines.

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 below automatically:

(1) 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.

2.4.2 For the definition and calculation methods of energy efficiency and emission index listed in 2.4.1, reference may be made to the following documents and information:

(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) ISC 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 The system is to be able to calculate the following carbon intensity indicators and relevant data automatically:

(1) CII;
(2) total annual fuel consumption;
(3) total annual CO2 emission.

Note: The above indicators and data are to be calculated in accordance with IMO 2022 Guidelines on Operational Carbon Intensity Indicators and the Calculation Methods (CII Guidelines, G1) (Resolution MEPC.352(78)). The annual operational carbon intensity indicators (CII) of ships are to be revised by means of the voyage adjustments and correction factors, as set out in 2022 Interim Guidelines on Correction Factors and Voyage Adjustments for CII Calculations (CII Guidelines, G5) (Resolution MEPC.355(78)).

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

(1) electric energy consumption per transport power;
(2) electric energy consumption per navigation distance;
(3) power consumption per hour;
(4) daily power consumption;
(5) power consumption per voyage/leg.

Note: The data from the battery management system and the monitoring systems of major energy-consuming devices may be used for the calculation of power consumption.

2.4.6 The indicators required in the Guidelines may be adjusted based on ship type, ship propulsion method, function needs, etc.

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

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 consumption per unit of time according to ship's fuel 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.

(4) predicting the potential annual operational carbon intensity indicators (CII) of the ship which can be achieved based on the monitoring data of CII;

(5) evaluating and rating the operational carbon intensity of the ship based on the calculation results of CII and relevant data according to 2.4.4 of this chapter and generating and exporting annual reports and relevant supporting information in compliance with rules and regulations automatically for audit, compliance verification, check and inquiry as needed. Relevant reports and supporting information for review and compliance verification of ship's annual operational carbon intensity indicators (CII) are to meet the requirements of IMO Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP).

Notes: The reference lines, reduction factor and evaluation and rating of CII may be calculated according to the following documents respectively:

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

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

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

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 ISC 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, energy consumption and carbon intensity evaluation;

(2) if value of ship's energy efficiency, energy consumption and carbon intensity index exceeds set value, the system is to be able to give an alarm or a warning on limit-exceeding.

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). In addition, general evaluation on ship's annual operational carbon intensity condition is also to be carried out after each calendar 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 (SEEMP) 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 Carbon emission data of the ship are to be collected and monitored in accordance with the requirements of the Ship Energy Efficiency Management Plan (SEEMP) and reports and relevant supporting information in accordance with certain format and requirements are to be generated for audit, compliance verification, check and inquiry.

Note: The requirements for collection and verification of ship's fuel consumption data are set out in 2022 Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP) (Resolution MEPC.346(78)).

2.7.2 Carbon emission data of the ship are to be collected and monitored in accordance with relevant MRV requirements and corresponding reports and supporting evidences in accordance with certain format and requirements are to be generated.

2.7.3 Emission control area (ECA) early warning (where applicable): 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.

2.7.4 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 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, fuel 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 fuel 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 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 ISC 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 5.6, Chapter 5 of ISC 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 ISC 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(Ex) notation, plans and documents are to be submitted for approval in accordance with Chapter 5 of ISC Rules for Intelligent Ships.

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) power, pressure and temperature of main energy-consuming equipment;
(2) fuel consumption of main energy-consuming equipment;
(3) main engine shaft power and rate of revolution;
(4) wind speed and direction;
(5) ship position, course and speed;
(6) speed through the water;
(7) ship inclination angle①;
(8) water depth value;
(9) ship draft value;
(10) surge parameter (when practicable, ship is able to obtain marine meteorological data).

5.2.3 Fuel piping system plan of main energy-consuming equipment: the fuel supply pipes of main energy-consuming equipment are to be fitted with flowmeters which are to be installed at such position that the fuel 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 The installation of the electronic inclinometer is to comply with the following requirements:

(1) The inclination sensor is to be installed horizontally and calibrated by a gradienter.

(2) The three axes of the inclination sensor is to be consistent with the hull coordinate. After completion of installation, the coordinate parameters of the inclination sensor are to be measured according to the hull plans and saved to the electronic inclinometer or recorded in the file for future reference.

Note: The definitions of the X, Y and Z coordinate system of the hull are set out in 8.3.72 of IEC61162-1.

(3) The electronic inclinometer and its inclination sensor are to maintain a minimum safety distance from the magnetic compass device.

5.2.7 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.

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① The ship inclination angle may be monitored by the clinometer or calculated through other parameters.

CHAPTER 6 INSPECTION OF PRODUCTS

6.1 Scope of application

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

6.2 Approval/inspection basis

6.2.1 The product approval and inspection basis of intelligent energy efficiency management system are as follows:

(1) Chapter 3 of PART ONE and Chapters 1 and 2 of PART SEVEN of ISC Rules for Classification of Sea-going Steel Ships.

(2) Chapters 1 and 5 of ISC Rules for Intelligent Ships.

(3) ISC Guidelines for Survey of Intelligent Energy Efficiency Management of 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 ISC to selecting respective samples for type test (marine environmental test, electromagnetic compatibility test).

6.4 Product certification requirements

6.4.1 The certification of the intelligent energy efficiency management system and its components is to meet relevant requirements of 1.10 of Chapter 1 of ISC Rules for Intelligent Ships.

6.5 Type approval

6.5.1 Type test

Prior to the type test of the product, visual and integrity inspection is to be carried out to confirm that the product is free of visual damage with clear identification and complete modules, the product is in conformity with the plans approved and confirm the name and version of the software.

The type test 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	Performance test	Refer to 6.5.2 of the Guidelines for details	
2	Marine environmental test	ISC Guidelines for Type Approval Test of Electric and Electronic Products	If the product contains hardware
3	Electromagnetic compatibility test	ISC 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 ISC. 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**		

NO.	Test item	Requirements for test results	Remarks
monitoring function			
1.1	Data collection function inspection	The system is to be at least able to monitor parameters in real time: (1) power, pressure and temperature of main energy-consuming equipment; (2) fuel consumption of main energy-consuming equipment; (3) main engine shaft power and rate of revolution; (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; (10) surge (if applicable); The data obtained by system is to be consistent with the original input data.	For data input interfaces of the same type, sampling verification can be used if the number is large.
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, emission and carbon intensity index calculation function inspection	Based on the applicable ship type, the system is to be at least able to calculate following energy efficiency, emission and carbon intensity index automatically: (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; (6) CII.	
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;	

NO.	Test item	Requirements for test results	Remarks
		(2) fuel consumption per day; (3) summary of fuel consumption per voyage (leg); (4) total annual fuel consumption; (5) total annual CO_2 emission.	
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; (3) It is to be able to predict the potential annual operational carbon intensity CII indicators of the ship which can be achieved based on the monitoring data of energy efficiency and emission indicators; (4) It is to be able to carry out evaluation and rating of ship's operational intensity based on calculation results of CII and relevant data and generate and output annual reports automatically for audit, examination and inquiry as demanded.	
2.5	Energy consumption distribution function inspection	(1) The system is to be able to obtain energy consumption 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, energy consumption and carbon intensity indexes; If value of ship's energy efficiency, energy consumption and carbon intensity index exceeds set value, the system is to be able to give	

NO.	Test item	Requirements for test results	Remarks
		alarm or warning on limit-exceeding.	
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. In addition, general evaluation on ship's annual operational carbon intensity condition is also to be carried out after each calendar year with output of 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, operational carbon intensity and energy consumption.	
4 Function of assistant management of energy efficiency			
4.1	Inspection of the carbon emission report generating function	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 function inspection	The system is to be able to provide Early warning for residual nautical 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	(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; (2) It is to be able to automatically calculate navigated distance and navigated time; (3) It is to be able to forecast arrival time according to residual voyage and current speed.	
5.1.2	Specific fuel consumption	(1) The system is to automatically	

NO.	Test item	Requirements for test results	Remarks
	calculation function inspection	calculate specific fuel consumption under current speed according to parameters such as speed, main propulsion equipment power and fuel consumption; (2) It is to be able to calculate fuel consumption for navigated miles and fuel necessary for residual miles.	
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 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 ISC 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 carrier (if applicable) 6) Trim optimization calculation 7) Trim adjustment energy saving estimation 8) Stowage optimization calculation 9) Optimized stowage plan output	

NO.	Test item	Requirements for test results	Remarks
6.3	Inspection of database for trim performance	The system is to establish the database for trim performance. (1) 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. (2) 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 a series of safety index of initial navigation.	
6.7	Optimal navigational state fitting function inspection	The system is to be able to set several target trim for loading plan optimization according to user demand. The system is to be able to automatically determine whether its value meets the ship's safety trim requirements. (1) 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. (2) If not, the system is to remind the user to re-select the trim.	

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

6.5.4 The intelligent energy efficiency management system may be implemented in accordance with the requirements for SL0 level cyber security in Chapter 2 of ISC Guidelines for Ship Cyber Security.

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, 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.

The process documents and test programmes which need to be approved by the attending surveyor mainly include:

(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 ISC 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 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 ISC 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.

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 system is good is to be confirmed and the integrity and accuracy of the data received by the 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, emission and carbon emission intensity data analysis and evaluation functions are to be verified during sea trial. See Appendix 1 Ship Energy Efficiency On-line Intelligent Monitoring Function Checklist of the Guidelines 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 of the Guidelines 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 of the Guidelines 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 more than 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 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 of the Guidelines.

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 ISC 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 Appendixes 1-3 of the Guidelines.

(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 ISC 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 ISC 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 the requirements of Appendix 2 Summary of Parameters of Energy Efficiency Equipment, Section 7, Chapter 6, PART ONE of ISC Rules for Classification of Sea-going Steel Ships.

9.1.2 When main energy-consuming equipment of the ship including main engine, diesel engine for auxiliary power generation and boiler use gas/low flashpoint fuel, apart from the requirements of 9.1.1, the energy efficiency equipment are also to meet the requirements of Appendix 4 of the Guidelines.

9.1.3 The collected parameters related to inert gas generator of energy-consuming equipment are listed in Appendix 5 of the Guidelines.

9.1.4 The collected parameters related to battery system are listed in Appendix 6 of the Guidelines.

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

The checklist in this appendix is to be filled in as follows:
(1) For the column of completion status, a "×" within the □ means completed, a "—" means not applicable and a "0" means not completed, something at question or to be further confirmed;
(2) For multiple surveys/tests, fill in the corresponding signature information (time, place and person) respectively.
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	Completion status
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, emission and carbon emission intensity data analysis:
Verifying the calculation of the following main energy efficiency index parameters by the software system:

No.	Survey items	Completion status
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.	□
6	CII	□

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

No.	Survey items	Completion status
1	Fuel consumption per hour	□
2	Fuel consumption per day	□
3	Summary of fuel consumption per voyage (leg)	□
4	Total annual fuel consumption	□
5	Total annual CO_2 emission	□

For pure-battery-powered ships, verifying the calculations and displays of the following energy efficiency/energy consumption indexes:

No.	Survey items	Completion status

1	Electric energy consumption per transport work	☐
2	Electric energy consumption per distance	☐
3	Power consumption per hour	☐
4	Daily power consumption	☐
5	Power consumption per voyage /leg	☐

3 Energy efficiency/energy consumption evaluation:

Verifying that the software system displays the following indexes:

No.	Survey items	Completion status
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 value of ship's energy efficiency, energy consumption and carbon emission intensity 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

The table in this appendix is to be filled in as follows:
(1) For the column of completion status, a "×" within the □ means completed, a "—" means not applicable and a "0" means not completed, something at question or to be further confirmed;
(2) For multiple surveys/tests, fill in the corresponding signature information (time, place and person) respectively.
Verifying the following functions of ship intelligent energy efficiency system speed optimization:

1 Speed optimization plan based on voyage plan:

No.	Survey items	Completion status
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	Completion status
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

The table in this appendix is to be filled in as follows:
(1) For the column of completion status, a "×" within the □ means completed, a "—" means not applicable and a "0" means not completed, something at question or to be further confirmed;
(2) For multiple surveys/tests, fill in the corresponding signature information (time, place and person) respectively.
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	Completion status
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	Completion status
1	Estimated energy saving percentage corresponding to optimization trim	□
2	Optimal stowage plan	□

Place of survey: Operator:
Attending surveyor:
Time of survey:

Appendix 4 Collected Parameters Related to Gas/Low Flashpoint Fuel

Serial No.	Parameters	Unit	Remarks
Main engine			
1	Gas/low flashpoint fuel inlet pressure	MPa	
2	Gas/low flashpoint fuel inlet temperature	℃	
3	Pilot fuel inlet pressure	MPa	Applicable to dual-fuel engine
4	Pilot fuel inlet temperature	℃	Applicable to dual-fuel engine
5	Use gas/low flashpoint fuel		
6	Use oil fuel		Applicable to dual-fuel engine
Diesel engine for power generation			
7	Gas/low flashpoint fuel inlet pressure	MPa	
8	Gas/low flashpoint fuel inlet temperature	℃	
9	Pilot fuel inlet pressure	MPa	Applicable to dual-fuel engine
10	Pilot fuel inlet temperature	℃	Applicable to dual-fuel engine
11	Use gas/low flashpoint fuel		
12	Use oil fuel		Applicable to dual-fuel engine
Boiler			
13	Gas/low flashpoint fuel inlet pressure	MPa	
14	Gas/low flashpoint fuel inlet temperature	℃	
15	Pilot fuel inlet pressure	MPa	
16	Pilot fuel inlet temperature	℃	
17	Use gas/low flashpoint fuel		
18	Use oil fuel		
Gas/low flashpoint fuel tank			
19	Gas/low flashpoint fuel pressure	MPa	
20	Gas/low flashpoint fuel temperature	℃	
21	Liquid level of gas/low flashpoint fuel	cm/m^3	
Gas/low flashpoint fuel flow meter			
22	Gas/low flashpoint fuel flow of main engine	m^3/h	
23	Gas/low flashpoint fuel flow of auxiliary engine	m^3/h	
24	Gas/low flashpoint fuel flow of boiler	m^3/h	
Pilot oil flow meter			
25	Pilot oil flow of main engine	L/h	
26	Pilot oil backflow of main engine	L/h	
27	Pilot oil flow of auxiliary engine	L/h	
28	Pilot oil backflow of auxiliary engine	L/h	

Appendix 5 Collected Parameters Related to Inert Gas Generator

Serial No.	Parameters	Unit	Remarks
1	Oxygen content of inert gas at the exit of inert gas generator	%	
2	Pressure of inert gas at the exit of inert gas generator	MPa	
3	Temperature of inert gas at the exit of inert gas generator	℃	
4	Fuel oil pressure	MPa	
5	Fuel oil temperature	℃	
6	Fuel oil flow rate	L/h	

Appendix 6 Collected Parameters Related to Battery System

Serial No.	Parameters	Unit	Remarks
1	Charge-discharge status of battery system		
2	Voltage of battery system	V	
3	Current of battery system	A	
4	Charge-discharge power of battery system	kW	
5	State of Charge (SOC)	%	
6	State of Health (SOH)	%	
7	Busbar voltage of direct current switchboard	V	
8	Navigation duration or mileage supported by the remaining capacity of battery	h or km/nm	
9	Ambient temperature	℃	
10	Electrical insulation resistance	MΩ	