GUIDANCE NOTES
GD17 – 2018

GUIDELINES FOR SURVEY OF INTELLIGENT CARGO MANAGEMENT OF SHIPS (OIL TANKERS)

2018

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Foreword

With the development of intelligent and information-based ships, the cargo loading and unloading control system which is one of the important parts of oil tanker is becoming more complicated and intelligent, and has become an integrated system combining multiple disciplines including computer, automatic control and electronic information technology as well as ship management. In order to cater to the development of ship cargo loading and unloading control system, enhance cargo loading and unloading efficiency, relieve fatigue of personnel during cargo loading and unloading, increase safety of ship and personnel, shorten ship stay time in port and achieve the fundamental objective of improving economic returns, ISC worked out the Guidelines for Survey of Intelligent Cargo Management of ships (Oil Tankers).

As a part of ISC Rules for Intelligent Ships (hereinafter referred to as "the Rules"), the Guidelines aim at oil tankers, providing supplementary instructions and detailed provisions in addition to the contents of management of intelligent cargo in Chapter 6 of the Rules, and specifying technical requirements, survey and test requirements which are applicable to classification survey of cargo and cargo tank monitoring alarm and assistant decision-making systems, intelligent cargo stowage system and automatic cargo loading and unloading system of ships (oil tankers). In addition to complying with the requirements of the Guidelines, approval and survey in this regard are to meet the provisions of ISC Rules for Intelligent Ships and Rules for Classification of Seagoing Steel Ships.

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Chapter 1 General

1.1 Purpose

1.1.1 The Guidelines provide technical requirements for cargo and cargo tanks monitoring alarm and assistant decision-making systems, intelligent cargo stowage system and automatic cargo loading and unloading system when an oil tanker is to be assigned with the functional notations of intelligent cargo management. The Guidelines can be used as a guidance document for ISC surveyors, manufacturers, service providers and ship management companies.

1.2 Application

1.2.1 The Guidelines are applicable to ships (oil tankers[①]) applying for functional notations C and/or C1 for intelligent cargo management system, as defined in Chapter 6 of ISC Rules for Intelligent Ships.

1.2.2 The Guidelines are applicable to approval and survey of cargo and cargo tank monitoring alarm and assistant decision-making systems, intelligent cargo stowage system and automatic cargo loading and unloading system relating to intelligent cargo management.

1.3 General requirements

1.3.1 Each system of intelligent cargo management is to comply with related requirements in Chapters 1 and 6 of Rules for Intelligent Ships.

1.3.2 Related computer systems are to comply with requirements for the computer system of category II in Chapter 2, PART SEVEN of Rules for Classification of Seagoing Steel Ships.

1.3.3 The systems of intelligent cargo management are normally supplied by the main power, and will automatically be switched to standby power in case of failure of main power supply. Uninterrupted power supply (UPS) may be used as the standby power, with a capacity of maintaining power supply for at least 30 minutes.

1.3.4 Approved indicative signals or information (for pre-warning, alarming) and suggested operation (from the assistant decision-making system) of the intelligent cargo management system are to be capable of being acknowledged and reset only from the same place where cargo control is performed, in addition, such information is to be displayed in the navigation bridge.

1.3.5 Intelligent cargo management system may be a whole new system (independent of conventionally designed loading computer system and related system, already fitted on board), or may be a system based on the conventionally designed loading computer system and related system already fitted on board and to perform data acquisition utilizing the hardware/sensors already available. The intelligent cargo management system is to be so designed that one single fault will not generate other faults and the risk caused by the single fault is to be as low as possible.

1.3.6 For automatic cargo loading and unloading system, in addition to complying with the requirements of the Guidelines, ship operators are to consider special requirements of the Administration and port authority.

① Oil tankers defined in paragraph 2.1.3(16), Chapter 2, PART ONE of ISC Rules for Classification of Seagoing Steel Ships, except for combination ships.

Chapter 2 Requirements for Cargo and Cargo tank Monitoring Alarm and Assistant Decision-making Systems

2.1 Application

2.1.1 This Chapter is applicable to intelligent ships to be granted with functional notation C.

2.2 Functional requirements

Cargo and cargo tank monitoring alarm and assistant decision-making system is to include, but not limited to, the following functions:

(1) monitoring the status of cargo, cargo tanks and ballast tanks on board ships according to the different characteristics of different cargoes;

(2) analyzing and identifying the status parameters monitored;

(3) self-monitoring function;

(4) early warning function to provide relevant assistant decision-making which will make the operator clearly understand the current working condition and make preparation in advance for the possible abnormal conditions, or prevent occurrence of abnormal conditions;

(5) alarming function to analyze the abnormal data monitored and provide corresponding assistant decision-making so that the operator can promptly take relevant corrective measures.

2.3 Parameters to be monitored

Cargo and cargo tank monitoring alarm and assistant decision-making systems are at least to monitor the following parameters:

(1) liquid level in cargo tanks;

(2) cargo temperature in cargo tanks (applicable to cargo tanks fitted with heating equipment);

(3) pressure in cargo tanks;

(4) oxygen content in cargo tanks (if relevant monitoring equipment is installed);

(5) liquid level in ballast tanks;

(6) concentration of flammable gas in pump room (if applicable);

(7) concentration of flammable gas in ballast tanks, void spaces and double bottom tanks adjacent to cargo tanks (if applicable);

(8) liquid level of bilge water in pump room.

2.4 Display function

Cargo and cargo tank monitoring alarm and assistant decision-making system is at least to display the following parameters:

(1) liquid level in cargo tanks;

(2) cargo temperature in cargo tank (applicable to cargo tanks fitted with heating equipment);

(3) pressure in cargo tanks;

(4) oxygen content in cargo tanks (if relevant monitoring equipment is installed);

(5) liquid level in ballast tanks;

(6) concentration of flammable gas in pump room (if applicable);

(7) concentration of flammable gas in ballast tanks, void spaces and double bottom tanks adjacent to cargo tanks (if applicable).

2.5 Early-warning function

Cargo and cargo tank monitoring alarm and assistant decision-making system is to have corresponding early-warning function. With this early-warning function, this system is to be capable of releasing early-warning signals according to the current working condition and with the overall consideration given to the variation trend of working conditions, to caution the operators of the possible abnormal conditions and provide the operators with assistant decisions, so that the operators can have enough time to make preparation in advance to prevent or postpone the occurrence of abnormal situations, and possible damage to be caused by the possible abnormal situations may be reduced or eliminated. The early-warning is to be set for variation trend of at least the following parameters:

(1) liquid level in cargo tanks;

(2) cargo temperature in cargo tanks (applicable to cargo tanks installed with heating equipment);

(3) pressure in cargo tank;

(4) oxygen content in cargo tank (if relevant monitoring equipment is installed);

(5) liquid level in ballast tank;

(6) concentration of flammable gas in pump room (if applicable);

(7) concentration of flammable gas in ballast tank, void spaces and double bottom tanks adjacent to cargo tanks (if applicable).

2.6 Alarming function

When any of the following abnormal conditions is detected, cargo and cargo tanks monitoring alarm and assistant decision-making system is to release an alarm:

(1) abnormal change of liquid level in cargo tanks, such as abnormal increase or decrease of liquid level in cargo tanks;

(2) high liquid level/overflow liquid level in cargo tanks;

(3) too high cargo temperature in cargo tanks (applicable to cargo tanks fitted with heating equipment);

(4) too low cargo temperature in cargo tanks (applicable to cargo tanks fitted with heating equipment);

(5) too high pressure in cargo tanks;

(6) too low pressure in cargo tanks;

(7) oxygen content higher than 8% in cargo tanks (if relevant monitoring equipment is installed);

(8) abnormal change of liquid level of ballast tanks, such as abnormal increase or decrease of liquid level in the ballast tanks;

(9) high liquid level in ballast tanks;

(10) high liquid level in void spaces (including double bottom tanks)within cargo area;

(11) high concentration of flammable gas in pump room (if applicable);

(12) high concentration of flammable gas in ballast tanks, void spaces and double bottom tanks adjacent to cargo tanks (if applicable);

(13) high level of bilge water in pump room.

2.7 Ability of Assistant Decision-making

This system is to have ability of data analyzing and processing, be capable of analyzing① detected data, releasing relevant early warning and alarm, and providing corresponding reasonable assistant decisions②.

① For example, when abnormal change of liquid level in cargo tank(s) and/or ballast tank(s) occurs, together with the hydrocarbon detection system, this system is to be able to make judgement if liquid leakage and/or transfer has happened between different cargo tanks, between different ballast tanks or between cargo tank(s) and ballast tank(s) after comprehensive consideration and comparison on the liquid level changes in cargo tanks and ballast tanks.

② Overall consideration is to be given to the ability of assistant decision-making described in this Chapter and paragraph 3.7 in Chapter 3.

Chapter 3 Requirements for Intelligent Cargo Loading System

3.1 Application

3.1.1 This Chapter is to apply to the intelligent ships to be granted with the functional notation C.

3.2 Functional requirements

The intelligent cargo loading system is an intelligent system, which can give the best cargo loading and operation solutions through automatic optimization, comprehensive consideration of different condition factors, collecting all data relating to cargo handling and ballast operation using different sensing devices (such as sensors, etc.) and making related calculation. In general, following factors are to be taken into consideration:

(1) safety, environmental protection and energy efficiency;

(2) ship floating condition, stability, strength, optimum trim(if applicable);

(3) capacity of cargo tanks and level of cargo;

(4) loading and unloading sequence, flow rate and duration;

(5) ballast water operation;

(6) ship's operation, charter contracts, ports and terminals;

(7) remote identification and tracking of cargos(if applicable);

(8) route, weather and hydrology;

(9) categories and grades of cargos;

(10) cargo density, temperature and other related characteristics;

(11) cargo loading plan (including related system, pumps, etc.);

(12) maximum allowable pressure (system, cargo tanks and shore receiving device);

(13) venting requirements;

(14) prevention of possible electrostatic damage to hull and cargo;

(15) loading rate;

(16) temperature control procedure(if applicable);

(17) cargo tank stripping procedure;

(18) minimum height of bridge;

(19) limit of UKC(Under Keel Clearance) for canals, ports and terminals;

(20) special preventive measures for specific cargoes.

3.3 Parameters to be monitored

In addition to the parameters listed in 2.3 of Chapter 2, the intelligent cargo loading system is also to monitor the following parameters:

(1) inert gas system, if applicable:

- status of inert gas device
- status of shore inert gas supply;

(2) status of cargo system, including, but not limited to:

- status of remote controlled valves
- status of cargo pumps (including stripping pumps)
- revolving speed or stroke number of cargo pumps (including stripping pumps) or opening of flow-control remote controlled valves
- inlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo piping (including stripping piping), if applicable;

(3) vapor pressure in cargo vapor emission control system, if applicable;

(4) status of ballast water system, including, but not limited to:

- operation status of ballast water treatment device, if applicable
- status of remote controlled valves
- status of ballast pumps
- speed of ballast pumps or opening of flow-control remote controlled valves
- inlet pressure of ballast pumps
- outlet pressure of ballast pumps;

(5) main engine power output;

(6) ship speed;

(7) ship floating status;

(8) ship stability;

(9) still water bending moment and shear force.

3.4 Display function

In addition to the parameters listed in 2.4 of Chapter 2, the intelligent cargo loading system is also display the following parameters:

(1) status of inert gas system, if applicable:

- status of inert gas device (normal operation/stopped/failure)
- status of shore inert gas supply (supply stopped/normal supply);

(2) status of cargo system, including, but not limited to:

- status of remote controlled valves (open/close/failure);
- status of cargo pumps, including stripping pumps (in operation/stopped/standby/failure);;
- revolving speed or stroke number of cargo pumps (including stripping pumps) or opening of flow-control remote controlled valves
- revolving speed or stroke number of cargo pumps (including stripping pumps) or opening of flow-control remote controlled valves as expected by the assistant decision;
- inlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo piping (including stripping piping), if applicable

(3) vapor pressure in cargo vapor emission control system, if applicable;

(4) status of ballast system, including, but not limited to:

- operation status of ballast water treatment device, if applicable

- status of remote controlled valves (open/close/failure)
- status of ballast pumps (in operation/stopped/standby/failure)
- speed of ballast pumps or opening of flow-control remote controlled valves
- speed of ballast pumps or opening of flow-control remote controlled valves as expected by the assistant decision
- inlet pressure of ballast pumps
- outlet pressure of ballast pumps;

(5) main engine power output;

(6) ship speed;

(7) ship floating status;

(8) ship stability;

(9) still water bending moment and shear force.

3.5 Early-warning function

Intelligent cargo loading system is to have appropriate early-warning function. With this early-warning function, this system is to be capable of releasing early-warning signals according to the current working condition and with overall consideration given to the variation trend of working conditions, to caution the operators of the possible abnormal conditions and provide the operators with assistant decisions, so that the operators can have enough time to make preparation in advance to prevent or postpone the occurrence of abnormal situations, and possible damage to be caused by the possible abnormal situations may be reduced or eliminated. In addition to the parameters listed in 2.5 of Chapter 2, corresponding early-warning is also to be set for the variation trend of the following parameters:

(1) inert gas system, if applicable:
- oxygen content in inert gas;

(2) liquid cargo system, including, but not limited to:
- inlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo pumps (including stripping pumps)
- outlet pressure of cargo piping (including stripping piping), if applicable;

(3) vapor pressure in cargo vapor emission control system, if applicable;

(4) ballast system, including, but not limited to:
- inlet pressure of ballast pumps
- outlet pressure of ballast pumps;

(5) ship floating status;

(6) ship stability;

(7) still water bending moment and shear force.

3.6 Alarming function

In addition to the abnormal situations listed in 2.6 of Chapter 2, the intelligent cargo loading system is also to release alarms when any of the following situations is detected:

(1) failure of inert gas system;

(2) failure of cargo system, including, but not limited to:
- failure of remote control valves

- failure of cargo pumps (including stripping pumps)
- too low inlet pressure of cargo pumps (including stripping pumps)
- too high outlet pressure of cargo pumps (including stripping pumps)
- too low outlet pressure of cargo piping (including stripping piping)
- too high outlet pressure of cargo piping (including stripping piping)

(3) cargo vapor emission control system, if applicable, including, but not limited to:

- vapor pressure too high
- vapor pressure too low (alarming pressure is not lower than atmospheric pressure for oil tankers with inerted cargo tanks);

(4) failure of ballast system, including, but not limited to:

- failure of ballast water treatment device, if applicable
- failure of remote control valves
- failure of ballast pumps
- inlet pressure too low of ballast pumps
- outlet pressure too high of ballast pumps;

(5) ship floating condition abnormal;

(6) ship stability abnormal;

(7) still water bending moment and shear force too high;

(8) initial loading rate abnormal.

3.7 Ability of Assistant Decision-making

This system is to have ability of the data analysis and processing, be capable of analyzing detected data, releasing relevant early-warning and providing corresponding reasonable assistant decisions; at the same time, this system is also to be capable of promptly and accurately providing reasonable suggestions and operations, based on all the real-time data collected. For example, in the process of cargo loading and ballast water transferring, this system is to be capable of making judgment and calculation according to the real-time parameters collected, such as loading rate, level in cargo tank(s), pressure in cargo tank(s), working conditions of ballast pumps (speed, displacement), level in ballast tank(s), ship's floating condition and/or hull structural strength, etc., releasing an early warning based on the present loading rate before the cargo in cargo tank(s) reaches an alarming situation of high level/high-high level so that the operator can make related preparation in advance, giving out the next working conditions (for example, to adjust the pump to an expected rotating speed, to adjust the flow-control remote controlled valve to an expected opening), and providing the most optimal procedure without endangering ship's floating conditions, stability and structural strength.

Chapter 4 Requirements for Automatic Cargo Loading and Unloading System

4.1 Application

4.1.1 This chapter is to apply to intelligent ships to be granted with CI functional notations, which is also to meet with requirements for the functional notation C, as described in Chapter 2 and Chapter 3, and at the same time its cargo system is to be capable of automatically performing cargo loading and unloading.

4.2 Functional requirements

Automatic cargo loading and unloading system is to have all monitoring, display, alarming and assistant decision-making functions required for intelligent cargo loading system as described in Chapter 3 of the Guidelines. On this basis, this system is also to have ability of independent decision-making and control function(s) to implement automatic cargo loading and unloading, including preparations and finishing work that is necessary for cargo loading and unloading, such as:

- cargo tank inerting;
- cargo tank stripping;
- cargo tank washing.
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4.3 Parameters to be monitored

Automatic cargo loading and unloading system is to be capable of monitoring at least the following parameters:

(1) cargo tank level;

(2) cargo temperature in cargo tanks;

(3) pressure in cargo tanks;

(4) oxygen content in cargo tanks;

(5) ballast water tanks level;

(6) flammable gas concentration in pump room;

(7) flammable gas concentration in ballast tanks, void spaces and double bottom tanks in adjacent to cargo tanks;

(8) pump room bilge water level;

(9) status of crude oil washing equipment;

(10) inert gas system, including, but not limited to:

- status of inert gas equipment;
- status of shore inert gas supply;

(11) cargo system status, including, but not limit to:

- status of remote controlled valves
- status of cargo pumps (including stripping pumps)
- revolving speed or stroke number of cargo pumps(including stripping pumps) or opening of flow-control remote controlled valves
- cargo pumps(including stripping pumps) inlet pressure
- cargo pumps(including stripping pumps) outlet pressure
- cargo piping (including stripping piping) outlet pressure(if applicable);

(12) vapour pressure in cargo vapour emission control system;

(13) status of ballast water system, including, but not limited to:

- operation status of ballast water treatment device (if applicable);
- status of remote controlled valve;
- status of ballast pump
- revolving speed of ballast pump or opening of flow-control remote controlled valves
- ballast pump inlet pressure
- ballast pump outlet pressure;

(14) main engine power output;

(15) ship speed;

(16) ship floating condition;

(17) ship stability;

(18) still water bending moment and still water shear force.

4.4 Display function

Automatic cargo loading and unloading system is to display at least the following parameters:

(1) cargo tank level;

(2) cargo temperature in cargo tanks;

(3) pressure in cargo tanks;

(4) oxygen content in cargo tanks;

(5) ballast tank level;

(6) flammable gas concentration in pump room;

(7) flammable gas concentration in ballast tanks, void spaces and double bottom tanks in adjacent to cargo tanks;

(8) status of crude oil washing equipment;

(9) status of inert gas system;

(10) cargo piping (including stripping piping) outlet pressure;

(11) status of inert gas system:

- status of inert gas system(normal operation/stopped/failure);
- status of shore inert gas supply (supply stopped/normal supply);

(12) cargo system condition, including, but not limited to:

- status of remote controlled valve (open/close/failure)
- status of cargo pumps(including stripping pumps) (in operation/stopped/failure)
- revolving speed or stroke number of cargo pumps(including stripping pumps) or opening of flow-control remote controlled valve
- expected revolving speed or stroke number of cargo pumps(including stripping pumps) or expected opening of flow-control remote controlled valve by assistant decisions
- cargo pumps(including stripping pumps) inlet pressure
- cargo pumps(including stripping pumps) outlet pressure
- cargo piping (including stripping piping) outlet pressure;

(13) vapour pressure in cargo vapour emission control system;

(14) status of ballast water system, including, but not limited to:

- operation status of ballast water treatment device (if applicable);
- status of remote controlled valve (open/close/failure)
- status of ballast pumps(in operation/stopped/standby/failure)
- revolving speed of ballast pump or opening of flow-control remote controlled valve

- expected revolving speed of ballast pump or expected opening of flow-control remote controlled valve by assistant decisions
- ballast pumps inlet pressure
- ballast pumps outlet pressure;

(15) main engine power output;

(16) ship speed;

(17) ship floating condition;

(18) ship stability;

(19) still water bending moment and still water shear force.

4.5 Early-warning function

Automatic cargo loading and unloading system is to have appropriate early-warning function. With this early-warning function, this system is to be capable of releasing early-warning signals according to the current working condition and with the overall consideration given to the variation trend of working conditions to caution the operators of the possible abnormal conditions and providing the operators with assistant decisions, so that the operators can have enough time to make preparation in advance to prevent or postpone the occurrence of abnormal situations, and possible damage to be caused by the possible abnormal situations may be reduced or eliminated. Or, when a certain time period is passed after releasing of an early warning and there is no operator interrupting/acknowledging, this system is to automatically operate according to the decisions generated to prevent occurrence of abnormal situations. Corresponding early-warning is to be set for the variation trend of the following parameters:

(1) cargo tank level;

(2) cargo temperature in cargo tanks;

(3) pressure in cargo tanks;

(4) oxygen content in cargo tanks;

(5) ballast water tank level;

(6) flammable gas concentration in pump room;

(7) flammable gas concentration in ballast tanks, void spaces and double bottom tanks in adjacent to cargo tanks;

(8) inert gas system:

- oxygen content of inert gas;

(9) cargo system, including, but not limited to:

- cargo pumps(including stripping pumps) inlet pressure
- cargo pumps(including stripping pumps) outlet pressure
- cargo piping (including stripping piping) outlet pressure;

(10) vapour pressure in cargo vapour emission control system;

(11) ballast water system, including, but not limited to:
- ballast pump inlet pressure
- ballast pump outlet pressure;

(12) ship floating condition;

(13) ship stability;

(14) still water bending moment and still water shear force.

4.6 Alarming function

The automatic cargo loading and unloading system is to release alarms when any of the following situations is detected:

(1) abnormal change of cargo tank level, e.g. abnormal increase or decrease of tank level;

(2) cargo tank high level/overflow level;

(3) cargo temperature too high in cargo tanks (applicable to cargo tanks fitted with heating equipment);

(4) cargo temperature too low in cargo tanks (applicable to cargo tanks fitted with heating equipment);

(5) too high pressure in cargo tanks;

(6) too low pressure in cargo tanks;

(7) oxygen content in cargo tanks higher than 8%;

(8) abnormal change of ballast tank level, e.g. abnormal rise or decrease of tank level;

(9) high ballast tank level;

(10) high level in void spaces of cargo area(including double bottom tanks);

(11) high concentration of flammable gas in pump room;

(12) high concentration of flammable gas in ballast tanks, void spaces and double bottom tanks in adjacent to cargo tanks;

(13) high level of pump room bilge water;

(14) failure of inert gas unit;

(15) failure of cargo system, including, but not limited to:

- failure of remote controlled valve
- failure of cargo pumps(including stripping pumps)
- liquid cargo pump (including stripping pump) inlet pressure too low
- liquid cargo pump (including stripping pump) outlet pressure too high
- liquid cargo piping(including stripping piping) outlet pressure too low
- liquid cargo piping(including stripping piping) outlet pressure too high;

(16) liquid cargo vapour emission control system, including, but not limited to:

- too high vapour pressure;
- too low vapour pressure (for oil tankers with inerted cargo tanks, alarm pressure not lower than atmospheric pressure)

(17) failure of ballast system, including, but not limited to:

- failure of ballast water treatment device;
- failure of remote controlled valve
- failure of ballast pump
- ballast pump inlet pressure too low
- ballast pump outlet pressure too high

(18) abnormal floating condition;

(19) abnormal stability;

(20) too high still water bending moment and still water shear force;

(21) abnormal initial loading rate;

(22) failure of crude oil washing unit.

4.7 Ability of autonomous decision-making

4.7.1 Based on the commands received, this system is to be capable of utilizing all the data received,

calculating and generating the most optimal loading condition and operation, and automatically controlling related equipment/systems/units/parts to perform any one of the following operations:

(1) cargo tank inerting;

(2) cargo loading;

(3) ballasting;

(4) cargo unloading;

(5) de-ballasting;

(6) cargo tank stripping;

(7) cargo tank washing.

4.7.2 This system is also to be capable of autonomously complete the following series of operations:

(1) the whole series of operations necessary from light ship arriving at port to full load departure, including cargo tanks inerting, cargo loading (including ballasting/de-ballasting which may be required at the same time)

(2) the whole series of operations necessary from full load arriving at port to ballast departure, including cargo unloading(including ballasting/de-ballasting which may be required at the same time), cargo tank stripping, cargo tank washing.

4.7.3 This system is also to have the following safety control functions:

(1) automatically emergency shut-down , in case of failure(s);

(2) manually emergency shut-down.

Chapter 5 Requirements for Examination of Drawings and Documents

5.1 Examination of drawings and documents

5.1.1 Drawings and documents are to be submitted by the stakeholders of the computer system involved in the intelligent cargo management system according to table 5.1.1, and to be witnessed and tested by ISC surveyors.

Summary of Drawings and Documents to be Submitted and Tests and Trials① Table 5.1.1

No.	Drawings and documents to be submitted	Stakeholders				ISC					
		Supplier Involved	System Integrator Involved	Ship Designer Involved	Owner Involved	Product Plan Approval	Product Type Approval	Ship Plan Approval	Unit Batch Inspection	Initial Survey	Survey after Construction
1	Software quality plan	○	×			Ⓐ	Ⓒ		Ⓒ		
2	Risk assessment report		×			Ⓐ	Ⓒ		Ⓒ		
3	System operation manual	○	×		Ⓒ	Ⓒ	Ⓒ	Ⓒ	Ⓒ	Ⓒ	
4	Software module functional description	○	×			Ⓒ	Ⓒ		Ⓒ		
5	System description (including detailed description of hardware configuration, description of system function and description of system self-monitoring)	○	×		Ⓒ	Ⓒ	Ⓒ	Ⓒ	Ⓒ	Ⓒ	
6	Block diagram of hardware and peripheral configuration (showing main unit/module of system)	○	×			Ⓒ	Ⓒ		Ⓒ		
7	System wiring connection diagram	○	×			Ⓒ	Ⓒ		Ⓒ		
8	Technical specifications of hardware and peripherals	○	×			Ⓒ	Ⓒ		Ⓒ		
9	Evidence of verification of software code	○	×				Ⓒ		Ⓒ		

① Refer to Section 6, Chapter 2, PART SEVEN of the existing Rules for Classification of Sea-going Steel Ships and Chapter 8 of Guidelines for Safety and Reliability Assessment for Marine Software.

No.	Drawings and documents to be submitted	Stakeholders				ISC					
		Supplier Involved	System Integrator Involved	Ship Designer Involved	Owner Involved	Product Plan Approval	Product Type Approval	Ship Plan Approval	Unit Batch Inspection	Initial Survey	Survey after Construction
10	Evidence of functional tests for elements included in system of Category II at the level of software module, sub-system and system tiers	×	×				Ⓒ		Ⓒ		
11	Type test program (including function tests and failure tests)	○	×				Ⓐ		Ⓒ		
12	Type test report (including function tests and failure tests)	○	×				ⒶⒸ		Ⓒ		
13	Sensor arrangement plan (pressure, temperature, level, etc.)			×	Ⓒ			Ⓒ		Ⓒ	
14	Shipboard system diagram (including power supply)			×	Ⓒ			Ⓐ		Ⓒ	
15	Monitoring and alarm items list		○	×	Ⓒ			Ⓐ		Ⓒ	
16	Shipboard system arrangement plan			×	Ⓒ			Ⓐ		Ⓒ	
17	Functional description of software	○	×		Ⓒ				Ⓒ		
18	List and version No. of software installed in system	○	×		Ⓒ				Ⓒ	Ⓒ	Ⓒ
19	Software maintenance and user manual (including necessary procedures for software and hardware change management)	○	×		Ⓒ				Ⓒ	Ⓒ	Ⓒ
20	List of interfaces between system and other ship systems	○	×		Ⓒ				Ⓒ	Ⓒ	
21	List of standards used for data links	○	×		Ⓒ				Ⓒ		

No.	Drawings and documents to be submitted	Stakeholders				ISC					
		Supplier Involved	System Integrator Involved	Ship Designer Involved	Owner Involved	Product Plan Approval	Product Type Approval	Ship Plan Approval	Unit Batch Inspection	Initial Survey	Survey after Construction
22	Factory acceptance test program	○	×						Ⓐ		
23	Factory acceptance test report	○	×						ⒶⒸ		
24	System installing procedure (if any)		×	○	Ⓒ					Ⓐ	Ⓐ
25	Test program for on board tests (includes wireless network testing)		×	○	Ⓒ					Ⓐ	Ⓐ
26	On board test report			×	Ⓒ					ⒶⒸ	ⒶⒸ
27	Updated software registry form		×		○				Ⓒ	Ⓒ	Ⓒ
28	Software modification effect analysis record and test report		×		○				Ⓒ	Ⓒ	Ⓒ

Note 1: The symbols used in the table and their meanings are as follows:

1) ⒶSubmitted to ISC for approval ⒸProvided to ISC for information ⒸTo be witnessed by ISC surveyors

2) Ⓒ Approved documents/documents for information to be submitted; × To be submitted/carried out; ○ To be submitted/carried out where necessary.

Note 2: The above mentioned items give the general requirements for the content to be covered in the documents submitted by the stakeholders, and the stakeholders may submit the applicable part of the above contents according to the actual situation.

Note 3: ⒸThe approved documents/documents for information, take item 3 System Operation Manual for example, are to be submitted by the system integrator or the supplier to ISC for information, and such documents with ISC seals ("NOTED") are to be provided to the ship designer, owner, ship plan approval, on-site inspection and other parties for use as supporting documents or background documents.

Note 4: ⒶⒸ The surveyor may examine test report, or witness test, or both examine test report and witness test.

Note 5: For ×and ○ in each line, it is suggested to be submitted by ×, or ○ can also submit. Submission by either of them is sufficient. For example, for Item 3: System Operation Manual, submission by either system supplier or integrator is acceptable.

Chapter 6 Product Approval and Survey Requirements

6.1 Application

6.1.1 The Chapter applies to the product approval and survey of the cargo and cargo tank monitoring alarm and decision support system, intelligent cargo stowage system and automatic cargo loading and unloading system.

6.2 Approval/survey criteria

6.2.1 Relevant requirements of Chapter 3 of PART ONE and PART SEVEN concerning computer systems of category II in ISC Rules for Classification of Sea-Going Steel Ships.

6.2.2 Chapters 1 and 6 of ISC Rules for Intelligent Ships and requirements of the Guidelines.

6.3 Selection of typical samples

6.3.1 The selection of test samples is to be representative and to cover the products for which type approval is applied.

6.3.2 Where the major elements (e.g. computer, display) of products are provided by different manufacturers, ISC may consider to take the samples for type test (including test for marine environment, electromagnetic compatibility test etc.) respectively according to the above principles.

6.4 Certification requirements for products

6.4.1 For products to be approved/surveyed, the certification requirements in Table 6.4.1 are to be met.

Certification Requirements for Marine Products Table 6.4.1

No.	Product name	Type of certificate		Approval mode				Plan approval	Remarks
		C/E	W	DA	TA-B	TA-A	WA	PA	
1	Cargo and cargo tank monitoring alarm and assistant decision-making systems	X	—	—	X	—	—	X	Apply for function notation C or Cl
1.1	Computer	—	X	—	X[3]	—	—	X	
1.2	Display	—	X	—	X[3]	—	—	X	
1.3	Uninterrupted Power Supply (UPS)	—	X	—	X[3]	—	—	X	
1.4	Programmable controller	—	X	—	X	—	—	X	
1.5	Sensor/monitoring equipment	O	X	—	X	—	—	X	
2	Cargo stowage system	X	—	—	X	—	—	X	Apply for function notation C or Cl
2.1	Computer	—	X	—	X[3]	—	—	X	
2.2	Display	—	X	—	X[3]	—	—	X	
2.3	Uninterrupted Power Supply (UPS)	—	X	—	X[3]	—	—	X	
2.4	Programmable controller	—	X	—	X	—	—	X	
2.5	Sensor/monitoring equipment	O	X	—	X	—	—	X	
3	Automatic cargo loading and unloading system	X		—	X	—	—	X	Apply for function notation Cl
3.1	Computer	—	X	—	X[3]	—	—	X	
3.2	Display	—	X	—	X[3]	—	—	X	
3.3	Uninterrupted Power Supply (UPS)	—	X	—	X[3]	—	—	X	
3.4	Programmable controller	—	X	—	X	—	—	X	

3.5	Sensor/monitoring equipment	O	X	—	X	—	—	X	

Symbols:

1) C – Marine Product Certificate; E – Equivalence document; W – Manufacturer's document; X – Applicable; O – Optional.

2) DA – Design approval; TA-B – Type approval B; TA-A – Type approval A; WA – Works approval; PA – Plan approval.

3) X^3: If certification requirements for purchased parts cannot be satisfied, a complete type test is to be carried out for the integral product.

6.5 Type approval

6.5.1 The type test programme is to be submitted to the surveyor in advance for approval, including preparation basis, test items, selection of sample, test location, etc. The test organization and its testing capability are to be approved by ISC. Refer to Guidelines for Approval of Testing Organization for Marine Products (GD08-2015) for requirements for approval.

6.5.2 Type test is to cover the test items listed in Table 6.5.2.

Type Test Items **Table 6.5.2**

No.	Test items	Requirements for test result	Remarks
1	Inspection of appearance identification and completeness	To confirm that there is no damage of the appearance of product, the identification is clear and modules of product are complete	
2	Function test	See Table 6.5.3 for details	
3	Marine environment test	ISC Guidelines for Type Approval Test of Electric and Electronic Products	To determine the test items according to the product utilization environment
4	Electromagnetic compatibility test	ISC Guidelines for Type Approval Test of Electric and Electronic Products	

6.5.3 The function test is to be capable of confirming that the system complies with the technical requirements of the approved drawing/information and the Guidelines. The function test is to cover those specified in Table 6.5.3.

Detailed test method is to be developed in combination with the product technical documents (technical conditions, specifications) approved by ISC. Decision support function may be verified by means of environmental simulation and the testing plan is to be confirmed by the surveyor.

Items of Function Test **Table 6.5.3**

No.	Test items	Requirements for test result	Remarks
I. General functions			
1	Inspection of manipulation-proofing function	Protective measures are to be provided to prevent the operator making unwitting or unauthorized amendments to the procedure and the update of procedure or software is to be recorded.	
2	Inspection of data communication failure alarming function	The system is to be capable of making continuous self-monitoring of communication lines and alarm is to be initiated once abnormal situation occurs (such as loss of data, data error).	
3	Inspection of the data acquisition function	To verify the completeness and accuracy of the data to be monitored and indicated.	To provide data acquisition interfaces with access to standard signal (e.g. temperature signal, pressure signal, flux signal) and to

No.	Test items	Requirements for test result	Remarks
			observe the data indication; data acquisition interfaces of the same type may be verified by sampling if the number of interfaces is large.
4	Inspection of the format of monitoring parameter	The record of monitoring parameter is at least to include the following information: (1) basic information of monitored equipment; (2) method for processing measuring data; (3) Date and time information.	
5	Inspection of the data storage function	The measured data is to be capable of being recorded in a standard format and stored periodically; the history data may be checked from the stored data and the contents of data are to be consistent with the original inputted data.	
6	Inspection of data backup capability	Equipment necessary for database backup is to be provided and verified effective.	
7	Power shifting function	The system is to be capable of shifting automatically to the backup power in the case of power loss during normal power supply. The storage battery maybe used as backup power and the capacity is to maintain the power supply for at least 30 minutes.	
8	Power failure alarm	Audio and visual alarms are to be initiated while the system power failure occurs.	
II. Cargo and cargo tank monitoring alarm and assistant decision-making systems			
9	Analysis and handling of monitoring data	The system is to be capable of implementing the analysis and handling of real-time data and history data and indicate visually the results.	
10	Decision support system	The system is to initiate the early warning and alarms for the results of data analysis and handling and provide operation and handling suggestion.	
11	History data query function	Decision support system is to facilitate the query of history data and output relevant records necessary for surveys.	
III. Intelligent cargo stowage system			
12	Intelligent cargo stowage function	To verify that the system is capable of utilizing sensing devices such as sensors to collect all data in relation to cargo handling and ballast water transfer, considering various restraining factors, making real-time calculation and analysis and giving optimized stowage plan.	
13	Decision support function	To verify that the system is capable of achieving intelligent stowage of cargo according to the optimized stowage plan and initiating early warning and alarms according to the analysis results and giving operation and handling suggestion.	

No.	Test items	Requirements for test result	Remarks
14	History data query function	To facilitate the query of history data and output relevant records necessary for surveys.	
IV. Automatic cargo loading and unloading system			
15	Autonomous decision-making capability	The system is to be capable of achieving autonomous calculation, analysis and decision-making based on monitored data and restraining conditions and giving optimized stowage plan and operation plan.	
16	Automatic control function	The system is to complete the cargo loading and unloading process automatically according to the optimized stowage and operation plan: (1) automatic control of the start and stop of cargo oil pump, automatic adjust the rotate speed or displacement; (2) automatic completion of the opening and closing of cargo tank, tank stripping and washing; (3) automatic control of cargo loading and unloading, such as cargo capacity, ballast water of ballast tank, maximum still water bending moment and shear force. Also to be capable of emergency handling and control according to the unexpected equipment failure or external environmental change so as to prevent damage to the ship or pollution of the environment.	
17	History record query function	The system is to facilitate the query of history automatic cargo handling records and the records of handing and control of unexpected situation and output relevant records necessary for surveys.	

6.5.4 The software of product is to be assessed as category II system in accordance with ISC Guidelines for Security and Reliability Assessment of Marine Software and the requirements of the standard are to be met.

6.5.5 The cyber system of product is to be assessed in accordance with ISC Guidelines for Requirement and Security Assessment of Ship Cyber System and the requirements of the standard are to be met.

6.6 Unit/batch inspection

6.6.1 After the type approval, unit-by-unit inspection of products is to be carried out by ISC surveyor.

6.6.2 If the applicant has no will for type approval, application for unit/batch inspection may be accepted with the approval by ISC, requiring that products are to carry out plan approval and inspection as required. In addition to the requirements of 6.6.3, the inspection is also to comply with the applicable requirements of 6.5.2.

6.6.3 Unit/batch product inspection is to be carried out according to the test items listed in Table 6.6.3.

Test items of unit/batch inspection Table 6.6.3

No.	Test items	Requirements for test result	Remarks
1	Inspection of appearance identification and completeness	To confirm that there is no damage of the appearance of product, the identification is clear and modules of product are complete.	

2	Check of information on sensors	To confirm that the accuracy of sensor complies with the system requirements by checking of certificate/evidence.	
3	Measurement of insulation resistance	Regulation 2.3 of ISC Guidelines for Type Approval Test of Electric and Electronic Products.	
4	Voltage resistance test	Regulation 2.14 of ISC Guidelines for Type Approval Test of Electric and Electronic Products.	
5	Function test	Applicable test items in Table 6.5.3 are to be included: (1) cargo and cargo tank monitoring alarm and decision support system :items 1 to 11 (2) intelligent cargo stowage system: items 1to14; (3) automatic cargo loading and unloading system: items 1to17.	

Chapter 7 Functional Notation Survey

7.1 Initial survey

7.1.1 This chapter is applicable to oil tankers for which the functional notation C or Cl for intelligent cargo management is requested.

7.1.2 It is to be checked that the drawings and documents required by the Rules for Intelligent Ships and the Guidelines have been approved, and it is to be confirmed that the arrangement and integrity of the system comply with the requirements of the drawings.

7.1.3 It is to be checked that the equipment and system hold the relevant certificates required by the Rules for Classification of Sea-going Steel Ships and the Guidelines.

7.1.4 Process documents (if applicable) and onboard test programs are to be checked or approved by the ISC surveyor.

7.1.5 It is to be verified that the training and operation procedures for the intelligent cargo management system have been established on board.

7.1.6 Onboard survey and test

(1) Tests are to be carried out in accordance with the approved onboard test program, which may be divided into two parts, the mooring test and the sea trial, and is to include at least the following:

a) Verifying the integrity and accuracy of the monitoring and display data required by each system.

b) Verifying that the alarm function of the monitoring alarm system is normal. The set values of the system alarm point parameters determined by the test meeting the requirements of the Guidelines are to be recorded and kept on board for information. The modification of the alarm set values is to be authorized to prevent arbitrary modification, and the historical records of parameter modification are to be checked.

c) Verifying that the system is running normally and meets the design function according to the system configuration and function specifications. Software functions can be verified through simulation operation. The system is to be able to analyze the detected data and provide operational guidance on whether to adjust loading and unloading cargo tank, whether to adjust loading and unloading speed and whether to continue loading and unloading.

d) For automatic loading and unloading cargo system with functional notation Cl, verifying that the system can automatically calculate and analyze according to the results of monitoring and alarms, decide whether to adjust the ballast condition, whether to adjust the loading and unloading speed, whether to adjust the loading and unloading cargo tank and whether to continue loading and unloading, and can automatically perform the decision function to realize the automatic loading and unloading of ships.

e) Any software change or version upgrade of the system is to be made by the manufacturer or the representative designated by the manufacturer, and to be recorded accordingly.

7.2 Survey after construction

7.2.1 This is applicable to oil tankers which are assigned with the functional notation C or Cl for intelligent cargo management.

7.2.2 Survey after construction for functional notation C or Cl for intelligent cargo management is to be carried out in conjunction with the annual, intermediate and special surveys for ship class as specified in Section 2, Chapter 5, PART ONE of the Rules for Classification of Sea-going Steel Ships. The following items are to be examined during survey:

(1) Confirming that there are no unapproved changes of the intelligent cargo and cargo tank monitoring alarm and assistant decision-making systems, intelligent cargo loading system, and/or automatic cargo loading and unloading system.

(2) Confirming that operators are familiar with system operation and examining the implementation status.

(3) Checking the maintenance, repair and replacement records of equipment and system, and checking the modification records of system alarm settings. Confirming that the equipment and system have been in normal operation since the last survey and checking all kinds of alarms using simulation methods as practical as possible.

(4) Checking software modification and upgrading. Any software change or version upgrade of the system is to be made by the manufacturer or the representative designated by the manufacturer and the record of such change is to be included in the updated software registry form. The modification records, software modification impact analysis records and test report are to be submitted to the ISC surveyor for information.

7.2.3 Occasional survey

When the equipment (such as computers, programmable controllers, etc.) and the system are repaired or updated, the ship owner is to notify ISC and apply for occasional survey and test to verify that the function of the equipment and the system at least comply with the technical requirements for the original equipment and system.