



GUIDANCE NOTES  
GD03-2018

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR SURVEY OF INTELLIGENT  
INTEGRATION PLATFORM

2018

Effective from 1st July 2018

## **Foreword**

As a part of CCS rules, the Guidelines specify applicable technical requirements for survey of classed equipment of ships and requirements for survey and testing, which supplement Chapter 7 of CCS Rules for Intelligent Ships.

The intelligent integration platform is mainly characterized by breaking the vertical integration and limited intercommunication of automation systems of traditional ships. By measuring more parameters and integrating data of multiple systems as well as conducting data mining with regard to a specific subject, it provides fault analysis, forecast and early warning and assistant decision-making, which are demonstrated in an efficient and clear manner. At the same time, requirements for security and reliability need to be satisfied. From the perspective of assessment and certification, the Guidelines mainly specify detailed and additional requirements in terms of ① category; ② requirements for data security; ③ requirements for networks and communication; ④ requirements for ergonomic system; ⑤ requirements for information application; ⑥ security requirements; ⑦ requirements for plans and documents and testing; ⑧ requirements for survey at each stage.

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

## **Release history**

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1. First release of the document

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## 1 Scope of application and explanation

1.1 The Guidelines are survey guidelines for intelligent integration platform of ship, specifying technical and survey requirements for such platform. The Guidelines are applicable to intelligent integration platform installed on classed ships and in compliance with classification requirements.

1.2 The intelligent integration platform is a unified integration platform of data. It is at least capable of supporting data requirements of three systems (i.e. intelligent navigation, intelligent machinery and intelligent energy efficiency management). It is to be open to realize monitoring and intelligent management for ship as well as data exchange with shore base.

### 1.3 Class notation for product

A system complying with the requirements of the Guidelines is assigned a notation of corresponding category upon satisfactory completion of type approval or unit/batch inspection, which is indicated in the column of class notation for product of the certificate. Symbols and explanations are given in Table 4.1.

### 1.4 Class notation for ship

After obtaining the class notation for product, the ship may be assigned a notation of corresponding category upon satisfactory completion of surveys during construction and after construction, provided that the ship has three notations for intelligent navigation, intelligent machinery and intelligent energy efficiency management required by the Rules for Intelligent Ships. The notation is indicated in the column of class notation for ship. Symbols and explanations are given in Table 4.1.

## 2 Normative references

2.1 The following referenced documents are indispensable for the application of the Guidelines. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

**References**

**Table 2.1**

1.		CCS Rules for Classification of Sea-going Steel Ships (2015) and amendments
2.		CCS Rules for Intelligent Ships, 2015
3.	GD22-2015	CCS Guidelines for Type Approval Test of Electric and Electronic Products
4.	GD13-2017	CCS Guidelines for Assessment of Security and Reliability of Marine Software
5.	GD14-2017	CCS Guidelines for Network System Requirements and Security Assessment of Ships
6.		CCS Guidelines for Surveys of Intelligent Machinery of Ships
7.		CCS Guidelines for Surveys of Intelligent Navigation of Ships
8.		CCS Guidelines for Surveys of Intelligent Energy

		Efficiency Management of Ships
9.	IACS UR E22	On Board Use and Application of Computer based systems
10.	IEC 60812	Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
11.	IEC 61162-450	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 450: Multiple talkers and multiple listeners - Ethernet interconnection
12.	IEC 61162-460	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 460: Multiple talkers and multiple listeners - Ethernet interconnection - Safety and security
13.	IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
14.	IEC 62940	Maritime navigation and radiocommunication equipment and systems - Integrated communication system (ICS) - Operational and performance requirements, methods of testing and required test results
15.	ISO 8000-8	Data quality -- Part 8: Information and data quality: Concepts and measuring
16.	ISO 9241-210	Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems
17.	ISO 16425	Ships and marine technology -- Guidelines for the installation of ship communication networks for shipboard equipment and systems
18.	ISO 18028-2	Information technology -- Security techniques -- IT network security -- Part 2: Network security architecture

### 3 Terms and abbreviations

#### 3.1 Terms

##### 3.1.1 System

Set of elements which interact according to a design, which may include hardware, software and human interaction.

##### 3.1.2 Stakeholders

A person or an organization that can affect, or is affected or is deemed being affected by decision-making or activities.

##### 3.1.3 Owner

The Owner is responsible for contracting the system integrator and/or suppliers to provide a hardware system including software according to the owner's specification. The Owner could be the Ship Builder Integrator (Builder or Shipyard) during initial construction. After vessel delivery, the owner may delegate some responsibilities to the vessel operating company.

##### 3.1.4 System integrator

The system integrator is responsible for the integration of systems and products provided by suppliers into the system invoked by the requirements specified herein and for providing the integrated system. The system integrator may also be responsible for integration of systems in the vessel. The role of system integrator is to be taken by the yard unless an alternative organisation is specifically contracted/assigned this responsibility. If there are multiple parties performing system integration at any one time a single party is to be responsible for overall system integration and coordinating the integration activities. If there are multiple stages of integration different System Integrators may be responsible for specific stages of integration but a single party is to be responsible for defining and coordinating all of the stages of integration.

#### 3.1.5 Supplier

The Supplier is any contracted or subcontracted provider of system components or software under the coordination of the System Integrator or Shipyard. The supplier is responsible for providing programmable devices, sub-systems or systems to the system integrator. The supplier provides a description of the software functionality that meets the Owner's specification, applicable international and national standards, and the requirements specified herein.

#### 3.1.6 Human-centred design (HCD)

An approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques

### 3.2 Abbreviations

3.2.1 CCS: China Classification Society

3.2.2 DCS: Distribution Control System

3.2.3 ESD: Emergency Shutdown Device

3.2.4 FAT: Factory Acceptance Test

3.2.5 IEC: International Electrotechnical Commission

3.2.6 IO: Input/Output

3.2.7 ISO: International Organization for Standardization

3.2.8 MD5: Message Digest Version 5

3.2.9 MPLS: Multi-protocol Label Switching

3.2.10 PLC: Programmable Logic Controller

3.2.11 SHA-1: Secure Hash Algorithm

3.2.12 VLAN: Virtual Local Area Network

3.2.13 VPN: Virtual Private Network

## 4 Category of intelligent integration platform

4.1 The category of intelligent integration platform is given in Table 4.1.

**Category of Intelligent Integration Platform**

**Table 4.1**

Category of platform	Class	Explanation
Ic1	Information summary and display	<ul style="list-style-type: none"> <li>– integrated shipboard LAN system</li> <li>– shipboard remote monitoring of intelligent navigation, intelligent machinery and intelligent energy efficiency management</li> <li>– shore-based remote monitoring of intelligent navigation, intelligent machinery and intelligent energy efficiency management, where applicable</li> <li>– automatic system configuration management</li> <li>– post processing of operating data</li> </ul>
Ic2	Assistant decision-making	<ul style="list-style-type: none"> <li>– integrated shipboard LAN system of interconnected systems</li> <li>– integrated intelligent navigation, intelligent machinery and intelligent energy efficiency management systems</li> <li>– providing assistant decision-making</li> <li>– achieving ship to ship and ship to shore communication and intelligent harmonization of navigation based on the shore-based data center, where applicable</li> <li>– control of equipment other than essential equipment, where applicable</li> </ul>
Ic3	Control related	<ul style="list-style-type: none"> <li>– achieving self-learning, judging and decision-making through data analysis</li> <li>– semi-automatic or automatic operation, automatic equipment maintenance and management system</li> <li>– perception and data analysis based on the environment, operation corresponding to automatic decision-making</li> <li>– on-line information sharing, enquiry and decision-making</li> </ul>

**5 System requirements**

5.1 General requirements

5.1.1 If a ship is assigned with the functional notation for intelligent integration platform, at least data of three systems (i.e. intelligent navigation, intelligent machinery and intelligent energy efficiency management) are to be integrated to form unified integration platform of data. Integration platform is to be open to realize monitoring and intelligent management for ship as well as data exchange with shore base.

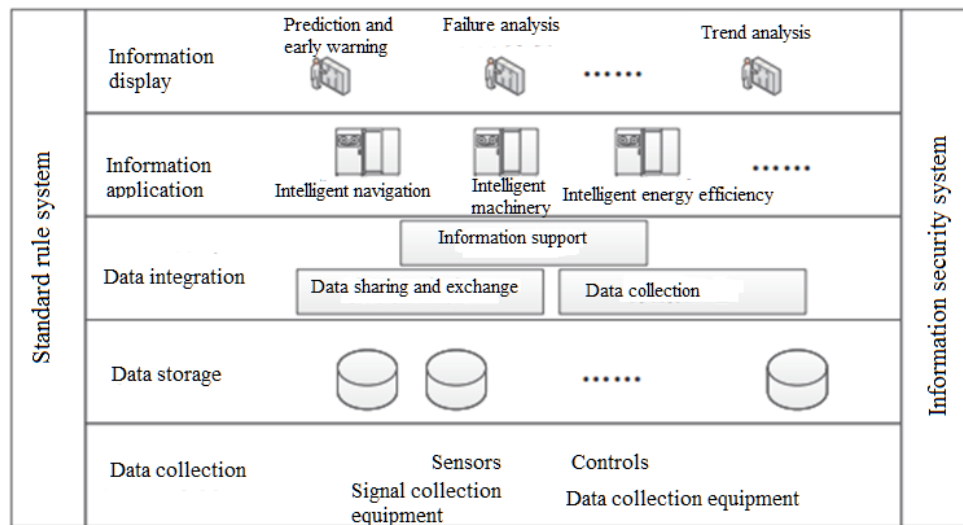
5.1.2 By general application of integrated data resource, intelligent integration platform is to have following basic functions:

- (1) statistical analysis and general evaluation, capable of providing automatic and standardized customized analysis;
- (2) providing general forecast and early warning for relevant index such as navigation, safety and economy according to multi-dimensional boundary conditions set by the user;
- (3) providing trend prediction for current ship operation and management plan by using ship’s historical operation condition and relevant parameters;

- (4) supporting good assistant decision-making, improving ship performance and decreasing error due to human factors. Capable of providing general management and operation plan for accident response, risk reaction plan, environmental protection measures, accident detection and prevention, economic performance promotion, resource management and communication according to evaluation and prediction results;
- (5) capable of realizing ship-shore data exchange.

## 5.2 System layer

### 5.2.1 Overall structure of system



**Figure 5.1 Overall Structure of System**

- (1) data collection, i.e. using sensing equipment such as sensor, control, signal collecting equipment and data collecting equipment to collect required data, collecting data, defining data standard, including standard relating to data definition, data description, data quality, data transmission and data handling, and realizing data traceability;
- (2) data storage, i.e. establishing subject-oriented, integrated and stable data set supporting decision-making and management process and reflecting historical change, carrying out storage as well as safety and evaluation management for data collected to ensure accuracy, integrity and availability of data;
- (3) data integration, i.e. carrying out system processing, aggregation, analysis integration and exchange based on necessary selection and cleaning of existing data, using multi-dimensional analysis method, analyzing and comparing from different angle, and extracting information hidden within data to provide information support for service application and assistant decision-making as well as play a role of information integration;
- (4) information application, i.e. providing relevant integration service application based on integrated data resource, aiming at customized subject, excavating data, and obtaining but not

limited to capability of failure analysis, forecast and early warning as well as assistant decision-making;

(5) information display, i.e. by means of human-computer interaction and according to customization, providing excavating results of relevant data, expressing failure cause in proper form and providing prediction and early warning for user operational decision-making by using data trend;

(6) standard rules system, which is to be observed during system integration process;

(7) information security system, i.e. based on requirements for information security (information confidentiality, authenticity, integrity, unauthorized copy and security of parasitic system) and from computer operation system, security agreement and mechanism (digital signature, message authentication and data encryption) to security system, proposing design thinking and protection strategy to ensure continuous, reliable and normal operation of system and uninterrupted information service as well as final continuous service.

### 5.3 System requirements

#### 5.3.1 General requirements

(1) Ic 1 Information summary and display and Ic2 Assistant decision-making of intelligent integration platform are to satisfy the requirements for CCS category II computer based systems. Ic3 Control related is to satisfy the requirements for CCS category III computer based systems. If the system category is revised by the stakeholder based on risk, the agreement of CCS is to be sought.

(2) System integration is to adopt unified input and output standard.

(3) Database is to have backup and disaster recovery mechanism to ensure data integrity and consistency.

(4) Stable and reliable communication protocol and system data transmission mechanism is to be adopted between ship and shore.

(5) Data collection is to have fault-tolerant mechanism.

(6) Database of integration platform is to have valid integration process, i.e. screening necessary data according to data quality of each system and functional requirements for integration platform.

(7) The system supports multi-terminal (PC and mobile device) access.

(8) When necessary, the system is to provide external data transmission interface and have capability of sharing data with relevant parties.

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

(10) In the event of a failure of normal power supply, the system is to be capable of being automatically changed over to an independent standby power supply. The standby power supply may be an accumulator battery, with a capacity at least sufficient for a period of supply of 30 min. Where such systems could be adversely affected by an interruption in power supply, change-over to the standby power supply is to be achieved without a break.

### 5.3.2 System integration requirements

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

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

(3) The system is to have certain expandability and complete data interface plan to facilitate access of other newly-added system. Data collected through newly-added system may be stored in intelligent integration platform database, or establish effective call relation with it.

### 5.4 Requirements for software and supporting hardware

5.4.1 Organizations in charge of software modifications are to be clearly declared by Owner to CCS. A System integrator is to be designated by the Owner and is to fulfil requirements of CCS Guidelines for Assessment of Security and Reliability of Marine Software. Limited life cycle steps may be considered for modifications already considered and accepted in the scope of initial approval. The software modification effect analysis record and test report are to be submitted to CCS for information. It is the responsibility of the owner to manage traceability of these modifications. The achievement of this responsibility is to be supported by system integrators updating the software registry.

5.4.2 The owner is to ensure that necessary procedures for software and hardware change management exist on board, and that any software modification/upgrade are performed according to the procedure. All changes to computer based systems in the operational phase are to be recorded and be traceable.

5.4.3 The owner, system integrator and suppliers are to adopt security policies and include these in their quality systems and procedures. Unauthorized modification of software is to be prevented. Physical and logical security measures are to be in place to prevent unauthorized or unintentional modification of software, whether undertaken at the physical system or remotely. Prior to installation, all artefacts, software code, executables and the physical medium used for installation on the vessel are to be scanned for viruses and malicious software. Results of the scan are to be documented and kept with the Software Registry.

5.4.4 For shipboard data servers, reference may be made to ISO 19847. For standard data for shipboard machinery and equipment, reference may be made to ISO 19848. For data quality and measurement, reference may be made to ISO8000-8.

## **6 Requirements for data security**

### **6.1 General requirements**

The following questions need to be addressed at the stage of demand analysis and design:

a. What kind of information needs to be protected? b. what are the security risks, and what kind of protection is needed to manage these risk? c. what are the distinct types of network activities that need to be protected? d. What are the distinct types of network equipment and facility groupings that need to be protected?

A risk assessment is preferably to be conducted to prioritize the protection requirements and help to determine the appropriate security measures for security architecture.

A multifaceted Reference Architecture in ISO 18028-2 is recommended by the Guidelines. The principles described by the multifaceted Reference Architecture can be applied to a wide variety of networks independent of the network's technology or location in the protocol stack. Here are the additional requirements.

### **6.2 Access Control Security Dimension**

The Access Control Security Dimension provides authorization for the use of the network resources. Access control ensures that only authorized personnel or devices are allowed access to network elements, stored information, information flows, services and applications. For example, Role-Based Access Control (RBAC) provides different access levels to guarantee that individuals and device can only gain access to and perform operations on network elements, stored information, and information flows for which they are authorized.

In general, some configuration parameters are preset by the designer while others are frequently changed by the operating and maintenance personnel in the pre-defined limit. The value of default parameters and the permissible scope of change (operators and engineers are usually different) have been determined subject to appropriate analysis, in order to establish and maintain safe and reliable operation of equipment and ship.

The maintenance of security data is to be designed in the system. The common type of protection is authorization at different levels, which is realized through the password protection of the user interface. For a ship with shore-based connection, as the vulnerability point of security data is changed, any circumvention of the normal user interface control mechanism is to be identified and mitigation measures are to be taken.

The access permit is to be examined on an irregular basis.

### **6.3 Authentication Security Dimension**

The Authentication Security Dimension serves to confirm the identities or other authorizing attributes of communicating entities. Authentication ensures the validity of the claimed identities when used by authorization or Access Control of the entities participating in communication (e.g. person, device, service or application) and provides assurance that an entity is not attempting a masquerade or unauthorized replay of a previous communication. Authentication methods that employ techniques based on user identification and password pair, two-factor authentication (e.g. token), biometrics are among widely used methods.

The following two important aspects need to be considered:

- data from a remote source, e.g. shore-based facilities; and
- time scale or order of received data.

#### 6.4 Non-repudiation Security Dimension

The Non-repudiation Security Dimension provides technical means for preventing an individual or entity from denying having performed a particular action related to data by making available proof of various network-related actions (such as proof of obligation, intent, or commitment; proof of data origin, proof of ownership, proof of resource use). It helps to ensure the availability of evidence that can be presented to a third party as technical proof that some kind of event or action has taken place. Note, however, that non-repudiation provided by technical means does not lead to a necessary conclusion of law. Cryptographic methods are often used for providing non-repudiation.

#### 6.5 Data Confidentiality Security Dimension

The Data Confidentiality Security Dimension protects data from unauthorized disclosure. Encryption is a method often used to ensure data confidentiality. Access control lists, and file permissions are methods that help to keep data confidential.

The management of confidentiality of decommissioned systems or components is to be considered.

#### 6.6 Communication Flow Security Dimension

The Communication Flow Security Dimension ensures that information flows only between the authorized end points (the information is not diverted or intercepted as it flows between these end points). Security mechanisms of Communication Flow Security Dimension do not protect against modification/corruption; this is a function of Data Integrity. MPLS tunnels, VLANs, and VPNs are examples of technologies that can provide communication flow security.

Other requirements are given in Chapter 7.

#### 6.7 Data Integrity Security Dimension

The Data Integrity Security Dimension ensures the correctness of accuracy (i.e., data are only processed by authorized processes or actions of authorized people or devices) of data. The data is protected against unauthorized modification, deletion, creation, and replication and provides an indication of these unauthorized activities. Hashed Message Authentication Code methods (e.g. MD5, SHA-1) often used for ensuring data integrity.

Data integrity needs to be managed as required by the system lifecycle, including through design and realization, at all operating stages, all operations in degraded modes and in case of any change to the system.

#### 6.8 Availability Security Dimension

The Availability Security Dimension ensures that there is no denial of authorized access to network elements, stored information, information flows, services and applications due to events impacting the network. Disaster recovery solutions are included in this category.

For conventional and small system architecture, the communication infrastructure may lack the capability to manage the maximum load or it is very sensitive to interruption.

Data availability is very important to intelligent ships with a growing trend of accessing remote information by applying satellite communication or providing shore to ship remote control to some extent.

At the concept design stage of system development, due consideration is to be given to the demand and strategy indicating data availability, in order to control the condition where data availability is limited. Such strategy is to include structural and detailed design solutions, e.g. redundant communication channel or alternative operation method by human intervention.

The adequacy of provisions regarding the management of data integrity is to be assessed at the design stage, including the following issues:① the extent to which the threat to data integrity has been determined; ② specific design parameters which have been included; ③ the level of safeguard that has been applied to data preparation; ④ data management characteristics of application programmes.

#### 6.9 Privacy Security Dimension

The Privacy Security Dimension provides for the protection of any information (identity of a party to communications or any data—including packet headers—pertaining to any activity carried by this party) that might be derived from the observation of network activities. Example of this information include web-sites that a user has visited, a user's geographic location, and the IP addresses and DNS names of devices in a Service Provider network. Network Address Translation (NAT) and application proxies are examples of the techniques that can be used for privacy protection. Depending on the respective national privacy and data protection legislations and regulations, this Privacy Security Dimension is also to provide the appropriate protection structure and controls for collection, processing and dissemination of personal information.

## 7 Requirements for networks and communication

### 7.1 General requirements

The Section focuses on the security of networks and communication infrastructure. The security and reliability of networks and software need to satisfy the requirements of Chapter 10, in addition to the following requirements:

- (1) Loss of a data link is to be specifically addressed in risk assessment analysis.
- (2) A single failure in data link hardware is to be automatically treated in order to restore proper working of system.
- (3) Characteristics of data link is to prevent overloading in any operational condition of system.
- (4) Data link is to be self-checking, detecting failures on the link itself and data communication failures on nodes connected to the link. Detected failures are to initiate an alarm.
- (5) Information can only flow between authorized endpoints (information will not be diverted or intercepted when flowing between these endpoints).

## 7.2 Wireless data links

Where wireless data links are used, the following are to be specially considered:

(1) Recognized international wireless communication system protocols are to be employed, incorporating:

- ① message integrity. Fault prevention, detection, diagnosis, and correction so that the received message is not corrupted or altered when compared to the transmitted message;
- ② configuration and device authentication. To only permit connection of devices that are included in the system design;
- ③ message encryption. Protection of the confidentiality and/or criticality of the data content;
- ④ security management. Protection of network assets, prevention of unauthorized access to network assets.

(2) The internal wireless system within the vessel is to comply with the radio frequency and power level requirements of International Telecommunication Union and the flag State requirements. Consideration should be given to system operation in the event of the port State and local regulations that pertain to the use of radio-frequency transmission prohibiting the operation of a wireless data communication link due to frequency and power level restrictions.

(3) For wireless data communication equipment, tests during harbour and sea trials are to be conducted to demonstrate that radio-frequency transmission does not cause failure of any equipment and does not self-fail as a result of electromagnetic interference during expected operating conditions.

## 7.3 Remote communication

(1) Appropriate type and bandwidth of remote communication are to be selected, in order to ensure that priority is granted to business essential systems or security system when needed.

(2) Appropriate operational control is to be considered to address bad communication that occurs occasionally.

# 8 Requirements for ergonomic system

## 8.1 Human-centred design

Human-centred design is necessary for system development and operation, the purpose of which is to provide a structure using human-centred methodology in order to ensure that the effect of human factor on intelligent integration platform is adequately located and relevant risk has been reduced to the lowest reasonable level. Design principles and evaluation can be carried out in accordance with ISO 9241-210.

Human-centred design follows the following principles:

- (1) an explicit description reflecting the operational idea of intelligent integration platform
- (2) early, continuous and effective personnel investment;
- (3) continuous improvement, learning based on experience, attempt or prototype;
- (4) providing system with persons and tasks based on user experience;
- (5) a multidisciplinary team.

Human-centred design is to be planned and integrated into all phases of the life cycle of intelligent integration platform. Human-centred design activities are to start at the earliest stage of the project. To ensure that it is followed through on and implemented effectively, the plan for human-centred design is to be subject to the same project disciplines (e.g. responsibilities, change control) as other key activities.

Human-centred design aspect in the project planning is to be reviewed and revised as appropriate in the life cycle of the project. Project planning is to allocate time and resources to human-centred activities. This is to include time for iteration and the incorporation of user feedback, and for evaluating whether the design solution satisfies the user requirements. Additional time is also to be allocated to communication and reconciliation among design teams.

## 8.2 Ergonomic considerations

### 8.2.1 General requirements

(1) Reducing human data processing. Data is to be processed by equipment insofar as practicable and the result is to be presented to relevant person for decision-making.

(2) Harmonization between physical layout and monitoring interface. The control and display in the monitoring interface are to be consistent with the equipment of physical layout. The flow chart is to reflect the logical relationship between equipment.

(3) Adapted to routine operational habit. The consistency between control action and display response is to be maintained during the platform design.

(4) Consistency of images:

- ① the same color is to denote the same meaning in different images;
- ② different images are to have the same style of layout;
- ③ the computer display is to correspond to panel display.

(5) Effective display:

- ① the intelligent platform is to avoid interference or meaningless tasks;
- ② common or important display is to be arranged in the central visual region so that the displayed information is clear and easy to understand;
- ③ the alarm is not to be triggered frequently, which might affect the attention of monitoring personnel;
- ④ information is to be grouped so that the monitoring personnel can process a large amount of information calmly;
- ⑤ the priority of tasks and alarms is to be established.

(6) Convenience of monitoring

- ① the control device is to be close to the corresponding display and within the operational range of personnel;
- ② when viewed from the nominal position, the monitor:
  - a. is to be easy to read;
  - b. is located within a direct field of view;
  - c. has sufficient color, brightness and contrast;

d. allows the monitoring personnel to see the environmental conditions (weather conditions or day and night) out of the corner of the eye.

- ③ The environment of the control room is not to interfere with the visual or audible signals;
- ④ operation that prevents negligence is to be in place;
- ⑤ all control equipment is to be easily accessible and operate.

(7) Effective images:

- ① effective methods are provided to show important and changed information;
- ② multiple displays are to be avoided to access frequently used or critical information. Critical information is to be displayed immediately;
- ③ cross reference between information display is to be avoided;
- ④ control is to be distinguishable from display;
- ⑤ identification is to be simple and easy to memorize;
- ⑥ the update of information is to be quick;
- ⑦ a clear and continuous automatic indication of system status is to be provided.

(8) Information search and interpretation are simplified by color coding:

- ① color is not to be used as the only coding mechanism to convey information, which is to be used in conjunction with other coding mechanisms;
- ② the use of color is not to reduce the readability of images, tags, maps, etc.;
- ③ it is to be easy to distinguish between used colors;
- ④ there are not to be more than 7 types of used colors.

## 8.2.2 Simple, direct, easy to input and control

(1) Providing direct manual control

The design of system interface is to be interactive, which can improve the operating speed. It is to be ensured that manual control is correctly performed through clear control entries. The automation system is to accept manual planned input and intervention.

(2) Clear identification control mode

Automatic, auxiliary and manual control modes are to be displayed clearly in the vicinity of control components.

(3) Prompt of any change of control mode

The changeover of control mode is to ensure that:

- ① confirmation from the operator is needed;
- ② the current control mode is to be indicated before the changeover takes place and a sound signal is given as a hint of changeover;
- ③ a clear audible and visual hint is to be given during the changeover to manual control mode.

(4) Providing guidance to human intervention in the automation system

Guidance is to be given in the following cases:

- ① when to take over from the automatic control;
- ② when or how to switch the control right from one place to another;

- ③ when to close the equipment or system.

(5) Providing direct and instant feedback for control action

Controls and corresponding display are to be placed together insofar as practicable.

- ① the operation or command of equipment is to be have corresponding display, accompanied by immediate display of feedback signal;
- ② in case of operation by several persons, all relevant information is to be provided to other responsible persons at the same time for task coordination;
- ③ information required for diagnostics or decision-making control is to be provided at the same time instead of continuously.

(6) Providing simple image display

- ① the menu hierarchy of image is not to exceed three levels;
- ② a hierarchy chart or other hinted information is to be provided, so as to help the operator find the required image conveniently.

(7) Response delay and availability of system status

The response of control system is to be recorded and the record of intermediate system response is to be available.

### 8.2.3 Reducing human errors

(1) Providing error prevention and tolerance

For operations that might directly endanger the ship, personnel or the environment, the software or hardware is to be provided with protective operations. An action that might cause harm is to be confirmed. In possible cases, the software is to supervise and guide the safety of personnel behavior.

(2) Considering the communication demand of tasks

The communication system is to satisfy the following requirements:

- ① frequent movement by operators to different positions for access to the communication equipment is to be avoided;
- ② consideration may be given to the use of portable, no-load equipment or fixed communication equipment.

(3) Avoiding any conflict of control

The concurrent control of system or equipment from different workstations is to be avoided. The concurrent operation of control and display of one piece of equipment conducted by two or more persons is to be avoided, i.e. the right of control of one system can only be obtained by one operator each time.

(4) Requirements for provision of operators

- ① the provision of personnel for all operating modes is determined based on the workload;
- ② considering whether the level, skill and experience of personnel can satisfy requirements for operation and failure disposal;
- ③ considering the provision of personnel in the worst case;
- ④ considering the provision of personnel in the normal case;

⑤ tasks are assigned in accordance with personnel skill and experience.

### 8.3 Training

#### 8.3.1 Determination of required knowledge, skill and capability

Understand what operators need to do and provide training to complete required work tasks.

#### 8.3.2 Identification of training demands and requirements

(1) specific training requirements are developed in terms of the intelligent platform and automation function;

(2) identify automatic function operation and intervention measures of operators. Identify automatic and manual conditions;

(3) provide training on automation control related to ship control;

(4) provide training on important tasks;

(5) provide practical training on changeover between automatic and manual control.

#### 8.3.3 Prompt of program

(1) provide available written or on-line program to guide and record uncommon conditions, complex or safety critical operations;

(2) provide guidance to the action of operators through the program rather than the display of commands in special alarm conditions;

(3) provide programs to address uncommon or assumed conditions;

(4) provide on-line help.

#### 8.3.4 Provision of tags and warning

Provide standardized, durable, readable and available tags for all equipment and components.

Tags and marks are to be consistent in terms of:

(1) use of codes and colors;

(2) display position;

(3) language and grammar;

(4) design style.

## 9 Information application requirements

### 9.1 Information display

#### 9.1.1 Information categorization and display

Information display is at least to include contents required in Guidelines for Survey of Intelligent Navigation, Intelligent Machinery, Intelligent Energy Efficiency Management.

The categorization and display of Intelligent Integration Platform information are to comply with the requirements of IMO Resolution A.1021(26).

Special attention is to be paid to the harmonization on the priority, categorization, processing, distribution and display of alarms so as to avoid adverse effects on ship's navigation or other functions related to safety and environmental protection.

#### 9.1.2 Input and output devices

Input and output devices of computer systems are to be designed for ease of handling and user-friendliness and are so far as possible to follow ergonomic principles.

- (1) The keyboard of a computer is to meet the following requirements:
- ① Where equipment operations or functions may be changed via keyboards, appropriate measures (such as setting password) are to be employed so as to limit access of such operations to authorized personnel only.
  - ② If the operation of a key is able to cause dangerous operating conditions, measures are to be taken to prevent the instruction in question from being executed by a single action such as use of a special key lock, or use of two or more keys.
- (2) The computer displays are to comply with following requirements:
- ① The size, color and resolution of text and graphic information displayed on a visual display unit is to be such that it may be easily read from the normal operator position under all operational lighting conditions. The brightness and contrast are to be capable of being adjusted to the prevailing ambient conditions.
  - ② Information is to be displayed in a logical priority.
  - ③ If alarm messages are displayed on color monitors, the distinctions in the alarm status are to be ensured even in the event of a failure of a primary color.
- (3) Where a display unit is used for alarm in place of a general indicating lamp, the following requirements are to be satisfied:
- ① The indication of the display unit is to be clear under the bright environmental condition. Data and information shown on the display unit are to be capable of being easily read by an operator in a normal working position.
  - ② The display unit is to be capable of clearly indicating all the alarm signals.
  - ③ The display unit is to be capable of distinguishing the status of fault alarms, i.e., the status before and after acknowledgment; but this distinction is not to be shown by means of different colors only.
  - ④ A storage device and an output interface are to be provided in order to record and output the faults and their time of occurrence.
  - ⑤ For the platform, at least a standby display unit or lamp panel is to be provided, or a printer is to be provided in order to record the faults and their time of occurrence.
  - ⑥ The display unit is to be capable of normal operation in the event of a failure of the normal power supply.
  - ⑦ Where a display unit is common to parameter and alarm displays, the parameter display is not to interfere with the initiation of alarm signals.

9.1.3 The displayed information is at least to include contents required to be displayed in Guidelines for Survey of Intelligent Navigation, Intelligent Machinery, Intelligent Energy Efficiency Management.

## 9.2 Information application

Where the Intelligent Integration Platform complies with the requirements for assistant decision-making of Ic2 or control-related categories of Ic3 in addition to information summary and display of Ic1, information processing and application are to comply with the contents of Guidelines for Survey of Intelligent Navigation, Intelligent Machinery, Intelligent Energy Efficiency Management.

## 10 Security requirements

10.1 The Intelligent Integration Platform is to comply with the basic requirements for automation systems in PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships.

10.2 Software is to comply with the requirements of CCS Guidelines for Assessment of Security and Reliability of Marine Software.

10.3 Cybersecurity is to comply with the requirements of CCS Guidelines for Network System Requirements and Security Assessment of Ships.

10.4 Hardware is to function in the environmental conditions specified in Section 1, Chapter 2, PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships and other working conditions.

## 11 Basic survey requirements

### 11.1 Product certification requirements

Products applying for approval/inspection are to comply with the certification requirements in the following table.

**Certification Requirements for the Intelligent Integration Platform Table 11.1**

No.	Product name	Document		Approval mode				Plan approval	Remarks
		C/E	W	DA	TA-B	TA-A	WA	PA	
1	Intelligent Integration Platform system	×	--	--	×	--	--	×	
1.1	Computer	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.2	Display	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.3	Uninterruptable power supply	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.4	Programmable controller	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.5	Internet devices such as router	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.6	Sensor	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	
1.7	Actuator	--	○	--	× <sup>2</sup> /× <sup>3</sup>	--	--	○	

Symbols:

- 1) C – Marine Products Certificate; E – Equivalent document; W – Manufacturer’s document; X – Applicable; O – Optional;
- 2) DA – Design approval; TA-B – Type approval B; TA-A – Type approval A; WA – Works approval; PA – Plan approval;
- 3) X<sup>1</sup>: Inspection is to be carried out according to approved integral product/system (ship, product) drawing.
- 4) X<sup>2</sup>: If certification requirements for purchased parts can not be satisfied, inspection is to be carried out according to the requirements of CCS rules;
- 5) X<sup>3</sup>: If certification requirements for purchased parts can not be satisfied, complete type test is to be carried out with integral product.

### 11.2 Plans and tests

The following Table lists plans to be submitted and tests and trials to be carried out by stakeholders.

**Lists of Plans to be Submitted and Tests and Trials to be Carried out**

**Table 11.2**

No	Requirement	Stakeholders				Classification Society				
		Supplier	System integrator	Ship designer	Owner	Type approval of product	Plan approval of ship	Unit/batch inspection	Construction survey	Survey after construction
1	System description	○	×			Ⓐ	Ⓒ	Ⓒ		
2	Hardware description	○	×			Ⓐ		Ⓒ		
3	Wiring connection diagram	○	×	Ⓒ		Ⓐ	Ⓒ	Ⓒ		
4	Software description	○	×			Ⓐ		Ⓒ		
5	User interface description	○	×	Ⓒ		Ⓐ	Ⓒ	Ⓒ		
6	Risk assessment report	○	×			Ⓐ		Ⓒ		
7	Type test program (excluding functional and failure tests)	○	×			Ⓐ				
8	Test program for functional and failure tests	○	×			Ⓐ		Ⓒ		
9	Operation Manuel	○	×	Ⓒ	Ⓒ	Ⓘ	Ⓒ	Ⓒ	Ⓒ	Ⓒ
10	Quality Plan	○	×			Ⓐ				
11	Evidence of verification of software	○	×			Ⓘ				
12	Type test report (including functional and failure tests)	○	×			ⒶⓂ				
13	Single line diagram of onboard systems (including power supply)			×	Ⓒ		Ⓐ	Ⓒ	Ⓒ	
14	Arrangement of onboard systems			×	Ⓒ		Ⓐ	Ⓒ	Ⓒ	
15	Functional description of software	○	×		Ⓒ			Ⓘ		
16	List and versions of software installed in system	○	×		Ⓒ			Ⓘ	Ⓒ	Ⓒ

No	Requirement	Stakeholders				Classification Society				
		Supplier	System integrator	Ship designer	Owner	Type approval of product	Plan approval of ship	Unit/batch inspection	Construction survey	Survey after construction
17	User manual including instructions during software maintenance (including necessary procedure for management of software and hardware changes)	○	×		©			①		©
18	List of interfaces between system and other ship systems	○	×		©			①	©	©
19	List of data transmission standards	○	×		©			①		
20	Factory acceptance test program	○	×					Ⓐ		
21	Factory acceptance test report	○	×					ⒶⓂ		
22	Test program for on board tests (including wireless network testing)		×	○	©				Ⓐ	©
23	System installation procedure		×	○	©				Ⓐ	
24	On board test report (acceptance test)		×	○	©				ⒶⓂ	
25	On board test report (integration test)		○	×	©				ⒶⓂ	①Ⓜ
26	Updated Software Registry		×		○			©	①	①
27	Analysis record and test report of software change effects		×		○			©	①	①

Symbols:

- 1) ① submitted to CCS for approval;                      ② submitted to CCS for information;
- ③ To be witnessed by CCS surveyors;
- 2) ④ Submitting approved documents/documents for information;
- × To be submitted/carried out;                      ○ To be submitted/carried out when necessary.

Note 1: The Table above gives general requirements for documents to be submitted by stakeholders, who may submit applicable part of the documents above according to the actual situation.

Note 2: ④ means submitting approved documents/documents for information. For example, for No.9 Operation Manual, system integrator or supplier submits it to CCS for information; after the Manual is stamped with CCS stamp “For information”, it needs to be provided to ship designer, owner and plan approval unit as supporting material or background material.

Note 3: ①③ means the surveyor may either check the test report or witness the test or carry out a combination of both.

Note 4: ②③ means the surveyor may either review the test report for information or witness the test or carry out a combination of both.

Note 5: For × and ○ in each line, documents are recommended to be submitted by ×, but may also be submitted by ○; submission by one party will suffice. For example, No.1 System instructions may be submitted by either system integrator or supplier.

### 11.3 Plans and documents

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

(1) System description (product technical specification) is to specify the general performance requirements as well as general design requirements for the product, covering at least applicable part of the following:

- ① provisions for the environmental conditions of the product: product compatibility requirements to the working conditions (including electromagnetic compatibility) specified in CCS Rules for Classification of Sea-going Steel Ships;
- ② detailed description of product functions: including system configuration, applicability of the product, control and monitoring functions of the product and detailed description of the realization method, detailed description of the safe status of each realized function, system characteristics in each operation condition (including emergency, failure) as well as operation guidelines of the system in normal and abnormal conditions;
- ③ detailed description of control changeover;
- ④ detailed description of redundancy setup and changeover mechanism;
- ⑤ detailed description of failure monitoring and identification functions (automatic and manual);
- ⑥ detailed description of data security, user’s security level (entry restriction to functions);
- ⑦ list of control and testing items: list of all input/output signals of the system (service description, instrumentation, types, range and set limit of systems and signals).

(2) Hardware description

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

- ① technical specification of hardware and peripheral configuration
- ② block diagram: showing internal connection of main components (software and hardware units, module) of system and interface with other system;

- ③ detailed description of main hardware configuration of the product;
- ④ detailed description of input and output devices;
- ⑤ detailed description of power supply equipment.

(3) Wiring connection diagram

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

- ① power supply arrangement: showing power supply arrangement of the system and the connection of the system to the switch board, battery, transformer or UPS;
- ② circuit diagram of important hardware circuit, such as emergency operation and interlock, details of input and output devices, power supply condition of each circuit.

(4) Software description

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

- ① description of the basic software installed in each hardware unit;
- ② description of the communication software installed on nodes in a network;
- ③ description of application software: information of system module keeping functions working and of system's dependency on other systems, relations of software modules keeping functions working, data flow and control flow among software modules;
- ④ software configuration, including preferred option;
- ⑤ changeover mechanism of redundant systems.

(5) User interface description

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

- ① function distribution of each working station and operation station as well as description of control changeover among stations;
- ② description of the functions specified for each input device;
- ③ layout, dimensions and necessary physical pictures of input/output devices;
- ④ user input interface description, menu description.

(6) Risk assessment report: risk assessment of the system is to be undertaken to determine the risk to the system throughout the lifecycle by identifying and evaluating the hazards associated with each function of the system. The risk assessment report is generally submitted by the system integrator or the supplier, including data coming from other suppliers. Based on the risk assessment, a revised system category might need to be agreed between CCS and the system supplier. Where the risks associated with a computer based system are well understood, it is permissible for the risk assessment to be omitted, however in such cases the supplier or the system integrator is to provide a justification for the omission. The justification is to give consideration to the known risks, the equivalence of the context of use of the current computer based system and the computer based system initially used to determine the risks as well as the adequacy of existing control measures in the current context of use.

(7) Type test program (excluding functional and failure tests): according to the requirements of CCS Guidelines for Type Approval Test of Electric and Electronic Products, the developed type test program is to include, as a minimum, visual inspection, insulation resistance measurement, power supply variation and failure test, marine environment test, high voltage test, enclosure test, electromagnetic compatibility test.

(8) Test program for functional and failure tests: the process for functional and failure tests includes FMEA or similar analysis that may be required by CCS. The test procedure is to describe test configuration and simulation method in conjunction with the characteristics of specific

products according to the provisions of Chapters 5 to 10 of the Guidelines. Each test is to stipulate initial state of equipment/system, test method, test result analysis and acceptance criteria. Each test is to cover normal mode and failure mode (including self-inspection of the system, simulation test of system failures, changeover of redundant devices, if any) as well as power supply and communication failure. Functional and failure tests can be demonstrated by simulation tests.

#### (9) Quality plan

A document based on life cycle, referred to herein as a Quality Plan, is to be produced that records how the quality management system will be applied for the specific computer based system and that includes, as a minimum, all of the following materials.

- ① Relevant procedures regarding responsibilities, system documentation, configuration management and competent staff.
- ② Relevant procedures regarding software lifecycle and associated hardware:
  - organization set in place for acquisition of related hardware and software from suppliers;
  - organization set in place for software code writing and verification;
  - organization set in place for system validation before integration in the vessel.
- ③ Minimum requirements for approval of Quality system:
  - the Intelligent Integration Platform is to have a specific procedure for verification of software code at the level of systems, sub-systems and programmable devices and modules;
  - the Intelligent Integration Platform is to have check points; examples of check points can be a required submittal of documentation, a test event, a technical design review meeting, or peer review meeting;
  - the owner is to be informed of a specific procedure for software modification and installation on board the vessel.

(10) Type test report: the surveyor may either check the test report or witness the test or carry out a combination of both.

(11) Single line diagram of onboard systems (including power supply)

(12) Arrangement of onboard systems

(13) Factory acceptance test program:

- ① Intra-system integration testing is to be done between system and sub-system software modules before being integrated on board. The objective is to check that software functions are properly executed, that the software and the hardware it controls interact and function properly together and that software systems react properly in case of failures. Faults are to be simulated as realistically as possible to demonstrate appropriate system fault detection and system response. The results of any required failure analysis are to be observed.
- ② The requirements for functional and failure tests are tailored according to test programs for functional and failure tests.
- ③ The test program is developed by the supplier or the system integrator and co-confirmed by the system integrator, the owner and the classification society. In general, the test program is to include but not limited to the following: kick-off meeting (document specification, plan, etc.), check of the supplier's documents (including factory test report), check of the list of hardware and software (including version No.), mechanical check

(acceptance), check of wiring and terminals, starting test, general system features (including hardware redundancy and diagnosis check), visual inspection/operation, functional and failure tests, check of advanced features and operation modes, system interface test, FAT changes, FAT closing meeting.

(14) Factory acceptance test report: the surveyor may either check the test report or witness the test or carry out a combination of both.

(15) Test program for on board tests (including wireless network testing):

- ① The test program for on board tests (activities and schedules) is developed by the system integrator and co-confirmed by the system integrator, the owner and the classification society. It includes acceptance and integration tests. On board tests are to check that a computer based system in its final environment, integrated with all other systems with which it interacts is: a) performing functions it was designed for; b) reacting safely in case of failures originated internally or by devices external to the system; c) interacting safely with other systems implemented on board vessel; d) functioning properly with regard to data collection, storage, transmission, display and application; e) the functions of intelligent navigation, intelligent machinery, intelligent energy efficiency management are surveyed according to the requirements of each integration system; f) the requirements for functional and failure tests are tailored according to test programs for functional and failure tests.
- ② Where the test program for mooring/sea trials has already included relevant contents of the test program for on board tests, then it is not necessary to develop a separate test program for on board tests.
- ③ Acceptance tests: the test program is to include but not limited to the following: kick-off meeting (document specification, plan, etc.), check of the supplier and system integrator's documents (including factory test report), check of the list of hardware and software (including version No.), mechanical check (earthing system, power supply, internet connection, etc.), starting/diagnosis check (switching on power, initializing/test running the controller, carrying out diagnosis check), downloading software.
- ④ Integration tests: generally the test program is to include but not limited to the following: kick-off meeting (document specification, plan, etc.), check of the supplier and system integrator's documents (including factory test report), mechanical check (communication chain between systems), diagnosis check (communication between systems, baud rate, etc.), downloading software, where applicable. The test is to be carried out by the owner after the site acceptance test of each system is completed satisfactorily. The test is to test the connection of two or more independent systems. For example, when the system is integrated in the following forms, the test is to be carried out: with DCS/PLC communication analysis system using non-conventional IO signal; emergency shutdown (ESD) system; with DCS/PLC of several manufacturers; DCS integrated to network of higher structure; other connection of the system may also require the test.

(16) System installation procedure:

- ① The system installation procedure is developed by the system integrator and co-confirmed by the system integrator, the owner and the classification society. It includes operation environment, installation requirements and procedures of relevant devices. In particular the following are to be specified: a) environmental control requirements for computers,

internet devices, sensors, actuators (e.g. temperature, humidity, salt air, vibration); b) requirements for installation, connection, electromagnetic compatibility, earthing of IT devices such as computers; c) installation requirements for sensors (e.g. routing of pipelines); d) requirements for selection of cables for sensors and actuators and for manufacturing connections; e) procedural requirements for cable laying.

(17) On board test report (acceptance test): the surveyor may either check the test report or witness the test or carry out a combination of both.

(18) On board test report (integration test): the surveyor for construction survey may either check the test report or witness the test or carry out a combination of both.

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

(1) Operating manual (including trouble-shooting instructions);

It is to include system startup, function restoration, maintenance and periodical test, data security and data backup, user permissions, software reinstallation and system recovery, trouble shooting and repair, system updates, and other matters that users should pay attention to.

(2) Evidence of software verification:

- ① Software modules functional description and associated hardware description for programmable devices. This is to be provided by the supplier and the system integrator.
- ② Evidence of verification (detection and correction of software errors) for software modules, in accordance with the selected software development standard. Evidence requirements of the selected software standard might differ depending on how critical the correct operation of the software is to the function it performs (i.e. IEC 61508 has different requirements depending on SILs, similar approaches are taken by other recognized standard). This is to be supplied by the supplier and the system integrator.
- ③ Evidence of functional tests for programmable devices at the software module, sub-system, and system level. This is to be supplied by the supplier via the system integrator. The functional testing is to be designed to test the provisions of features used by the software but provided by the operating system, function libraries, customized layer of software and any set of parameters.

(3) Description of software functions;

(4) List and versions of software installed in system;

(5) User manual including instructions for use during software maintenance (including necessary procedures for management of software and hardware changes);

(6) List of interfaces between system and other ship systems;

(7) List of standards used for data links;

(8) On board test report (integration test): the surveyor for survey after construction may either review the test report for information or witness the test or carry out a combination of both.

(9) Updated Software Registry:

- ① list and versions of software installed in system;
- ② scan results for viruses and malicious software;
- ③ check points of automated systems and the preset parameters of safety systems are to be included;
- ④ calibration log of the device is to be included, where applicable.

(10) Analysis record and test report of software change effects.

## 12 Supplementary requirements for survey

### 12.1 Type approval of products

Type approval of products is to be carried out according to the requirements of Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. There are following supplementary requirements:

(1) Type test is to be carried out according to type test program (not including tests of functional testing and failure testing) as well as test program of functional testing and failure testing.

(2) Approval of programmable devices integrated inside a system is to be delivered to the system integrator or supplier. Approval can be granted on case by case basis, or as part of a product type approval, so long as the documents 1-11 of Table 11.2 have been reviewed/approved and the document 12 has been submitted upon completion of type tests. Documentation should address the compatibility of the programmable device in the ship's application, the necessity to have on board tests during ship integration and should identify the components of system using the approved programmable devices.

(3) Sub-systems and programmable devices may be approved for limited applications with service restrictions by CCS when the ship system where they will be integrated is not known. In this case, additional drawings, details, tests reports and surveys related to the standard declared by the supplier may be required by CCS upon request. Sub-systems and programmable devices may in this case be granted with a limited approval mentioning the required checks and tests performed.

### 12.2 Ship plan approval

Ship plan approval is to be carried out according to the requirements of Section 5, Chapter 2, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. There are following supplementary requirements:

(1) System integrators or suppliers are to submit documents 13 and 14 referred to in Table 11.2 for satisfactory review.

### 12.3 Unit/batch inspection

(1) In general, products/systems have been approved according to requirements for type approval of products mentioned above, and plan approval has been completed according to the requirements for ship plan approval mentioned above. At this point, product plan approval and inspection is carried out according to the requirements for unit/batch inspection in Section 2, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

(2) If products/systems have not been approved, application for unit/batch inspection need to be carried out according to the requirements of paragraph 3.2.2.4, Section 2, Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

(3) Documents 15 to 20 referred to in Table 11.2 are to be submitted for satisfactory review.

(4) There are following supplementary requirements for factory acceptance test:

Test is to be carried out according to factory acceptance test program with detailed test steps as follows:

- ① Test preparation. Rack/long distance IO (to force IO by connecting simulation equipment at field end), bus interface, subsystem connection.
- ② Test implementation, including system property, project-related supply and examination of application contents, mainly as follows: examination testing of system property (start-up testing, including normal functional testing of hardware redundancy and diagnosis), examination of contents relating to project provided (document examination, examination of

hardware and software list (including version), machinery examination (acceptance), wiring and terminal examination), pressure-resistant insulation test (if applicable), references.

- ③ Steps of application examination: HMI display examination, comprehensive function and interlock examination, additional function, communication testing with each subsystem, system function examination (in addition to testing of relevant application function, system property also includes system failure recovery, redundancy, alarm processing and confirmation, guaranteed system performance, e.g. refresh rate).

#### 12.4 Construction survey

##### (1) Document review

- ① Documents 22 and 23 referred to in Table 11.2 are to be submitted for satisfactory review.
- ② Relevant work is to be carried out after satisfactory review by the construction surveyor.
- ③ For program and technology with approval comments, the surveyor is to check shipyard's reply to the comments and implement them during corresponding survey.
- ④ During review, the emphasis is to confirm whether relevant requirements of PART SEVEN of CCS Rules for Classification of Sea-going Steel Ships are met. Approval of installation technology of relevant sensors is to meet corresponding technical requirements of the manufacturer.

##### (2) Onboard test

- ① Acceptance test and integration test are to be carried out according to onboard test program.
- ② For the requirements of acceptance test and integration test, refer to paragraph 11.3.1(14).
- ③ If the supplier has carried out acceptance test and integration test mentioned in ② of this sub-paragraph, the supplier's report may also be accepted after audit. Satisfactory audit result can be treated as equivalent replacement to items 24 and 25 in Table 11.2, and the report is to be signed with record.

#### 12.5 Survey after construction

##### (1) Following items are to be checked during annual, intermediate and special surveys:

- ① Previous operation records of intelligent integration platform are to be checked to confirm good operation of intelligent integration platform.
- ② Normal exchange of system data between ship and shore to confirm historical record of data exchange.
- ③ Random examination of system backup records to confirm that effective backup has been implemented to the system.
- ④ Survey of intelligent navigation, intelligent machinery and intelligent energy efficiency management according to the requirements of each integration system (integration test according to onboard test program when necessary).
- ⑤ If the supplier has carried out the testing work mentioned in above ① to ④, the supplier's report may also be accepted after audit. If site witness is impracticable due to time or testing condition, testing report completed within nearly one year may be audited. Satisfactory audit result can be treated as equivalent replacement to ① to ④, and the report is to be signed with record.
- ⑥ Whether following documents examined by CCS are kept on board ship: operational manual, software list and edition No. of system installation, software maintenance and instruction manual (including necessary procedure for management of software and hardware

alteration), list of interface between system and other systems of the ship, onboard test program (items 9, 16, 17, 18 and 22 in Table 11.2).

⑦ Documents 26 and 27 referred to in Table 11.2 (if applicable) are to be submitted for satisfactory audit.

(2) Ship modification or alteration is to be carried out according to relevant requirements of Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

## Annex 1 Supplementary explanation of test

Examples in this Annex are only for reference, and test items and acceptance basis are to be negotiated by the stakeholders.

The purpose of type approval test is to demonstrate capability of device with expected function under specified test condition.

Classification of environment condition is shown in paragraph 1.3.2 of CCS Guidelines for Type Approval Test of Electric and Electronic Products (hereinafter referred to as CCS Guidelines for Test).

According to purpose and installation position, electric and electronic devices are to be subject to relevant type approval test according to the provisions of Table 1.3.3.a of CCS Guidelines for Test. Type approval test items for electric and electronic devices of different type are shown in Table 1.3.3b of CCS Guidelines for Test.

Test items of type test (not including tests of functional testing and failure testing) are illustrated as follows:

Examples of test items of type test (not including tests of functional testing and failure testing)

No.	Test items	Test requirements	Remarks
1	Visual inspection	Paragraph 2.1 of CCS Guidelines for Test	
2	Insulation resistance test	Paragraph 2.3 of CCS Guidelines for Test	
3	Power supply variation and failure test	Paragraphs 2.4 and 2.5 of CCS Guidelines for Test	
4	Marine environment test	Paragraphs 2.6 to 2.13 of CCS Guidelines for Test	
5	High voltage test	Paragraph 2.14 of CCS Guidelines for Test	
6	Enclosure test	Paragraph 2.15 of CCS Guidelines for Test	
7	Flame retardant test	Paragraph 2.16 of CCS Guidelines for Test	When applicable
8	Electromagnetic compatibility test	Chapter 3 of CCS Guidelines for Test	

For tests of functional testing and failure testing, supplements are as follows:

The process for functional and failure tests includes FMEA or similar analysis that may be required by CCS. The test procedure is to describe test configuration and simulation method in conjunction with the characteristics of specific products according to the provisions of Chapters 5 to 10 of the Guidelines. Each test is to stipulate initial state of equipment/system, test method, test result analysis and acceptance criteria. Each test is to cover normal mode and failure mode (including self-inspection of the system, simulation test of system failures, changeover of redundant devices, if any) as well as power supply and communication failure. Functional and failure tests can be demonstrated by simulation tests.

Examples of functional testing and failure testing are shown in the following Table.

For the test program for on board tests (including wireless network testing), supplements are as follows:

- ① The test program for on board tests (activities and schedules) is developed by the system integrator and co-confirmed by the system integrator, the owner and the classification society. It includes acceptance and integration tests. On board tests are to check that a computer based system in its final environment, integrated with all other systems with

which it interacts is: a) performing functions it was designed for; b) reacting safely in case of failures originated internally or by devices external to the system; c) interacting safely with other systems implemented on board vessel; d) functioning properly with regard to data collection, storage, transmission, display and application; e) the functions of intelligent navigation, intelligent machinery, intelligent energy efficiency management are surveyed according to the requirements of each integration system; f) the requirements for functional and failure tests are tailored according to test programs for functional and failure tests.

- ② Where the test program for mooring/sea trials has already included relevant contents of the test program for on board tests, then it is not necessary to develop a separate test program for on board tests.
- ③ Acceptance tests: the test program is to include but not limited to the following: kick-off meeting (document specification, plan, etc.), check of the supplier and system integrator's documents (including factory test report), check of the list of hardware and software (including version No.), mechanical check (earthing system, power supply, internet connection, etc.), starting/diagnosis check (switching on power, initializing/test running the controller, carrying out diagnosis check), downloading software.
- ④ Integration tests: generally the test program is to include but not limited to the following: kick-off meeting (document specification, plan, etc.), check of the supplier and system integrator's documents (including factory test report), mechanical check (communication chain between systems), diagnosis check (communication between systems, baud rate, etc.), downloading software, where applicable. The test is to be carried out by the owner after the site acceptance test of each system is completed satisfactorily. The test is to test the connection of two or more independent systems. For example, when the system is integrated in the following forms, the test is to be carried out: with DCS/PLC communication analysis system using non-conventional IO signal; emergency shutdown (ESD) system; with DCS/PLC of several manufacturers; DCS integrated to network of higher structure; other connection of the system may also require the test.

Examples of acceptance test and integration test are shown in the following Table.

Examples of function testing and failure testing

No.	Test item	Initial condition of device/system	Test method	Test result analysis and acceptance criteria	Test result requirements	Remarks
1	Document check		Checking whether all documents have been submitted and they are issued as controlled copies			
2	General examination of software and hardware		Verifying that contents of hardware structure, quantity, size and painting are consistent with relevant documents. In addition, contents of software authorization, spare parts and consumables are also to be checked			
2.1	Hardware examination					
2.2	Software authorization, edition (including firmware) check					
2.3	Examination of spare parts, consumables and tools					
3	Examination of mechanical and electrical installation		Hardware structure and design are examined by referring to approval documents			
3.1	Cable entry method, bracket and attachment (cable fixing clamp and fixing head, etc.)					
3.2	Mark, label					
3.3	Installation of components and modules					
3.4	Screw fastening connection and terminal connection					
3.5	Earthing and equal potential connection					

3.6	Protection against electric shock, warning mark					
3.7	Maintainability of cabinet fan and mechanism structure					
3.8	Spare capacity					
4	Wiring and terminal examination		Checking that wiring complies with guiding policy provided in engineering project rules, and approved hardware documents and technology comply with industrial standards			
4.1	Wiring, internal circuit wiring					
4.2	Fusing, circuit breaker					
4.3	Mark, label					
4.4	Division of cable, color, cross section, voltage and explosion-proof grade					
4.5	Cable bending examination					
4.6	Artificial cable bending and straining test					
4.7	Cable pipe load					
4.8	Wiring of I/O to terminal and connection mark					
4.9	System cable plug direction					
4.10	System voltage insulation testing					
5	Start testing and basic function of system		Survey system can start in normal condition, recover from power failure and upload on line. In addition, it is also to check whether the system is operated within given restriction scope.			
5.1	Restart		Using new memory card and removing spare battery of control			

5.2	Online change					
5.3	Control cycle time					
5.4	Display call time					
5.5	Numerical update time					
5.6	System load (memory capacity, storage capacity, etc.)					
5.7	Landing policy and level					5.3.1(9)
5.8	Alarm processing policy and confirmation method					
6	System alarm testing		Report of alarm in survey system, including system-related failure, control tank alarm and system alarm			
6.1	Power failure, UPS monitoring					
6.2	Circuit breaker, fuse monitoring					
6.3	Cooling fan					
6.4	Communication, network monitoring					
6.5	Short circuit, disconnection, outrange, earthing failure					
6.6	Watchdog					
7	Hardware redundancy and diagnosis examination		Ensuring that redundant parts can operate and monitor in normal condition			5.3.1(2)~(5), (10)
7.1	Redundant operation and monitoring of control					
7.2	Redundant operation and monitoring of communication and network					
7.3	Redundant operation and monitoring of power supply					
7.4	Redundant operation and monitoring of operator station					
7.5	Redundant operation and monitoring of I/O device					
7.6	Redundant operation and monitoring of all other devices not					

	mentioned above					
8	Monitoring/operation		Verifying consistency of standard function and graphic display plan with specification			8
8.1	Background color and color change					
8.2	Symbol					
8.3	Static text and dynamic change					
8.4	Picture organization (folding, conversion , subpicture)					
9	Function testing carried out according to function block diagram and function plan		Verifying consistency of system function with given document requirements			8, 9
9.1	Identification and labeling of loop/function					
9.2	Display of testing relevant I/O to picture					
9.3	Carrying out detailed function examination after putting all relevant interlock, alarm, message, display and trend and updating signals on graphic picture and device picture					
9.4	Bit number operation and trend collection function (internal and external)					
9.5	Priority processing of alarm					
10	Complicated function and operation mode		Checking consistency of system function with given document requirements			
10.1	Carrying out detailed function examination after putting all relevant interlock, alarm, message, display and trend and updating signals on graphic picture and device picture					8, 9
10.2	Whether the system has integrated data of three systems of intelligent navigation, intelligent machinery and intelligent energy efficiency, whether the system is open to realize ship monitoring		Checking consistency of system function with Chapter 5 of the Guidelines			5.1

	and intelligent management as well as data exchange with shore base					
10.3	System requirements					
10.3.1	Ic1 Information summary and display and Ic2 Assistant decision-making of intelligent integration platform are to satisfy the requirements for CCS category II computer based systems. Ic3 Control related is to satisfy the requirements for CCS category III computer based systems. If the system category is revised by the stakeholder based on risk, the agreement of CCS is to be sought		Carrying out evaluation to the system according to Guidelines for Assessment of Security and Reliability of Marine Software			5.3.1(1), 5.4, 6, 10.1, 10.2
10.3.2	Database of integration platform is to have valid integration process, i.e. screening necessary data according to data quality of each system and functional requirements for integration platform. The system supports multi-terminal (PC and mobile device) access. When necessary, the system is to provide external data transmission interface and have capability of sharing data with relevant parties					5.3.1(6)-(8), 5.3.2, 7
10.4	The system is to meet the requirements for network security		Network security is to comply with the requirements of CCS Guidelines for Network System Requirements and Security Assessment of Ships			10.3
11	Sub-function integration testing		Verifying interoperability of each relevant system			8, 9
11.1	Carrying out detailed function examination after putting all relevant interlock, alarm, message, display and trend and updating signals on graphic picture and device picture					

Example of acceptance test

No.	Test items	Initial condition of device/system	Test method	Test result analysis and acceptance criteria	Test result requirements	Remarks
1	Examination of control system documents					
2	Examination of hardware specification and quantity					
3	Examination of software specification and quantity (correct software/firmware edition, etc.)					
4	Examination of mechanical and electrical installation					
4.1	Correct connection of earthing system					
4.2	Correct connection of power supply system					
4.3	Correct connection of network system					
5	Start/diagnosis examination					
5.1	Power on of relevant hardware					
5.2	Debugging/initializing relevant hardware and carrying out diagnosis examination					
6	Downloading software					

Example of integration test

No.	Test items	Initial condition of device/system	Test method	Test result analysis and acceptance criteria	Test result requirements	Remarks
1	Examination of control system documents					
2	Examination of mechanical and electrical installation					
3	Correct installation and connection among systems (serial port, Ethernet, optical fiber, etc.)					
3.1	Correct setting of communication baud rate (dial switch on the					

	hardware, software setting, etc.)					
3.2	Verifying normal communication of system I/O signals among different systems					
4	Picture of subsystems in the system is set according to the requirements of the Rules					
4.1	Function is to comply with applicable contents of functional testing and failure testing in type approval					