RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part X   COMPUTER-BASED SYSTEMS

Rules for the Survey and Construction of Steel Ships
Part X   ESTABLISHMENT
Guidance for the Survey and Construction of Steel Ships
Part X   ESTABLISHMENT

Rule No.67 / Notice No.63   22 December 2023

Resolved by Technical Committee on 27 July 2023

ClassNK
NIPPON KAIJI KYOKAI

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part X   **COMPUTER-BASED SYSTEMS**

2023 ESTABLISHMENT

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An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

Rule No.67   22 December 2023
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part X has been established as follows.

Part X   COMPUTER-BASED SYSTEMS

Chapter 1   INTRODUCTION

1.1   General

1.1.1   Scope
This Part applies to computer-based systems, including the hardware and software which constitute such systems.

1.1.2   Equivalency
Computer-based systems which do not comply with this Part may be accepted provided that they are deemed by the Society to be equivalent to those specified in this Part.

Chapter 2   PLANS, DOCUMENTS AND TESTS

2.1   Submission of Plans and Documents

2.1.1   Submission of Plans and Documents
The following drawings and data are, in principle, to be submitted.
(1)   Plans and documents for approval:
    (a)   Plans and documents for computer-based systems subject to **Chapter 3** that are required to be submitted for approval purposes are specified in **2.2.1** and **2.2.2** according to system category. Summaries of said plans and documents are shown in **Tables X2.1** and **X2.2**. However, submission of plans and documents may be omitted in accordance with **2.1.2-6, Part B** for computer-based systems approved for use in accordance with **Chapter 8, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.
    (b)   Other plans and documents considered necessary by the Society
(2)   Plans and documents for reference:
    (a)   Plans and documents for computer-based systems subject to **Chapter 3** that are required to be submitted for reference purposes are specified in **2.2.1** and **2.2.2** according to system category. Summaries of said plans and documents are shown in **Tables X2.1** and **X2.2**. However, submission of plans and documents may be omitted in accordance with **2.1.2-6, Part B** for computer-based systems approved for use in accordance with **Chapter 8, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**, except for the "list of system categorisations" specified in **2.2.2-3**.
    (b)   Other plans and documents considered necessary by the Society

Table X2.1   Plans and Documents to be Submitted by System Suppliers

Referenced requirements	Plans and documents	Category I		Categories II and III	
		Reference	Approval	Reference	Approval
2.2.1-1 and **3.4.2-1**	Quality plan (and quality manual)	-	-	-	○
2.2.1-3 and **3.4.2-3**	System descriptions (System specification and design)	○*	-	-	○
2.2.1-4 and **3.4.2-4**	Environmental compliance	○*	-	○	-
2.2.1-5 and **3.4.2-5**	Software test report	-	-	○*	-
2.2.1-6 and **3.4.2-6**	System test report	-	-	○*	-
2.2.1-7 and **3.4.2-7**	FAT program	-	-	-	○
2.2.1-7 and **3.4.2-7**	FAT report	-	-	○	-
2.2.1-7 and **3.4.2-7**	Additional FAT documentation (e.g. user manuals)	-	-	○*	-
2.2.1-8 and **3.4.2-8**	Change management procedure	-	-	-	○

(Notes)

Approval: Plans and documents to be submitted for approval

Reference: Plans and documents to be submitted for reference

○ : Submission required

○*: Submission required only when deemed necessary by the Society or its surveyor

See **3.3.1** for information on system categories

Table X2.2   Plans and Documents to be Submitted by Systems Integrators

Referenced requirements	Plans and documents	Category I		Categories II and III	
		Reference	Approval	Reference	Approval
2.2.2-2 and **3.4.3-2**	Quality plan	-	-	-	○*
2.2.2-3 and **3.4.3-3**	List of system categorisations	For reference (regardless of category) ○			
2.2.2-4 and **3.4.3-4**	Risk assessment report (For determining system category)	For reference (regardless of category) ○*			
2.2.2-5 and **3.4.3-5**	Vessel's system architecture	○*	-	○*	-
2.2.2-6 and **3.4.3-6**	SAT program	-	-	-	○
2.2.2-6 and **3.4.3-6**	SAT report	-	-	○	-
2.2.2-7 and **3.4.3-7**	SOST program	-	-	-	○
2.2.2-7 and **3.4.3-7**	SOST report	-	-	○	-
2.2.2-8 and **3.4.3-8**	Change management procedure	-	-	-	○*

(Notes)

Approval: Plans and documents to be submitted for approval

Reference: Plans and documents to be submitted for reference

○ : Submission required

○*: Submission required only when deemed necessary by the Society or its surveyor

See **3.3.1** for information on system categories

2.2   Tests

Computer-based systems subject to **Chapter 3** are to be verified by the Society in accordance with **2.2.1** and **2.2.2** based on their system category. A summary of the tests to be witnessed and verified by Society surveyors are shown in **Table X2.3**.

Table X2.3   Test Witnessing and Verifying

Referenced requirements	Verification details	Responsible party	Category I	Category II	Category III
2.2.1-7 and **3.4.2-7**	Witness FAT	System supplier	-	○	○
2.2.2-6 and **3.4.3-6**	Witness SAT	Systems integrator	-	○	○
2.2.2-7 and **3.4.3-7**	Witness SOST	Systems integrator	-	○	○
3.6.12	Verification of changes	Systems integrator	-	○	○

(Notes)

○: Test required to be witnessed and verified by a Society surveyor

See **3.3.1** for information on system categories

2.2.1   Verification Items for System Suppliers

1   Quality plan (and quality manual) (see **3.4.2-1**)

(1)   Category I: This requirement is not applicable. (hereafter referred to as "N/A" in this Chapter)

(2)   Categories II and III:

    (a)   Quality plan (and quality manual) are to be submitted for approval.

    (b)   Quality plan (and quality manual) are to be made available during FAT.

2   Unique identification of systems and software (see **3.4.2-2**)

(1)   Category I: N/A

(2)   Categories II and III: Application of the identification system is verified as a part of the FAT (see **3.4.2-7**) and SAT (see **3.4.3-6**)

3　System description (System specification and design) (see **3.4.2-3**)

(1)　Category I: The system description documentation is to be submitted for reference when deemed necessary by the Society.

(2)　Categories II and III: The system description documentation is to be submitted for approval.

4　Environmental compliance of hardware components (see **3.4.2-4**)

(1)　Category I: Environmental tests may be omitted. However, certificates issued in accordance with **Chapter 1, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** or documents proving the passing of the environmental tests specified in **18.7.1(1), Part D** are to be submitted for reference when deemed necessary by Society (see **3.3.2**).

(2)　Categories II and III: Certificates issued in accordance with **Chapter 1, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** or documents proving the passing of the environmental tests specified in **18.7.1(1), Part D** are to be submitted for reference.

5　Software code creation, parameterisation, and testing (see **3.4.2-5**)

(1)　Category I: N/A

(2)　Categories II and III: Software test report is to be submitted for reference when deemed necessary by the Surveyor.

6　Internal system testing before FAT (see **3.4.2-6**)

(1)　Category I: N/A

(2)　Categories II and III:

　　(a)　Internal system test report is to be available during survey (FAT).

　　(b)　Internal system test report is to be submitted for reference when deemed necessary by the Surveyor.

7　FAT before installation on board (see **3.4.2-7**)

(1)　Category I: N/A

(2)　Categories II and III:

　　(a)　The FAT program is to be submitted for approval before the test.

　　(b)　The FAT is to be witnessed by the Surveyor.

　　(c)　The FAT report is to be submitted to the Society branch office in charge for reference.

　　(d)　Additional FAT documentation (e.g. user manuals and internal system test reports specified in **-6**) is to be made available during the FAT.

　　(e)　Additional FAT documentation (e.g. user manuals and internal system test reports specified in **-6**) is to be submitted for reference when deemed necessary by the Surveyor.

8　Secure and controlled software installation on the vessel (see **3.4.2-8**)

(1)　Category I: N/A

(2)　Categories II and III: The change management procedure is to be submitted for approval. The change management procedure may be included in quality plan (and quality manual).

2.2.2　Verification Items for Systems Integrators

1　Appointed systems integrator (see **3.5.1-1**)

The Society is to be informed in a timely manner by owners about the systems integrators appointed to be responsible for implementing any changes to the systems in conjunction with system suppliers.

2　Quality plan (see **3.4.3-2**)

(1)　Category I: N/A

(2)　Categories II and III:

　　(a)　Quality plan is to be made available for verification by the Surveyor during surveys (SAT/SOST).

　　(b)　Quality plan is to be submitted for the approval when deemed necessary by the Society.

3   Determining the category of the system in question (see **3.4.3-3**)

The categories for the different systems are to be documented in the list of system categorisations and submitted for reference.

4   Risk assessment of the system (see **3.4.3-4**)

Risk assessment report is to be submitted for approval when deemed necessary by the Society.

5   Define the vessel's system architecture (see **3.4.3-5**)

The vessel's system architecture is to be submitted for reference when deemed necessary by the Society.

6   System acceptance test (SAT) on board the vessel (see **3.4.3-6**)

(1)   Category I: N/A

(2)   Categories II and III:

     (a)   The SAT program is to be submitted to the Surveyor for approval before the test.

     (b)   The SAT is to be witnessed by the Surveyor.

     (c)   The SAT report is to be submitted to the Surveyor for reference.

7   SOST at the vessel level (see **3.4.3-7**)

(1)   Category I: N/A

(2)   Categories II and III:

     (a)   The SOST program is to be submitted to the Surveyor for approval before the test.

     (b)   The SOST is to be witnessed by the Surveyor.

     (c)   The SOST report is to be submitted to the Surveyor for reference.

8   Change management (see **3.4.3-8**)

(1)   Category I: N/A

(2)   Categories II and III: The change management procedure is to be submitted for approval when deemed necessary by the Society.

Chapter 3   COMPUTER-BASED SYSTEMS

3.1   General

3.1.1   Scope
This chapter applies to the design, construction, testing and maintenance of computer-based systems that are subject to classification requirements, including the hardware and software which constitute such systems. However, this chapter does not apply to computer-based systems subject to statutory regulation such as the following **(1)** to **(4)**.
(1)   the navigating equipment specified in the **Rules for Safety Equipment**,
(2)   the radio installations specified in the **Rules for Radio Installations**,
(3)   stability computers, and
(4)   loading computers.

3.1.2   References
The following identified standards may be used for the development of hardware / software of computer-based systems. Other industry standards, however, may also be considered.
(1)   *IEC* 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems
(2)   *ISO/IEC* 12207:2017 Systems and software engineering - Software life cycle processes
(3)   *ISO* 9001:2015 Quality Management Systems – Requirements
(4)   *ISO/IEC* 90003:2018 Software engineering - Guidelines for the application of ISO 9001:2015 to computer software
(5)   *IEC* 60092-504:2016 Electrical installations in ships - Part 504: Special features - Control and instrumentation
(6)   *ISO/IEC* 25000:2014 Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - Guide to SQuaRE
(7)   *ISO/IEC* 25041:2012 Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - Evaluation guide for developers, acquirers and independent evaluators
(8)   *IEC* 61511:2016 Functional safety - Safety instrumented systems for the process industry sector
(9)   *ISO/IEC* 15288:2015 Systems and software engineering - System life cycle process
(10)   *ISO* 90007:2017 Quality management - Guidelines for configuration management
(11)   *ISO* 24060:2021 Ships and marine technology - Ship software logging system for operational technology

3.1.3   Structure
1   General certification requirements for computer-based systems and their relationship to approval of use are described in **3.2**.
2   The requirements and extent of verification for a computer-based system depends on its categorisation. There are three categories, and they are described in **3.3**.
3   Activities related to the development and delivery of computer-based system are described in **3.4**, while activities related to maintenance in the operational phase are described in **3.5**. This Chapter covers the life cycle of computer-based systems from design through operations. The requirements are split into groups representing the different phases of the life cycle and the parties responsible for meeting said requirements.
4   Change management for software and systems is given special attention in this Chapter and the main aspects of a change management process are described in **3.6**.
5   This Chapter mainly focuses on the activities to be performed, but it also contains some

technical requirements, and these requirements are described in **3.7**.

6   The plans and documents to be submitted, and the tests required to be carried out are described in **Chapter 2**.

3.1.4   Terminology
The terms used in this Chapter are defined as follows.

(1)   "Black-box description" means a description of a system's functionality and behaviour and performance as observed from outside the system in question.

(2)   "Black-box test methods" means verification of the functionality, performance and robustness of a system, sub-system or component by only manipulating the inputs and observing the outputs. This does not require any knowledge of the system's inner workings and focuses only on the observable behaviour of the system or component being tested in order to achieve the desired level of verification.

(3)   "Computer-based system" means a programmable electronic device, or interoperable set of programmable electronic devices, organised to achieve one or more specified purposes such as collection, processing, maintenance, use, sharing, dissemination or disposition of information. Onboard computer-based systems include Information Technology (IT) and Operational Technology (OT) systems, and may be a combination of sub-systems connected via network. Onboard computer-based systems may be connected directly or via public means of communications (e.g. the Internet) to on-shore computer-based systems, other vessels' computer-based systems or other facilities.

(4)   "Failure mode description" means a document describing the effects due to failures in the system, not failures in the equipment supported by the system. The following aspects are to be covered:
(a)   A list of failures which are subject to assessment.
(b)   A description of the system response to each failure.
(c)   Comments on the consequences of each failure.

(5)   "Owner" means the organisation or person which orders the vessel in the construction phase or the organisation which owns or manages the vessel in service.

(6)   "Parameterisation" means the configuration and tuning of a system and software functionality by changing parameters. It does not usually require computer programming and is normally done by system suppliers or service providers, not operators or end-users.

(7)   "Programmable device" means the physical component in which software is installed.

(8)   "Robustness" means the ability to respond to abnormal inputs and conditions.

(9)   "Service supplier" means a person or company, not employed by the Society, who at the request of an equipment manufacturer, shipyard, vessel's owner or other client acts in connection with inspection work and provides services for a ship or a mobile offshore unit such as measurements, tests or maintenance of safety systems and equipment. The results of these services are then used by the Surveyors in making decisions affecting classification or statutory certification and services.

(10)   "Simulation test" means monitoring, control or safety system testing in which the equipment under control is either partly or fully replaced with simulation tools, or in which parts of the communication network and lines are replaced with simulation tools.

(11)   "Vessel-specific certificate" means compliance document issued by the Society stating the following:
(a)   Conformity with applicable rules and requirements.
(b)   That tests and inspections have been carried out on either the finished certified component itself or on samples taken from earlier stages in the production of the component, when applicable.
(c)   That tests and inspections were carried out either in the presence of a Society surveyor or

in accordance with the **Rules for Approval of Manufacturers and Service Suppliers**.

(12) "Software component" means a standalone piece of code that provides specific and closely coupled functionality.

(13) "Software master files" means computer-files that constitute the original source of software. For custom made software this may be readable source-code files, and for commercial-off-the-shelf (COTS) software it may be different forms of binary files.

(14) "Software-structure" means overview of how the different software components interact and is commonly referred to as the software architecture or software hierarchy.

(15) "Sub-system" means an identifiable part of a system, which may perform a specific function or set of functions.

(16) "Supplier" means a generic term used for any organisation or person that is a contracted or a subcontracted provider of services, system components or software.

(17) "System" means a combination of components, equipment and logic which has a defined purpose, functionality and performance. In the context of this Chapter, a specific system is delivered by one system supplier. An illustrative system hierarchy is shown in **Fig. X3.1**.

(18) "System of systems" means a system which is made up of several systems. In the context of this Chapter, a system of systems encompasses all monitoring, control and safety systems delivered from the shipyard as a part of a vessel.

(19) "System supplier" means an organisation or person that is a contracted or a subcontracted provider of system components or software under the coordination of the systems integrator.

(20) "Systems integrator" means single organisation or a person coordinating interaction between Suppliers of systems and sub-systems at all stages of life cycle of computer-based systems in order to integrate them into a verified vessel-wide system of systems and to provide proper operation and maintenance for the computer-based systems. The shipyard is the default systems integrator during the design and delivery phases, while the owner is the default systems integrator during the operations phase.

(21) "Vessel" means ship or offshore unit where the computer-based system is to be installed.

(22) "FAT" means factory acceptance test before installation on board in accordance with **3.4.2-7**.

(23) "SAT" means system acceptance test onboard the vessel in accordance with **3.4.3-6**.

(24) "SOST" means system of systems (SoS) test at the vessel level in accordance with **3.4.3-7**.

Fig. X3.1 Illustrative System Hierarchy
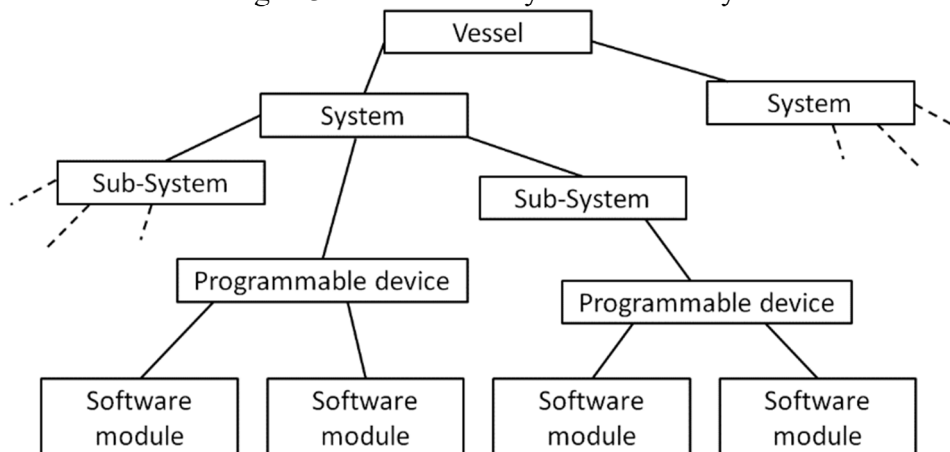
3.2 Approval of Systems and Components

3.2.1 System Certification*

1 Computer-based systems that are needed to accomplish vessel functions of Category II or Category III (as defined in **3.3.1**) are to be delivered with a vessel-specific certificate. The objective of vessel-specific system certification is to confirm that the design and manufacturing of a system has been completed and that the system complies with applicable requirements of the Society. Vessel-specific system certification consists of two main verification activities:

(1) Assessment of vessel-specific documentation (see **3.4.2** and **3.6**)
(2) Survey and testing of the system to be delivered to the vessel (see **3.4.2-7**)

2 The Society may apply the **Rules for Approval of Manufacturers and Service Suppliers** as the requirements specified otherwise by the Society to the confirmation and issuance of vessel-specific certificates specified in **-1** above.

3.2.2 Approval of Use for Computer-based Systems

1 Computer-based systems that are routinely manufactured and include standardised software functions may be approved in accordance with **Chapter 8, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**. Hardware is to be documented according to **2.2.1-4**. The approval of use consists of two main verification activities:

(1) assessment of type-specific documentation, and
(2) survey and testing of the standardised functions.

2 In principle, vessel-specific system certification is required as specified in **3.2.1** even if the approval of use is acquired for computer-based systems. However, for such computer systems, submitted drawings may be omitted subject to **2.1.1(1)(a)** and **(2)(a)**, and tests may be subject to **3.2.1-2**.

3.3 System Categories

3.3.1 Definitions

The categorisation of a system in the context of this Chapter is based on the potential severity of the consequences if the system serving the function fails. **Table X3.1** provides the definitions of the categories.

Table X3.1   System Categories

Category	Failure effects	Typical system functionality
I	Those systems whose failure will not lead to dangerous situations for human safety, vessel safety or a threat to the environment.	Monitoring, informational and administrative functions
II	Those systems whose failure could eventually lead to dangerous situations for human safety, vessel safety or a threat to the environment.	Vessel alarm, monitoring and control functions that are necessary to maintain the vessel in its normal operational and habitable conditions
III	Those systems whose failure could immediately lead to dangerous or catastrophic situations for human safety, vessel safety or a threat to the environment.	- Control functions for maintaining vessel propulsion and steering - Vessel safety functions

3.3.2 Scope of Application

Category I systems are normally not subject to verification by the Society since a failure of such systems does not lead to dangerous situations. However, information pertinent to Category I systems is to be provided upon request to determine the correct category and ensure that they do not influence the operation of Category II and III systems.

3.3.3 Examples*

The category of a system is always to be evaluated in the context of the specific vessel in question; thus, the categorisation of a system may vary from one vessel to the next. This means that the examples of categories below are not exhaustive but only being given for reference. For determining the categorisation of systems for a specific vessel, see **3.4.3-3**.

(1) Examples of Category I systems
　　(a) Fuel monitoring system
　　(b) Maintenance support system
　　(c) Diagnostics and troubleshooting system
　　(d) Closed circuit television (CCTV)
　　(e) Cabin security
　　(f) Entertainment system
　　(g) Fish detection system
(2) Examples of Category II systems
　　(a) Fuel control system
　　(b) Alarm monitoring and safety systems for propulsion and auxiliary machinery
　　(c) Inert gas system
　　(d) Control, monitoring and safety system for cargo containment system
(3) Examples of Category III systems
　　(a) Propulsion control system
　　(b) Steering gear control system
　　(c) Electric power system (including power management system)
　　(d) Dynamic positioning system (Classes 2 and 3)

3.4 Requirements for Development and Certification of Computer-based Systems

3.4.1 General Requirements

1 Life cycle approach with appropriate standards

A global top-down approach is to be undertaken in the design and development of both hardware and software, and the integration in sub-systems, systems, and system of systems, spanning the complete system life cycle. This approach is to be based on the standards listed herein or other standards recognised by the Society. This is to be verified by the Society as a part of the quality management system verification described in **-2** below.

2 Quality management systems

Systems integrators and system suppliers are to comply with a recognised quality standard (e.g. *ISO* 9001 incorporating principles of *IEC/ISO* 90003) with respect to the quality management of Category II and III computer-based systems. Quality management systems for Category II and III systems are to as a minimum include the items specified in **Table X3.2**. In addition, quality management systems are to be verified by following **(1)** or **(2)**.

(1) The Society confirms that the quality management system is certified as compliant with a recognised standard by an organisation with accreditation under a national accreditation scheme.

(2) The Society confirms that the quality management system complies with a standard through a specific assessment of the quality management system. The documentation requirements for this method will be defined on a per case basis.

Table X3.2   Quality Management Systems

	Area		Role	
#	Topic		System supplier	Systems integrator
1	Responsibilities and competency of the staff		×	×
2	The complete life cycle of the delivered software and associated hardware		×	×
3	Specific procedure for unique identification of a computer-based system, its components and versions		×	-
4	Creation and update of the vessel's system architecture		-	×
5	Organisation set in place for the acquisition of software and related hardware from suppliers		×	×
6	Organisation set in place for software code writing and verification		×	-
7	Organisation set in place for system validation before integration in the vessel		×	-
8	Specific procedure for conducting and approving of systems at FAT and SAT		×	×
9	Creation and update of system documentation		×	-
10	Specific procedure for software modification and installation on board the vessel, including interactions with shipyards and owners		×	×
11	Specific procedures for verification of software code		×	-
12	Procedures for integrating systems with other systems, and testing of the system of systems for the vessel		×	×
13	Procedures for managing changes to software and configurations before FAT		×	-
14	Procedures for managing and documenting changes to software and configurations after FAT		×	×
15	Checkpoints for the organization's own follow-up of adherence to its quality management system		×	×

(Note)
×: To be included in the quality management system

3.4.2   Requirements for System Suppliers*

1 Define and follow a quality plan supplemented by quality manual as necessary (hereinafter referred to as "quality plan and quality manual")

(1) System suppliers are to document that the quality management system is being applied to the design, construction, delivery, and maintenance of the specific system to be delivered.

(2) All applicable items described in **Table X3.2** (for system suppliers) are to be demonstrated to exist and to be being followed, as relevant.

2 Unique identification of systems and software

A method for uniquely identifying a system, its different software components and different revisions of the same software component is to be applied. Said method is to be applied throughout the life cycle of the system and its software. Relevant technical requirements for the system in question are specified in **3.7.1**. The documentation of the method is, in general, considered to be part of the quality management system specified in **3.4.1-2**.

3 System description (System specification and design)

(1) The system's specification and design are to be determined and documented in a system description. In addition to serving as a specification for the detailed design and implementation of the system, the purpose of the system description is to document that the entire system-delivery is in accordance with the specifications and in compliance with applicable requirements and restrictions.

(2) System descriptions are to include the following information.

    (a) Purpose and main functions, including any safety aspects

    (b) System category, as defined

    (c) Key performance characteristics

    (d) Compliance with the technical requirements and the Society's Rules

    (e) User interfaces / mimics

    (f) Communication and interface aspects
        Identification and description of interfaces to other vessel systems
    (g) Hardware-arrangement related aspects
        i)   Network-architecture / topology, including all network components like switches, routers, gateways, firewalls, etc.
        ii)   Internal structure with regards to all interfaces and hardware nodes in the system (e.g. operator stations, displays, computers, programmable devices, sensors, actuators, I/O modules)
        iii) I/O allocation (mapping of field devices to channel, communication link, hardware unit, logic function)
        iv) Power supply arrangements
    (h) Risk assessment report by FMEA (failure mode effect analysis) or justification for the omission of risk assessment

4   Environmental compliance of hardware components

Environmental tests for hardware, which includes systems and sub-systems, are to comply with **18.7.1(1), Part D**.

5   Software code creation, parameterisation, and testing

(1)   Software created, changed or configured for the project is to be developed and have quality assurance activities assessed in accordance with selected standards, as described in the quality plan (and quality manual).

(2)   Quality assurance activities may be performed on several levels of the software structure and are to include both custom-made software and configured components (e.g. software libraries), as appropriate.

(3)   Verification of the software is, at a minimum, to verify the following aspects based on black-box methods:
    (a) correctness, completeness and consistency of any parameterisation and configuration of software components;
    (b) intended functionality; and
    (c) intended robustness.

(4)   For Category II and III system components, the scope, purpose and results of all performed reviews, analyses, tests and other verification activities are to be documented in test reports.

6   Internal system testing before FAT

(1)   Systems are, as far as practicable, to be tested before FAT. The main purpose of such testing is for system suppliers to verify that the entire system is in accordance with specifications and approved documentation, in compliance with applicable rules and regulations, and, furthermore, is complete and ready for FAT.

(2)   Testing is, at a minimum, to verify the following aspects of the system.
    (a) Functionality
    (b) Effect of faults and failures (including diagnostic functions, detection, alert responses)
    (c) Performance
    (d) Integration between software and hardware components
    (e) Human-machine interfaces
    (f) Interfaces to other systems

(3)   Faults are to be simulated as realistically as possible to demonstrate appropriate system fault detection and system response.

(4)   Some of the testing may be performed by utilising simulators and replica hardware.

(5)   The test environment is to be documented, including a description of any simulators, emulators, test-stubs, test-management tools, or other tools affecting the test environment and its limitations.

(6) Test cases and test results are to be documented in test programs and test reports, respectively.

7 Factory acceptance test (FAT) before installation on board

(1) FAT is to be carried out for each product or when the computer-based system acquires approval of use in accordance with **Chapter 8, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**. The main purpose of FAT is to demonstrate to the Society that the system is complete and compliant with applicable requirements, thus enabling issuance of a vessel-specific certificate for the system.

(2) FAT test programs are to cover a representative selection of test items from internal system tests (see **3.4.2-6**), including normal system functionality and response to failures.

(3) For Category II and III systems, network testing to verify the network resilience required by **3.7.2-1** is to be performed. If agreed to by all parties, such testing may be performed as part of system tests on board the vessel.

(4) FAT is, in principle, to be performed with project specific software operating on the actual hardware components to be installed on board, with necessary means for simulation of functions and failure responses. However, other solutions such as replica hardware or simulated hardware (emulators) may be agreed upon with the Society.

(5) For each test case, it is to be noted whether the test was passed or failed, and test results are to be documented in test reports. Such test reports are to also contain a list of the software (including software versions) that were installed in the system when the test was performed.

8 Secure and controlled software installation on board vessels

(1) The initial installation and subsequent updates of the software components of a system are to be carried out in accordance with a change management procedure which has been agreed upon between the system supplier and the systems integrator.

(2) The change management procedure is to comply with **3.6**.

(3) Cyber security measures are to be deemed appropriate by the Society.

3.4.3 Requirements for Systems Integrators*

1 Responsibilities

For the purposes of this Chapter, the shipyard is considered to be the systems integrator for the development and delivery phases unless another organisation or person is explicitly appointed as such by the shipyard.

2 Define and follow a quality plan

(1) Systems integrators are to document that quality management systems are being applied to the installation, integration, completion and maintenance of the systems to be installed on board.

(2) All applicable items described in **Table X3.2** (for systems integrators) are to be demonstrated to exist and to be being followed, as relevant.

3 Determining the category of the system in question

(1) For each system delivery to a particular vessel, it is to be decided which category the system falls under based on the failure effects of the system (as defined in **3.3**).

(2) The category for a specific system is to be conveyed to the relevant system supplier.

(3) The Society may decide that a risk assessment is needed to verify the proper system category.

4 Risk assessment of the system

(1) If requested by the Society, a risk assessment of a specific system in context of the specific vessel in question is to be performed and documented in order to determine the applicable category for the system.

(2) The method of risk assessment is to be agreed to by the Society.

5 Define the vessel's system architecture

(1) The system of systems is to be specified and documented. This architecture specification provides the basis for category determination and development of the different interconnected systems by allocating functionality to individual systems and by identifying the main

interfaces between the systems.

(2) It is also to serve as a basis for the SOST at the vessel level (see **3.4.3-7**).

(3) The vessel's system architecture is to include at least the following information.
(a) Overview of the total system architecture (the system of systems)
(b) Each system's purpose and main functionality
(c) Communication and interface aspects between different systems
(d) Risk assessment report for the system of systems

6 System acceptance test (SAT) on board vessels

(1) SAT is to be performed on board the vessel. The main purpose of the SAT is to verify system functionality after installation and integration with the applicable machinery / electrical / process systems on board (including possible interfaces with other control and monitoring systems).

(2) For each testcase, it is to be noted whether the test was passed or failed, and the test results are to be documented in a test report. Such test reports are to also contain a list of the software (including software versions) that were installed in the system when the test was performed.

7 SOST at the vessel level

(1) Integration tests are to be conducted after the installation and integration of different systems in their final environment on board. The purpose of such tests is to verify the functionality of the complete installation (system of systems) including all interfaces and inter-dependencies in compliance with requirements and specifications.

(2) Testing is, at a minimum, to verify the following aspects of the system of systems.
(a) Overall functionality of the interacting systems as a whole
(b) Failure response between systems
(c) Performance
(d) Human-machine interfaces
(e) Interfaces between the different systems

8 Change management
Systems integrators are to follow the procedures for change management described in **3.6**.

3.5 Requirements for Maintenance of Computer-based Systems

3.5.1 Requirements for Vessel Owners

For the purposes of this Chapter, the vessel owner is considered to be the systems integrator in the operations phase unless another organisation or person is explicitly appointed by the owner. When a systems integrator, which is responsible for implementing any changes to the systems in conjunction with system suppliers, is appointed, this information is to be given to the Society in a timely manner.

3.5.2 Requirements for Systems Integrators

Change management is to comply with following requirements. In addition, it is to be noted that the verification specified in **3.6.12** is required in annual survey in accordance with **Chapter 3, Part B** for computer-based systems of categories II and III.

(1) Systems integrators are to ensure that necessary procedures for software and hardware change management exist on board, and that any software modifications or upgrades are performed according to such procedures. For details about change management, see **3.6** below.

(2) Changes to computer-based systems in the operational phase are to be recorded. Such records are to include information about the relevant software versions and other relevant information described in **3.6.11**.

3.5.3 Requirements for System Suppliers

1 Regarding change management, system suppliers are to follow procedures for maintenance of the system including procedures for change management described in **3.6**.

2 System suppliers are to make sure that the planned changes to a system have passed relevant in-house tests before the change is made to systems on board.

3 It is to be noted that the verification specified in **3.6.12** is required in annual survey in accordance with **Chapter 3, Part B** for computer-based systems of categories II and III.

3.6 Change Management

3.6.1 General

This **3.6** specifies requirements for the change management throughout the lifecycle of a computer-based system. Different procedures for the change management may be defined for specific phases in a system's lifecycle as the different phases typically involve different stakeholders. The Society's verification is described in **3.6.12**.

3.6.2 Documented Change Management Procedures

The organisation in question is to have defined and documented change management procedures applicable for the computer-based system in question covering both hardware and software. After FAT, the system supplier is to manage all changes to the system in accordance with the procedure. Examples could be qualification of new versions of acquired software, new hardware, modified control logic, changes to configurable parameters. The procedures are to at least describe the activities listed in **3.6.3** through **3.6.11**. The outcome of the impact analysis in **3.6.8** will determine to what extent the activities in **3.6.3** to **3.6.12** are to be performed. Change records (see **3.6.11**) are always to be produced.

3.6.3 Agreement between Relevant Stakeholders*

The change management process is to be coordinated and agreed upon between relevant stakeholders along the different stages of the life cycle of the computer-based system.

3.6.4 Approved Software is to be Under Change Management

If changes are required to a system after it has been approved by applicable stakeholders (typically the systems integrator and the Society at FAT), such modifications are to follow defined change management procedures.

3.6.5 Unique Identification of System and Software Versions

System suppliers are to make sure that each system and software version is uniquely identifiable (see **3.4.2-2**).

3.6.6 Handling of Software Master Files

There are to be defined mechanisms for the handling of files that constitute master-files for a software component. Personnel authorities are to be clearly defined along with the tools and mechanisms used to ensure the integrity of master files.

3.6.7 Backup and Restoration of Onboard Software

It is to be clearly defined how to perform backup and restoration of the software components of a computer-based system on board the vessel.

3.6.8 Impact Analysis before Change is Made

Before a change to a system is made, an impact analysis is to be performed in order to determine the following:

(1) the criticality of the change,

(2)   the impact on existing documentation,

(3)   the needed verification and test activities,

(4)   the need to inform other stakeholders about the change, and

(5)   the need to obtain approval from other stakeholders (e.g. The Society or owner) before the change is made.

3.6.9   Roll-back in Case of Failed Software Changes

When maintenance includes installation of new versions of software in a system, it is to be possible to perform a roll-back of the software to the previous installed version with the purpose of returning the system to a known, stable state. Roll-backs are to be documented and analysed to find and eliminate the root cause.

3.6.10   Verification and Validation of System Changes

To the largest degree practically possible, modifications are to be verified before being installed on board. After installation, the modifications are to be verified on board according to a documented verification program containing the following:

(1)   Verification that the new functionalities or improvements have had the intended effect.

(2)   Regression test to verify that the modification has not had any negative effects on functionality or capabilities that was not expected to be affected.

3.6.11   Change Records

1   Changes to systems and software are to be documented in change records to allow for visibility and traceability of the changes. The change records are to contain at least the following items:

(1)   the purpose for a change,

(2)   a description of the changes and modifications,

(3)   the main conclusions from the impact analysis (see **3.6.8**),

(4)   the identity and version of any new system or software versions (see **3.6.5**), and

(5)   test reports or tests summaries (see **3.6.10**).

2   Documentation of the changes to software may be recorded in the planned maintenance system, in a software registry or in the equivalent thereto.

3.6.12   Verification of Change Management by the Society

1   Operational (vessel in service) phase

The verification by the Society of the change management in operation is generally performed during annual surveys of the vessel. Procedures for change management and relevant change records (see **3.6.11**) are to be made available at the times of such surveys.

In the cases where the change requires approval from the Society in advance, the relevant procedures and documentation for the change in question may be verified at that time.

2   During newbuilding

The verification of change management during the newbuilding phase is divided into two parts: procedures are verified as a part of the verification of the quality management system (see **3.4.1-2**), while project specific implementation of the procedures are verified during FAT (see **3.4.2-7**) and after FAT (see **3.6.12-1**)

3.7   Technical Requirements for Computer-based Systems

This **3.7** specifies technical requirements for computer-based systems. Compliance with these requirements is to be documented in the design documentation (see **3.4.2-3**) and verified through the verification activities described in this Chapter.

3.7.1   Reporting of System and Software Identification and Version

Systems are to provide means to identify their names, versions, identifiers, and manufacturers. It is recommended that systems be capable of automatically reporting the status of their software to a ship software logging system (SSLS) as specified in the international standard *ISO* 24060.

3.7.2   Data Links

1   General requirements of data links for Category II and III systems

Data links are to comply with following **(1)** to **(5)**. In addition, loss of a data link is to be specifically addressed in risk assessment analysis / FMEA (see **3.4.2-3**).

(1)   A single data link failure is not to cause loss of vessel functions of Category III. The effects of such failures are to meet the principle of fail-to-safe for the vessel functions being served.

(2)   For vessel functions of Categories II and III, any loss of functionality in remote control systems is to be compensated for by local or manual means.

(3)   Data links are to be provided with means for preventing or coping with excessive communication rates.

(4)   Data links are to be self-checking so as to detect failures or performance issues on the links themselves and data communication failures on nodes connected to the links.

(5)   Detected failures are to initiate alarms.

2   Specific requirements for wireless data links

(1)   Category III systems are not to use wireless data links unless specifically considered by the Society on the basis of an engineering analysis carried out in accordance with an international or national standard acceptable to the Society.

(2)   Systems of other categories may use wireless data links on the condition they satisfy the following **(a)** to **(d)**:

     (a)   Recognised international wireless communication system protocols incorporating the following **i)** to **iv)** are to be complied with.

         i)   Message integrity

         Fault prevention, detection, diagnosis and correction so that the received message is not corrupted or altered when compared to the transmitted message.

         ii)   Configuration and device authentication

         Only permit the connection of devices that are included in the system design.

         iii)   Message encryption

         Protect the confidentiality and criticality of data content.

         iv)   Security management

         Protect network assets and prevent unauthorised access to such assets.

     (b)   Internal wireless systems within vessels are to comply with the radio frequency and power level requirements of the International Telecommunication Union (ITU) and the requirements of flag states.

     (c)   Consideration is to be given to system operation in the event of port state and local restrictions that pertain to the use of radio-frequency transmission and prohibit the operation of wireless data communication links due to frequency and power level restrictions.

     (d)   For wireless data communication equipment, tests during harbour and sea trials are to be performed to demonstrate the following **i)** and **ii)**:

         i)   Radio-frequency transmission does not cause failure of any equipment during expected operating conditions.

         ii)   Radio-frequency transmission does not cause itself to fail as a result of electromagnetic interference during expected operating conditions.

3.7.3 Verification of Technical Requirements by the Society

The implementation of the technical requirements in **3.7** is to be verified by the Society as part of the system description (**3.4.2-3**), FAT (**3.4.2-7**) and SAT (**3.4.3-6**) described above.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2024.
2. Notwithstanding the amendments to the Rules, the current requirements apply to ships for which the date of contract for construction* is before the effective date.
    * "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.
2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
    For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
    (1) such alterations do not affect matters related to classification, or
    (2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
    The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.
3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.
4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part X   COMPUTER-BASED SYSTEMS

2023   ESTABLISHMENT

Notice No.63   22 December 2023

Resolved by Technical Committee on 27 July 2023

AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part X has been established as follows.

Part X   COMPUTER-BASED SYSTEMS

X3   COMPUTER-BASED SYSTEMS

X3.2   Approval of Systems and Components

X3.2.1   System Certification

The wording "requirements specified otherwise by the Society" in **3.2.1-2, Part X of the Rules**, means confirmation of the following when assessments are carried out based on the **Rules for Approval of Manufacturers and Service Suppliers**.
(1)   The computer-based system in question is to acquire the approval of use (including the approval of quality plan (and quality manual) specified in **2.2.1-1, Part X of the Rules**) specified in **3.2.2, Part X of the Rules**. Tests for approval of use may be carried out at the same time as an assessment based on the **Rules for Approval of Manufacturers and Service Suppliers**.
(2)   The manufacturers in question perform quality management based on the quality plan (and quality manual) specified in **2.2.1-1, Part X of the Rules**.

X3.3   System Categories

X3.3.3   System Category Examples

The wording "diagnostics and troubleshooting systems" in **3.3.3(1)(c), Part X of the Rules**, does not means the "condition monitoring system" specified in **B9.1.4-5(2), Part B**.

X3.4   Requirements on Development and Certification of Computer-based Systems

X3.4.2   Requirements for System Suppliers

1   The wording "system description (System specification and design)" in **3.4.2-3, Part X of the Rules** means the information listed in **3.4.2-3(2)(a)** to **(h)**. It may, however, be divided into a number of different documents and models.
2   Some of the methods utilised in the activities listed to in **3.4.2-5, Part X of the Rules** are sometimes referred to as "software unit tests" or "developer tests" and may also include verification methods like code-reviews and static or dynamic code analysis.
3   The wording "factory acceptance test (FAT) before installation on board" in **3.4.2-7, Part X of the Rules** means only those tests carried out for computer-based systems in accordance with this Chapter. Therefore, it does not mean "shop test" in accordance with other requirements in other Parts. For complex systems, there may be a large differences in scope between "internal system testing before FAT" activity and the FAT, while for some systems the scope may be identical.

X3.4.3　　Requirements for Systems Integrators

1　With respect to **3.4.3-4, Part X of the Rules**, *IEC/ISO* 31010 "Risk management – Risk assessment techniques" may be used as guidance in order to determine the risk assessment method.

2　For the SAT and SOST activities specified respectively in **3.4.3-6** and **3.4.3-7, Part X of the Rules**, there may be a large difference in scope on board the vessel for complex systems, while for some systems the scope may be overlapping or identical. It is possible to combine the two activities into one when the test scope is similar. In addition, test programs and test reports may be allowed to be made common.

X3.6　　Change Management

X3.6.3　　Agreement between Relevant Stakeholders

　The change management specified in **3.6.3, Part X of the Rules** is, in principle, to address at least three different stages:

(1)　The "development and internal verification before FAT" stage involving system suppliers and sub-suppliers.

(2)　The "from FAT to the handing over of the vessel to its owner" stage involving system suppliers, systems integrators, the Society and owners.

(3)　The "in operation" stage involving system suppliers, service suppliers, owners, and the Society.

EFFECTIVE DATE AND APPLICATION

1.　The effective date of the amendments is 1 July 2024.

2.　Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction* is before the effective date.

　*　"contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

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1.　The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2.　The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.

　For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:

(1)　such alterations do not affect matters related to classification, or

(2)　If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.

　The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3.　If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4.　If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.