Contents

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part X COMPUTER-BASED SYSTEMS

Chapter 1 INTRODUCTION

1.1 General

1.1.1 Scope

This Part applies to computer-based systems. Details of the scope of application are to be in accordance with **Chapter 3** and subsequent chapters.

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** according to system category. Summaries of said plans and documents are shown in **Tables X2.1** and **X2.2**. However, 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**, plans and documents submitted for the approval of use may be reutilized.

(b) Plans and documents for computer-based systems subject to **Chapter 4** that are required to be submitted for approval purposes are specified in **4.4.1(1), (2), (3), (4)** and **(6)**. Summaries of said plans and documents are shown in **Table X2.3**. However, for computer-based systems approved for use in accordance with **Chapter 10, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**, where appropriate "Test Reports" specified in **4.4.1(10)** are submitted, plans and documents submitted for the approval of use may be reutilized except for "Computer-based Systems Asset Inventory" specified in **4.4.1(1)** and "Topology Diagram" specified in **4.4.1(2)**.

(c) Plans and documents for computer-based systems subject to **Chapter 5** that are required to be submitted for approval purposes are specified in **2.2.3-3(4), (5), (6), (7)** and **(8)**. Summary of plans and documents with related actions are shown in **Table X2.4**. Summary of requirements and related plans and documents are shown in **Table X2.5**.

(d) 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** according to system category. Summaries of said plans and documents are shown in **Tables X2.1** and **X2.2**. However, 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,** plans and documents submitted for the approval of use may be reutilized except for the "list of system categorisations" specified in **2.2.1-3(3)**.

(b) Plans and documents for computer-based systems subject to **Chapter 4** that are required to be submitted for reference purposes are specified in **4.4.1(5), (7), (8)** and **(9)**. Summaries of said plans and documents are shown in **Table X2.3**. However, for computer-based systems approved for use in accordance with **Chapter 10, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**, where appropriate "Test Reports" specified in **4.4.1(10)** are submitted, plans and documents submitted for the approval of use may be reutilized.

(c) Other plans and documents considered necessary by the Society

Table X2.1 System Supplier's Plans and Documents to be Submitted (Related to Chapter 3 COMPUTER-BASED SYSTEMS)

#	Referenced requirements	Plans and documents	Category I		Categories II and III	
			Reference	Approval	Reference	Approval
1	**2.2.1-2(1)** and **3.4.2-1**	Quality plan (and quality manual)	-	-	-	○
2	**2.2.1-2(3)** and **3.4.2-3**	System descriptions (System specification and design)	○*	-	-	○
3	**2.2.1-2(4)** and **3.4.2-4**	Environmental compliance	○*	-	○	-
4	**2.2.1-2(5)** and **3.4.2-5**	Software test report	-	-	○*	-
5	**2.2.1-2(6)** and **3.4.2-6**	System test report	-	-	○*	-
6	**2.2.1-2(7)** and **3.4.2-7**	FAT program	-	-	-	○
7	**2.2.1-2(7)** and **3.4.2-7**	FAT report	-	-	○	-
8	**2.2.1-2(7)** and **3.4.2-7**	Additional FAT documentation (e.g. user manuals)	-	-	○*	-
9	**2.2.1-2(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 Systems Integrator's Plans and Documents to be Submitted (Related to Chapter 3 COMPUTER-BASED SYSTEMS)

#	Referenced requirements	Plans and documents	Category I		Categories II and III	
			Reference	Approval	Reference	Approval
1	**2.2.1-3(2)** and **3.4.3-2**	Quality plan	-	-	-	○*
2	**2.2.1-3(3)** and **3.4.3-3**	List of system categorisations	For reference (regardless of category) ○			
3	**2.2.1.43(4)** and **3.4.3-4**	Risk assessment report (For determining system category)	For reference (regardless of category) ○*			
4	**2.2.1-3(5)** and **3.4.3-5**	Vessel's system architecture	○*	-	○*	-
5	**2.2.1-3(6)** and **3.4.3-6**	SAT program	-	-	-	○
6	**2.2.1-3(6)** and **3.4.3-6**	SAT report	-	-	○	-
7	**2.2.1-3(7)** and **3.4.3-7**	SOST program	-	-	-	○
8	**2.2.1-3(7)** and **3.4.3-7**	SOST report	-	-	○	-
9	**2.2.1-3(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

Table X2.3 Supplier's Plans and Documents to be Submitted (Related to Chapter 4 CYBER RESILIENCE OF ON-BOARD SYSTEMS AND EQUIPMENT)

#	Document (Referenced requirements)	Requirements (Referenced requirements)	Reference	Approval
1	Computer-based system asset inventory (**4.4.1(1)**)	To be incorporated in vessel asset inventory (**5.4.2(1)**)	-	○(1), (2)
2	Topology diagrams (**4.4.1(2)**)	Enabling system integrator to design security zones and conduits (**5.4.3(1)**)	-	○(1), (2)
3	Description of security Capabilities (**4.4.1(3)**)	Required security capabilities (**4.4.2**) Additional security capabilities, if applicable (**4.4.3**)	-	○(1)
4	Test procedure for security Capabilities (**4.4.1(4)**)	Required security capabilities (**4.4.2**) Additional security capabilities, if applicable (**4.4.3**)	-	○(1)
5	Security configuration Guidelines (**4.4.1(5)**)	Network and security configuration settings (No.**29** in **Table X4.1**)	○(1)	-
6	Secure development lifecycle (**4.4.1(6)**)	Secure development lifecycle requirements (**4.5**)	-	○(1)
7	Plans for maintenance and Verification (**4.4.1(7)**)	Security functionality verification (No.**19** in **Table X4.1**)	○(1)	-
8	Information supporting incident response and recovery plans (**4.4.1(8)**)	Auditable events (No.**13** in **Table X4.1**) Deterministic output (No.**20** in **Table X4.1**) System backup (No.**26** in **Table X4.1**) System recovery and reconstitution (No.**27** in **Table X4.1**)	○(1)	-
9	Management of change plan (**4.4.1(9)**)	Management of change process (**Chapter 3**)	○(1)	-
10	Test reports (**4.4.1(10)**)	Configuration of security capabilities and hardening (**4.4.1(5)** and **4.5.8**)	○(2)	-

(Notes)

Approval: Plans and documents to be submitted for approval

Reference: Plans and documents to be submitted for reference

○: Submission required

(1): Submitted when approval of use has not been obtained in accordance with **Chapter 10, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**

(2): Submitted when approval of use has been obtained in accordance with **Chapter 10, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**

Table X2.4 Systems Integrator's or Shipowner's Plans and Documents to be Submitted (Related to Chapter 5 CYBER RESILIENCE OF SHIPS)

#	Document (Referenced requirements)	Systems integrator			Shipowner			
		Design	Construction	Commissioning	Operation	1st AS	AS/IS	SS
1	Approved supplier documentation (**2.2.3**)	-	Maintain	Maintain	Maintain	-	-	-
2	Zones and conduit diagram (**2.2.3-3(4)**)	Submit	Maintain	Maintain	Maintain	-	-	-
3	Cyber security design description (**2.2.3-3(5)**)	Submit	Maintain	Maintain	Maintain	-	-	-
4	Vessel asset inventory (**2.2.3-3(6)**)	Submit	Maintain	Maintain	Maintain	-	-	-
5	Risk assessment for the exclusion of computer-based systems (**2.2.3-3(7)**)*	Submit	Maintain	Maintain	Maintain	-	-	-
6	Description of compensating countermeasures (**2.2.3-3(8)**)*	Submit	Maintain	Maintain	Maintain	-	-	-
7	Ship cyber resilience test procedure (**2.2.3-4(2)**)	-	Submit	Demon-strate	Maintain	-	-	Demon-strate
8	Ship cyber security and resilience program (**2.2.3-5(7)**) - Management of change (MoC) (**5.4.2(1)(d)iv)**) - Management of software updates (**5.4.2(1)(d)iv)**) - Management of firewalls (**5.4.3(1)(d)iv)**) - Management of malware protection (**5.4.3(3)(d)iv)**) - Management of access control (**5.4.3(4)(d)iv**)) - Management of access control (**5.4.3(4)(d)iv**)) - Management of remote access (**5.4.3(6)(d)iv**)) - Management of mobile and portable	-	-	-	Maintain	Submit	Demon-strate	-

	devices (**5.4.3(7)(d)iv**) - Detection of security anomalies (**5.4.4(1)(d)iv**) - Verification of security functions (**5.4.4(2)(d)iv**) - Incident response plans (**5.4.5(1)(d)iv**) - Recovery plans (**5.4.6(1)(d)iv**)							

(Notes)

*：If applicable

Submit: The stakeholder is to submit the document to the Society for verification and approval of compliance with requirements in **Chapter 5**.

Maintain: The stakeholder is to keep the document updated in accordance with procedure for management of change (MoC). Updated document and change management records are to be submitted to the Society as per **Table X2.2**.

Demonstrate: The stakeholder is to demonstrate compliance to the Society in accordance with the approved document.

1st AS：First Annual Survey

AS/IS：Subsequent Annual Survey/Intermediate survey

SS：Special Survey

Table X2.5 Summary of Requirements and Documents (Related to Chapter 5 CYBERESILIENCE OF SHIPS)

Vessel asset inventory (**5.4.2(1)**)		
Computer-based system security capabilities	Provide documentation of product security updates Provide documentation of dependent component security updates Provide security updates	**4.5.3** **4.5.4** **4.5.5**
Computer-based system documentation	Computer-based system asset inventory Management of change plan	**4.4.1(1)** **4.4.1(9)**
Vessel design documentation	Vessel asset inventory	**5.4.2(1)(d)i)**
Ship cyber security and resilience program	Management of change Management of software updates	**5.4.2(1)(d)iv)** **5.4.2(1)(d)iv)**
Security zones and network segmentation (**5.4.3(1)**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	Topology diagrams	**4.4.1(2)**
Vessel design documentation	Zones and conduit diagram Design description Ship cyber resilience test procedure	**5.4.3(1)(d)i)** **5.4.3(1)(d)i)** **5.4.3(1)(d)iii)**
Ship cyber security and resilience program	Management of security zone boundary devices (e.g., firewalls)	**5.4.3(1)(d)iv)**
Network protection safeguards (**5.4.3(2)**)		
Computer-based system security capabilities	Denial of service (DoS) protection Deterministic output	No.**24** in **Table X4.1** No.**20** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities	**4.4.1(3)** **4.4.1(4)**
Vessel design documentation	Ship cyber resilience test procedure	**5.4.3(2)(d)iii)**
Ship cyber security and resilience program	-	-
Antivirus, antimalware, antispam and other protections from malicious code (**5.4.3(3)**)		
Computer-based system security capabilities	Malicious code protection	No.**18** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities	**4.4.1(3)** **4.4.1(4)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.3(3)(d)i)** **5.4.3(3)(d)iii)**
Ship cyber security and resilience program	Management of malware protection	**5.4.3(3)(d)iv)**
Access control (**5.4.3(4)**)		
Computer-based system security capabilities	Human user ID and authorisation Account management Identifier management Authenticator management Authorisation enforcement	No.**1** in **Table X4.1** No.**2** in **Table X4.1** No.**3** in **Table X4.1** No.**4** in **Table X4.1** No.**8** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities	**4.4.1(3)** **4.4.1(4)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.3(4)(d)i)** **5.4.3(4)(d)iii)**
Ship cyber security and resilience program	Management of confidential information Management of logical and physical access	**5.4.3(4)(d)iv)** **5.4.3(4)(d)iv)**

Wireless communication (5.4.3(5))		
Computer-based system security capabilities	Wireless access management	No.**5** in **Table X4.1**
	Wireless use control	No.**8** in **Table X4.1**
Computer-based system documentation	Description of security capabilities	**4.4.1(3)**
	Test procedure for security capabilities	**4.4.1(4)**
Vessel design documentation	Design description	**5.4.3(5)(d)i)**
	Ship cyber resilience test procedure	**5.4.3(5)(d)iii)**
Ship cyber security and resilience program	-	-
Remote access control and communication with untrusted networks (5.4.3(6))		
Computer-based system security capabilities	Multifactor authentication	No.**31** in **Table X4.2**
	Process / device ID and authorisation	No.**32** in **Table X4.2**
	Unsuccessful login attempts	No.**33** in **Table X4.2**
	System use notification	No.**34** in **Table X4.2**
	Access via untrusted networks	No.**35** in **Table X4.2**
	Explicit access request approval	No.**36** in **Table X4.2**
	Remote session termination	No.**37** in **Table X4.2**
	Cryptographic integrity protection	No.**38** in **Table X4.2**
	Input validation	No.**39** in **Table X4.2**
	Session integrity	No.**40** in **Table X4.2**
	Invalidation of session ID	No.**41** in **Table X4.2**
Computer-based system documentation	Description of security capabilities	**4.4.1(3)**
	Test procedure for security capabilities	**4.4.1(4)**
Vessel design documentation	Design description	**5.4.3(6)(d)i)**
	Ship cyber resilience test procedure	**5.4.3(6)(d)iii)**
Ship cyber security and resilience program	Management of remote access and communication with/via untrusted networks	**5.4.3(6)(d)iv)**
Use of mobile and portable devices (5.4.3(7))		
Computer-based system security capabilities	Use control for portable devices	No.**10** in **Table X4.1**
Computer-based system documentation	Description of security capabilities	**4.4.1(3)**
	Test procedure for security capabilities	**4.4.1(4)**
Vessel design documentation	Design description	**5.4.3(7)(d)i)**
	Ship cyber resilience test procedure	**5.4.3(7)(d)iii)**
Ship cyber security and resilience program	Management of mobile and portable devices	**5.4.3(7)(d)iv)**
Network operation monitoring (5.4.4(1))		
Computer-based system security capabilities	Use control for portable devices	No.**10** in **Table X4.1**
	Auditable events	No.**13** in **Table X4.1**
	Denial of service (DoS) protection	No.**24** in **Table X4.1**
	Alarm excessive bandwidth use	**3.7.2-1.**
Computer-based system documentation	Description of security capabilities	**4.4.1(3)**
	Test procedure for security capabilities	**4.4.1(4)**
Vessel design documentation	Ship cyber resilience test procedure	**5.4.4(1)(d)iii)**
Ship cyber security and resilience program	Incident response plans	**5.4.4(1)(d)iv)**
Verification and diagnostic functions of computer-based system and networks (5.4.4(2))		
Computer-based system security capabilities	Security function verification	No.**19** in **Table X4.1**
Computer-based system documentation	Description of security capabilities	**4.4.1(3)**
	Test procedure for security capabilities	**4.4.1(4)**
	Plans for maintenance and verification	**4.4.1(7)**

Vessel design documentation	Ship cyber resilience test procedure	**5.4.4(2)(d)iii)**
Ship cyber security and resilience program	Verification of security functions	**5.4.4(2)(d)iv)**
Incident response plan (**5.4.5(1)**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.5(1)(d)i)** **5.4.5(1)(d)iii)**
Ship cyber security and resilience program	Incident response plans	**5.4.5(1)(d)iv)**
Local, independent and/or manual operation (**5.4.5(2)**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.5(2)(d)i)** **5.4.5(2)(d)iii)**
Ship cyber security and resilience program	Incident response plans	**5.4.5(2)(d)iv)**
Network isolation (**5.4.5(3)**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.5(3)(d)i)** **5.4.5(3)(d)iii)**
Ship cyber security and resilience program	Incident response plans	**5.4.5(3)(d)iv)**
Fallback to a minimal risk condition (**5.4.5(4)**)		
Computer-based system security capabilities	Deterministic output	No.**20** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.5(4)(d)i)** **5.4.5(4)(d)iii)**
Ship cyber security and resilience program	Incident response plans	**5.4.5(4)(d)iv)**
Recovery plan (**5.4.6(1)**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.6(1)(d)i)** **5.4.6(1)(d)iii)**

Ship cyber security and resilience program	Recovery plans	**5.4.6(1)(d)iv)**
Backup and restore capability (**5.4.6(2)**)		
Computer-based system security capabilities	System backup System recovery and reconstitution	No.**26** in **Table X4.1** No.**27** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Ship cyber resilience test procedure	**5.4.6(2)(d)iii)**
Ship cyber security and resilience program	Recovery plan	**5.4.6(2)(d)iv)**
Controlled shutdown, reset, restore and restart (**5.4.6(3)**)		
Computer-based system security capabilities	System recovery and reconstitution	No.**27** in **Table X4.1**
Computer-based system documentation	Description of security capabilities Test procedure for security capabilities Information supporting incident response and recovery plans	**4.4.1(3)** **4.4.1(4)** **4.4.1(8)**
Vessel design documentation	Design description Ship cyber resilience test procedure	**5.4.6(3)(d)i)** **5.4.6(3)(d)iii)**
Ship cyber security and resilience program	Recovery plans	**5.4.6(3)(d)iv)**
Risk assessment for exclusion of computer-based system from the application of requirements (**5.5**)		
Computer-based system security capabilities	-	-
Computer-based system documentation	-	-
Vessel design documentation	Risk assessment for the exclusion of computer-based systems	**5.5**
Ship cyber security and resilience program	-	-

2.2 Tests

2.2.1 Tests (Related to Chapter 3 COMPUTER BASED SYSTEMS)

1 Computer-based systems subject to **Chapter 3** are to be verified by the Society in accordance with **-2** and **-3** based on their system category. A summary of the tests to be witnessed and verified by Society surveyors are shown in **Table X2.6**.

2 Verification Items for System Suppliers

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

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

(b) Categories II and III:

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

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

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

(a) Category I: N/A

(b) 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**)

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

(b) 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**)

(a) 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**).

(b) 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**)

(a) Category I: N/A

(b) 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**)

(a) Category I: N/A

(b) Categories II and III:

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

ii) 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**)

(a) Category I: N/A

(b) Categories II and III:

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

ii) The FAT is to be witnessed by the Surveyor.

iii) The FAT report is to be submitted for reference.

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

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

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

(a) Category I: N/A

(b) 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).

3 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**)

(a) Category I: N/A

(b) Categories II and III:

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

ii) 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 may be required for reference 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**)

(a) Category I: N/A

(b) Categories II and III:

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

ii) The SAT is to be witnessed by the Surveyor.

iii) The SAT report is to be submitted to the Society for reference.

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

(a) Category I: N/A

(b) Categories II and III:

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

ii) The SOST is to be witnessed by the Surveyor.

iii) The SOST report is to be submitted to the Society for reference.

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

(a) Category I: N/A

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

Table X2.6 Test Witnessing and Verifying

Referenced requirements	Verification details	Responsible party	Category I	Category II and III
2.2.1-2(7) and **3.4.2-7**	Witness FAT	System supplier	-	○
2.2.1-3(6) and **3.4.3-6**	Witness SAT	Systems integrator	-	○
2.2.1-3(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

2.2.2 Tests (Related to Chapter 4 CYBER RESILIENCE OF ON-BOARD SYSTEMS AND EQUIPMENT)

1 Computer-based systems subject to **Chapter 4** are to be subjected to survey and factory acceptance testing as specified in **-2** to **-5**.

2 General survey items

The supplier is to demonstrate that design, construction, and internal testing has been completed. It is to also be demonstrated that

the system to be delivered is correctly represented by the approved documentation. This is to be done by inspecting the system and comparing the components and arrangement/architecture with the asset inventory (**4.4.1(1)**) and the topology diagrams (**4.4.1(2)**).

3 Test of security capabilities

The supplier is to test the required security capabilities on the system to be delivered. The tests are to be carried out in accordance with the approved test procedure in **4.4.1(4)** and be witnessed/accepted by a surveyor. The tests are to provide the surveyor with reasonable assurance that all requirements are met. This implies that testing of identical components is normally not required.

4 Correct configuration of security capabilities

The supplier is to test/demonstrate for a surveyor that security settings in the system's components have been configured in accordance with the configuration guidelines in **4.4.1(5)**. This demonstration may be carried out in conjunction with testing of the security capabilities. The security settings are to be documented in a report, e.g. a ship-specific instance of the configuration guidelines.

5 Secure development lifecycle

The supplier is to, in accordance with documentation in **4.4.1(6)**, demonstrate compliance with requirements for secure development lifecycle in **4.5**.

(1) Controls for private keys (*IEC* 62443-4-1/SM-8)

This requirement applies if the system includes software that is digitally signed for the purpose of enabling the user to verify its authenticity. The supplier is to present management system documentation substantiating that policies, procedures and technical controls are in place to protect generation, storage and use of private keys used for code signing from unauthorized access. The policies and procedures are to address roles, responsibilities and work processes. The technical controls are to include e.g. physical access restrictions and cryptographic hardware (e.g. Hardware security module) for storage of the private key.

(2) Security update documentation (*IEC* 62443-4-1/SUM-2)

The supplier is to present management system documentation substantiating that a process is established in the organization to ensure security updates are informed to the users. The information to the users are to include the items listed in **4.5.3**.

(3) Dependent component security update documentation (*IEC* 62443-4-1/SUM-3)

The supplier is to present management system documentation, as required by **4.5.4**, substantiating that a process is established in the organization to ensure users are informed whether the system is compatible with updated versions of acquired software in the system (new versions/patches of operating system or firmware). The information is to address how to manage risks related to not applying the updated acquired software.

(4) Security update delivery (*IEC* 62443-4-1/SUM-4)

The supplier is to present management system documentation, as required by **4.5.5**, substantiating that a process is established in the organization ensuring that system security updates are made available to users, and describing how the user may verify the authenticity of the updated software.

(5) Product defence in depth (*IEC* 62443-4-1/SG-1)

The supplier is to present management system documentation, as required by **4.5.6**, substantiating that a process is established in the organization to document a strategy for defence-in-depth measures to mitigate security threats to software in the computer-based system during installation, maintenance and operation. Examples of threats could be installation of unauthorised software, weaknesses in the patching process, tampering with software in the operational phase of the ship.

(6) Defence in depth measures expected in the environment (*IEC* 62443-4-1/SG-2)

The supplier is to present management system documentation, as required by **4.5.7**, substantiating that a process is established in the organization to document defence-in-depth measures expected to be provided by the external environment, such as physical arrangement, policies and procedures.

(7) Security hardening guidelines (*IEC* 62443-4-1/SG-3)

The supplier is to present management system documentation, as required by **4.5.8**, substantiating that a process is established in the organization to ensure that hardening guidelines are produced for the system. The guidelines are to specify how to reduce vulnerabilities in the system by removal/prohibiting/disabling of unnecessary software, accounts, services, etc.

2.2.3 Tests (Related to Chapter 5 CYBER RESILIENCE OF SHIPS)

1 Computer-based systems subject to **Chapter 5** are to be subjected to tests for demonstration of compliance as specified in **-2** to **-5**.

2 General

(1) Evaluation of compliance with requirements in **Chapter 5** is to be carried out by the Society by assessment of documentation and survey in the relevant phases as specified in the following subsections.

(2) Documentation to be submitted by suppliers to the Society is specified in **Chapter 4**. The approved versions of this documentation is also to be provided by the suppliers to the systems integrator as specified in **4.6.2**.

(3) Documents to be provided by the systems integrator are listed in **2.2.3-3** and **-4**.

(4) Documents to be provided by the shipowner are listed in **2.2.3-5**.

(5) Upon delivery of the ship, the systems integrator is to provide below documentation to the shipowner:

(a) Documentation of the computer-based systems provided by the suppliers (see **4.6.2**)

(b) Documentation produced by the systems integrator (see **2.2.3-3** and **-4**)

3 During design and construction phases

(1) The supplier is to demonstrate compliance to the Society by following the certification process specified in **4.6**.

(2) The systems integrator is to demonstrate compliance by submitting documents in the following subsections to the Society for assessment.

(3) During the design and construction phases, modifications to the design are to be carried out in accordance with the management of change (MoC) requirements in **3.6**.

(4) The content of "Zones and conduit diagram" is specified in **5.4.3(1)(d)i)**.

(5) The content of "Cyber security design description (CSDD)" is specified in subsections "Design phase" for each requirement in **5.4**.

(6) The content of "Vessel asset inventory" is specified in **5.4.2(1)**.

(7) The content of "Risk assessment for the exclusion of computer-based systems" is specified in **5.5**.

(8) If any computer-based system in the scope of applicability of this Chapter has been approved with compensating countermeasures in lieu of a requirement in **Chapter 4**, "Description of compensating countermeasures" is to specify the respective computer-based system, the lacking security capability, as well as provide a detailed description of the compensating countermeasures. See also **4.4.1(3)** requiring that the supplier describes such compensating countermeasures in the system documentation.

4 Upon ship commissioning

(1) Before final commissioning of the ship, the systems integrator is to:

(a) Submit updated design documentation to the Society (as-built versions of the documents in **2.2.3-3**).

(b) Submit Ship cyber resilience test procedure to the Society describing how to demonstrate compliance with **Chapter 5** by testing and/or analytic evaluation.

(c) Carry out testing, witnessed by the Society, in accordance with the approved Ship cyber resilience test procedure.

(2) Ship cyber resilience test procedure

(a) The content of this document is specified for the Commissioning phase in each subsection "Demonstration of compliance" in **5.4**.

(b) For each computer-based system, the required inherent security capabilities and configuration thereof are verified and tested in the certification process of each computer-based system (see **Chapter 4**). Testing of such security functions may be omitted if specified in the respective subsection "Commissioning phase" in **5.4**, on the condition that these security functions have been successfully tested during the certification of the computer-based system as per **Chapter 4**. Nevertheless, all tests are to be included in the Ship cyber resilience test procedure and the decision to omit tests will be taken by the Society. Tests may generally not be omitted if findings/comments are carried over from the certification process to the commissioning phase, if the respective requirements have been met by compensating countermeasures, or due to other reasons such as modifications of the computer-based system after the certification process.

(c) The Ship cyber resilience test procedure is also to specify how to test any compensating countermeasures described in **2.2.3-3(8)**.

(d) The Ship cyber resilience test procedure is to include means to update status and record findings during the testing, and specify the following information:

i) Necessary test setup (i.e. to ensure the test can be repeated with the same expected result)

ii) Test equipment

iii) Initial condition(s)

iv) Test methodology, detailed test steps

v) Expected results and acceptance criteria

(e) Before submitting the Ship cyber resilience test procedure to the Society, the systems integrator is to verify that the information is updated and placed under change management; that it is aligned with the latest configurations of computer-based systems and networks connecting such systems together onboard the ship and to other computer-based systems not onboard (e.g., ashore); and that the tests documented are sufficiently detailed as to allow verification of the installation and operation of measures adopted for the fulfilment of relevant requirements on the final configuration of computer-based systems and networks onboard.

(f) The systems integrator is to document verification tests or assessments of security controls and measures in the fully integrated ship, maintaining change management for configurations, and noting in the documented test results where safety conditions may be affected by specific circumstances or failures addressed in the Ship cyber resilience test procedure.

(g) The testing is to be carried out on board in accordance with the approved Ship cyber resilience test procedure after other commissioning activities for the computer-based systems are completed. The Society may request execution of additional tests.

5 During the operational life of the ship

(1) After the ship has been delivered to the shipowner, the shipowner is to manage technical and organisational security countermeasures by establishing and implementing processes as specified in **Chapter 5**.

(2) Modifications to the computer-based systems in scope of applicability of **Chapter 5** are to be carried out in accordance with the management of change (MoC) requirements in **3.6**. This includes keeping documentation of the computer-based systems up to date.

(3) The shipowner, with the support of suppliers, is to keep the Ship cyber resilience test procedure up to date and aligned with the computer-based systems onboard the ship and the networks connecting such systems to each other and to other computer-based systems not onboard (e.g. ashore). The shipowner is to update the Ship cyber resilience test procedure considering the changes occurred on computer-based systems and networks onboard, possible emerging risks related to such changes, new threats, new vulnerabilities and other possible changes in the ship's operational environment.

(4) The shipowner is to prepare and implement operational procedures, provide periodic training and carry out drills for the onboard personnel and other concerned personnel ashore to familiarize them with the computer-based systems onboard the ship and the networks connecting such systems to each other and to other computer-based systems not onboard (e.g. ashore), and to properly manage the measures adopted for the fulfilment of requirements.

(5) The shipowner, with the support of supplier, is to keep the measures adopted for the fulfilment of requirements up to date, e.g. by periodic maintenance of hardware and software of computer-based systems onboard the ship and the networks connecting such systems.

(6) The shipowner is to retain onboard a copy of results of execution of tests and an updated Ship cyber resilience test procedure and make them available to the Society.

(7) First Annual Survey

(a) In due time before the first Annual Survey of the ship, the shipowner is to submit to the Society a Ship cyber security and resilience program documenting management of cyber security and cyber resilience of the computer-based systems in the scope of applicability of **Chapter 5**.

(b) The Ship cyber security and resilience program are to include policies, procedures, plans and/or other information documenting the processes/activities specified in subsections "Demonstration of compliance" in **5.4**.

(c) After the Society has approved the Ship cyber security and resilience program, the shipowner is to in the first Annual Survey demonstrate compliance by presenting records or other documented evidence of implementation of the processes described in the approved Ship cyber security and resilience program.

(d) Change of vessel management company will require a new verification of the Ship cyber security and resilience program.

(8) Subsequent Annual Surveys

In the subsequent Annual Surveys of the ship, the shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program.

(9) Special Survey

Upon renewal of the ship's *Certificate of Classification*, the shipowner is to carry out testing witnessed by the Society in accordance with the Ship cyber resilience test procedure. Certain security safeguards are to be demonstrated at Special Survey whereas other need only be carried out upon request by the Society based on modifications to the computer-based systems as specified in subsections "Operation phase" in **5.4**.

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.

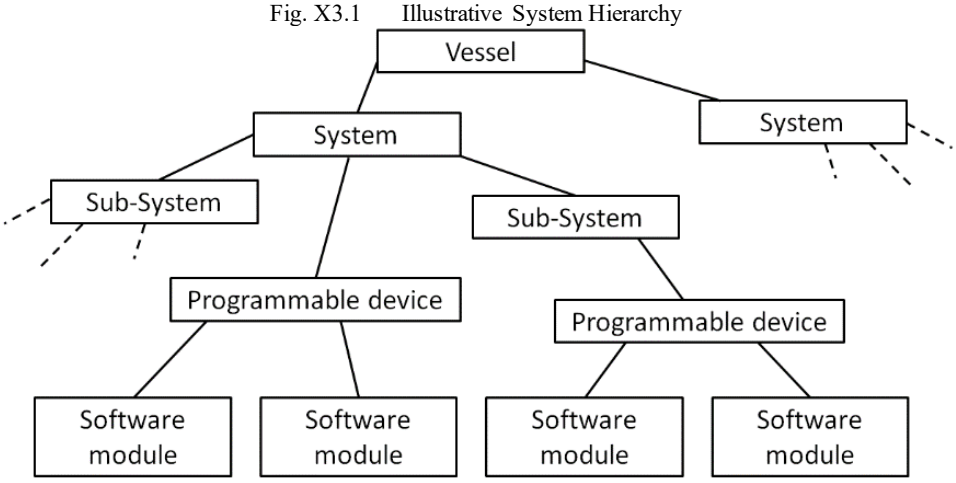
(21) "Vessel" means ship or offshore unit where the computer-based system is to be installed.

(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 **2.2.1-2(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.

Chapter 4 CYBER RESILIENCE OF ON-BOARD SYSTEMS AND EQUIPMENT

4.1 General

4.1.1 General*

This Chapter specifies requirements for cyber resilience of on-board systems and equipment.

4.1.2 Scope

1 This Chapter applies to the following **(1)** and **(2)**:

(1) This Chapter applies to the following ships:

(a) Passenger ships (including passenger high-speed craft) engaged in international voyages

(b) Cargo ships of 500 GT and upwards engaged in international voyages

(c) High speed craft of 500 GT and upwards engaged in international voyage

(d) Mobile offshore drilling units of 500 GT and upwards

(e) Self-propelled mobile offshore units engaged in construction (i.e. wind turbine installation maintenance and repair, crane units, drilling tenders, accommodation, etc.)

(2) This Chapter may be used for the following ships as non-mandatory guidance:

(a) Ships of war and troopships

(b) Cargo ships less than 500 gross tonnage

(c) Vessels not propelled by mechanical means

(d) Wooden ships of primitive build

(e) Passenger yachts (passengers not more than 12)

(f) Pleasure yachts not engaged in trade

(g) Fishing vessels

(h) Site specific offshore installations (i.e. FPSOs, FSUs, etc)

2 This Chapter applies to systems and interfaces for the following **(1)** and **(2)**.

(1) Operational Technology (OT) systems onboard ships, i.e. those computer-based systems using data to control or monitor physical processes that can be vulnerable to cyber incidents and, if compromised, could lead to dangerous situations for human safety, safety of the vessel and/or threat to the environment. In particular, the computer-based systems used for the operation of the following ship functions and systems, if present onboard, are to be considered:

(a) Propulsion

(b) Steering

(c) Anchoring and mooring

(d) Electrical power generation and distribution

(e) Fire detection and extinguishing systems

(f) Bilge and ballast systems, loading computer

(g) Watertight integrity and flooding detection

(h) Lighting (e.g. emergency lighting, low locations, navigation lights)

(i) Any required safety system whose disruption or functional impairing may pose risks to ship operations (e.g. emergency shutdown system, cargo safety system, pressure vessel safety system, gas detection system)

(j) Navigational systems required by statutory regulations

(k) Internal and external communication systems required by class rules and statutory regulations

For navigation and radiocommunication systems, the application of *IEC* 61162-460 or other equivalent standards in lieu of the required security capabilities in 4.4 may be accepted by the Society, on the condition that requirements in this Chapter are complied with.

(l) Other systems or interfaces considered necessary by the Society

(2) Any Internet Protocol (IP)-based communication interface from computer-based systems in scope of this Chapter to other

systems. Examples of such systems are, but not limited to, the following:

(a) passenger or visitor servicing and management systems

(b) passenger-facing networks

(c) administrative networks

(d) crew welfare systems

(e) any other systems connected to OT systems, either permanently or temporarily (e.g. during maintenance).

4.1.3 Limitations

This Chapter does not cover environmental performance for the system hardware and the functionality of the software. In addition to this Chapter, the following requirements are to be applied:

(1) **18.7.1(1), Part D**, if required by **18.7.1, Part D**, for the environmental performance of the system hardware

(2) **Chapter 3**, if applicable per **3.1.1**, for safety of equipment for the functionality of the software

4.2 Definitions and Abbreviations

4.2.1 Terminology

The terminology used in this Chapter is as specified in the following (1) to (27):

(1) "Attack surface" is the set of all possible points where an unauthorized user can access a system, cause an effect on or extract data from. The attack surface comprises two categories: digital and physical. The digital attack surface encompasses all the hardware and software that connect to an organization's network. These include applications, code, ports, servers and websites. The physical attack surface comprises all endpoint devices that an attacker can gain physical access to, such as desktop computers, hard drives, laptops, mobile phones, removable drives and carelessly discarded hardware.

(2) "Authentication" is provision of assurance that a claimed characteristic of an identity is correct.

(3) "Compensating countermeasure" is an alternate solution to a countermeasure employed in lieu of or in addition to inherent security capabilities to satisfy one or more security requirements.

(4) "Computer Based System" is a programmable electronic device, or interoperable set of programmable electronic devices, organized to achieve one or more specified purposes such as collection, processing, maintenance, use, sharing, dissemination, or disposition of information. computer-based system on-board include IT and OT systems. A computer-based system may be a combination of subsystems connected via network. On-board computer-based system may be connected directly or via public means of communications (e.g. Internet) to ashore computer-based systems, other vessels' computer-based system and/or other facilities.

(5) "Computer Network" is a connection between two or more computers for the purpose of communicating data electronically by means of agreed communication protocols.

(6) "Control" is a means of managing risk, including policies, procedures, guidelines, practices or organizational structures, which can be administrative, technical, management, or legal in nature.

(7) "Cyber incident" is an event resulting from any offensive cyber manoeuvre, either intentional or unintentional, that targets or affects one or more computer-based system onboard, which actually or potentially results in adverse consequences to an onboard system, network and computer or the information that they process, store or transmit, and which may require a response action to mitigate the consequences. Cyber incidents include unauthorized access, misuse, modification, destruction or improper disclosure of the information generated, archived or used in onboard computer-based system or transported in the networks connecting such systems. Cyber incidents do not include system failures.

(8) "Cyber resilience" is the capability to reduce the occurrence and mitigating the effects of incidents arising from the disruption or impairment of operational technology (OT) used for the safe operation of a ship, which potentially lead to dangerous situations for human safety, safety of the vessel and/or threat to the environment.

(9) "Defence in depth" is information security strategy integrating people, technology, and operations capabilities to establish variable barriers across multiple layers and missions of the organization.

(10) "Essential Systems" are Computer Based System contributing to the provision of services essential for propulsion and steering, and safety of the ship. Essential services comprise "Primary Essential Services" and "Secondary Essential Services": Primary Essential Services are those services which need to be in continuous operation to maintain propulsion and steering; Secondary

Essential Services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the vessel's safety.

(11) "Firewall" is a logical or physical barrier that monitors and controls incoming and outgoing network traffic controlled via predefined rules.

(12) "Firmware" is software embedded in electronic devices that provide control, monitoring and data manipulation of engineered products and systems. These are normally self-contained and not accessible to user manipulation.

(13) "Hardening" is the practice of reducing a system's vulnerability by reducing its attack surface.

(14) "Information Technology (IT)" are devices, software and associated networking focusing on the use of data as information, as opposed to Operational Technology (OT).

(15) "Integrated system" is a system combining a number of interacting sub-systems and/or equipment organized to achieve one or more specified purposes.

(16) "Network switch (Switch)" is a device that connects devices together on a computer network, by using packet switching to receive, process and forward data to the destination device.

(17) "Offensive cyber manoeuvre" are actions that result in denial, degradation, disruption, destruction, or manipulation of OT or IT systems.

(18) "Operational technology (OT)" are devices, sensors, software and associated networking that monitor and control onboard systems. Operational technology systems may be thought of as focusing on the use of data to control or monitor physical processes.

(19) "OT system" are computer based systems, which provide control, alarm, monitoring, safety or internal communication functions.

(20) "Patches" are software designed to update installed software or supporting data to address security vulnerabilities and other bugs or improve operating systems or applications

(21) "Protocols" are a common set of rules and signals that computers on the network use to communicate. Protocols allow to perform data communication, network management and security. Onboard networks usually implement protocols based on TCP/IP stacks or various field buses.

(22) "Recovery" is develop and implement the appropriate activities to maintain plans for resilience and to restore any capabilities or services that were impaired due to a cyber security event. The Recovery function supports timely return to normal operations to reduce the impact from a cyber security event.

(23) "Supplier" is a manufacturer or provider of hardware and/or software products, system components or equipment (hardware or software) comprising of the application, embedded devices, network devices, host devices etc. working together as system or a subsystem. The Supplier is responsible for providing programmable devices, sub-systems or systems to the System Integrator.

(24) "System" is combination of interacting programmable devices and/or sub-systems organized to achieve one or more specified purposes.

(25) "System Categories (I, II, III)" are system categories based on their effects on system functionality, which are defined in **3.3.1**.

(26) "System Integrator" is the specific person or organization responsible for the integration of systems and products provided by suppliers into the system invoked by the requirements in the ship specifications and for providing the integrated system. The system integrator may also be responsible for integration of systems in the ship. Until vessel delivery, this role is to be taken by the shipyard unless an alternative organization is specifically contracted/assigned this responsibility.

(27) "Untrusted network" is any network outside the scope of applicability of this Chapter.

4.3 Security Philosophy

4.3.1 Systems and Equipment

1 A system can consist of group of hardware and software enabling safe, secure and reliable operation of a process. Typical example could be Engine control system, DP system, etc.

2 Equipment may be one of the following:

(1) Network devices (i.e. routers, managed switches)

(2) Security devices (i.e. firewall, Intrusion Detection System)

(3) Computers (i.e. workstation, servers)

(4) Automation devices (i.e. Programmable Logic Controllers)

(5) Virtual machine cloud-hosted

4.3.2 Cyber Resilience

The cyber resilience requirements in 4.4.2 and 4.4.3 will be applicable for all systems in scope of Chapter 5 as applicable. Additional requirements related to interface with untrusted networks will only apply for systems where such connectivity is designed.

4.3.3 Essential Systems Availability

1 Security measures for Essential system is not to be adversely affect the systems availability.

2 Implementation of security measures are not to cause loss of safety functions, loss of control functions, loss of monitoring functions or loss of other functions which could result in health, safety and environmental consequences.

3 The system is to be adequately designed to allow the ship to continue its mission critical operations in a manner that ensures the confidentiality, integrity, and availability of the data necessary for safety of the vessel, its systems, personnel and cargo.

4.3.4 Compensating Countermeasures

1 Compensating countermeasure may be employed in lieu of or in addition to inherent security capabilities to satisfy one or more security requirements.

2 Compensating countermeasure(s) are to meet the intent and rigor of the original stated requirement considering the referenced standards as well as the differences between each requirement and the related items in the standards, and follow the principles specified in 4.4.1(3).

4.4 Requirements for Cyber resilience of on-board systems and equipment

4.4.1 Documentation for Cyber resilience of on-board systems and equipment

The following documents are to be submitted to the Society for review and approval in accordance with the requirements in this Chapter (see also 4.6.2).

(1) Computer-based system asset inventory

The computer-based system asset inventory is to include the information below.

(a) List of hardware components (e.g. host devices, embedded devices and network devices)

i) Name

ii) Brand/manufacturer

iii) Model/type

iv) Short description of functionality/purpose

v) Physical interfaces (e.g. network and serial)

vi) Name/type of system software (e.g. operating system and firmware)

vii) Version and patch level of system software

viii) Supported communication protocols

(b) List of software components (e.g. application software and utility software)

i) The hardware component where it is installed

ii) Brand/manufacturer

iii) Model/type

iv) Short description of functionality/purpose

v) Version of software List of software components (e.g. application software and utility software)

(2) Topology diagrams

(a) The physical topology diagram is to illustrate the physical architecture of the system. It is to be possible to identify the hardware components in the computer-based system asset inventory. The diagram is to illustrate the following:

i) All endpoints and network devices, including identification of redundant units

ii) Communication cables (networks, serial links), including communication with I/O units

iii) Communication cables to other networks or systems

(b) The logical topology diagram is to illustrate the data flow between components in the system. The diagram is to illustrate the following:

i) Communication endpoints (e.g. workstations, controllers and servers)
ii) Network devices (switches, routers, firewalls)
iii) Physical and virtual computers
iv) Physical and virtual communication paths
v) Communication protocols

(c) One combined topology diagram may be acceptable if all requested information can be clearly illustrated.

(3) Description of security capabilities

(a) This document is to describe how the computer-based system with its hardware and software components meets the required security capabilities in **4.4.1**.

(b) Any network interfaces to other computer-based systems in the scope of applicability of this Chapter are to be described. The description is to include destination computer-based system, data flows, and communication protocols. If the System integrator has allocated the destination computer-based system to another security zone, components providing protection of the security zone boundary (see **5.4.3(2)(a)**) are to be described in detail if delivered as part of the computer-based system.

(c) Any network interfaces to other systems or networks outside the scope of applicability of this Chapter (untrusted networks) are to be described. The description is to specify compliance with the additional security capabilities in **4.4.3**, and include relevant procedures or instructions for the crew. Components providing protection of the security zone boundary (see **5.4.3(2)(a)**) are to be described in detail if delivered as part of the computer-based system.

(d) A separate chapter is to be designated for each requirement. All hardware and software components in the system are to be addressed in the description, as relevant.

(e) If any requirement is not fully met, this is to be specified in the description, and compensating countermeasures are to be proposed. The compensating countermeasures should the following:

i) protect against the same threats as the original requirement,
ii) provide an equal level of protection as the original requirement,
iii) not be a security control that is required by other requirements in this Chapter, and
iv) not introduce a higher security risk.

(f) Any supporting documents (e.g. OEM information) necessary to verify compliance with the requirements are to be referenced in the description and submitted.

(4) Test procedure of security capabilities

(a) This document is to describe how to demonstrate by testing that the system complies with the requirements in **4.4.2** and **4.4.3**, including any compensating countermeasures. Demonstration of compliance by analytic evaluation may be specially considered. The procedure is to include a separate chapter for each applicable requirement and describe the following:

i) necessary test setup (i.e. to ensure the test can be repeated with the same expected result),
ii) test equipment,
iii) initial condition(s),
iv) test methodology, detailed test steps, and
v) expected results and acceptance criteria.

(b) The procedure is to also include means to update test results and record findings during the testing.

(5) Security configuration guidelines

(a) This document is to describe recommended configuration settings of the security capabilities and specify default values. The objective is to ensure the security capabilities are implemented in accordance with **Chapter 5** and any specifications by the System integrator (e.g. user accounts, authorisation, password policies, safe state of machinery, firewall rules, etc.)

(b) The document is to serve as basis for verification of No.**29** in **Table X4.1**.

(6) Secure development lifecycle documents

This documentation is to be submitted to the Society upon request and is to be describe the supplier's processes and controls in accordance with requirements for secure development lifecycle in **4.5**. Software updates and patching are to be described. The document is to prepare the Society for survey as per **2.2.2-5**.

(7) Plans for maintenance and verification of the computer-based system

This document is to be submitted to the Society upon request and is to include procedures for security-related maintenance and testing of the system. The document is to include instructions for how the user can verify correct operation of the system's security functions as required by No.**19** in **Table X4.1**.

(8) Information supporting the owner's incident response and recovery plan

This document is to be submitted to the Society upon request and is to include procedures or instructions allowing the user to accomplish the following:

(a) local independent control (see **5.4.5(2)**),

(b) network isolation (see **5.4.5(3)**),

(c) forensics by use of audit records (see No.**13** in **Table X4.1**),

(d) deterministic output (see **5.4.5(4)** and No.**20** in **Table X4.1**),

(e) backup (see No.**26** in **Table X4.1**),

(f) restore (see No.**27** in **Table X4.1**), and

(g) controlled shutdown, reset, roll-back and restart (see **5.4.6(3)**).

(9) Management of change plan

This document is to be submitted to the Society upon request. It is expected that this procedure is not specific for cyber security and is also required by **Chapter 3**.

(10) Test reports

Computer-based systems with approval certificate covering the security capabilities of this Chapter may be exempted from survey by the Society. However, test reports signed by the supplier are to be submitted to the Society, demonstrating that the supplier has completed design, construction, testing, configuration, and hardening as would otherwise be verified by the Society in survey (**4.6.3** and **2.2.3**).

4.4.2 Required Security Capabilities*

The security capabilities specified in **Table X4.1** are required for computer-based systems in the scope specified in **4.1.2**. The requirements in **Table X4.1** are based on the selected requirements in *IEC* 62443-3-3. To determine the full content, rationale and relevant guidance for each requirement, the reader should consult the referenced standard. In this table, "*IEC* 62443-3-3/SR x.x" as used (where x is a number) indicates that it is related to the corresponding SR (System requirement) specified in the following *IEC* standards:

- *IEC* 62443-3-3:2013 (Industrial Communication Networks, Network and System Security, Part 3-3: System security requirements and security levels)

4.4.3 Additional Security Capabilities

1 The security capabilities specified in **Table X4.2** are Required for computer-based systems with network communication to untrusted networks (i.e. interface to any networks outside the scope of this chapter). In **Table X4.2**, "*IEC* 62443-3-3/SR x.x, RE x.x" as used (where x is a number) indicates the RE (Requirement enhancement) related to the relevant SR (System requirement).

2 Computer-based systems with communication traversing the boundaries of security zones are also to meet requirements for network segmentation and zone boundary protection in **5.4.3(1)** and **(2)**.

Table X4.1 Required Security Capabilities

Item No.	Objective	Requirements
Protect against casual or coincidental access by unauthenticated entities		
1	Human user identification and authentication	The computer-based system is to identify and authenticate all human users who can access the system directly or through interfaces. (*IEC* 62443-3-3/SR 1.1)
2	Account management	The computer-based system is to provide the capability to support the management of all accounts by authorized users, including adding, activating, modifying, disabling and removing account. (*IEC* 62443-3-3/SR 1.3)
3	Identifier management	The computer-based system is to provide the capability to support the management of identifiers by user, group and role. (*IEC* 62443-3-3/SR 1.4)
4	Authenticator management	The computer-based system is to provide the capability to do the following: - initialize authenticator content, - change all default authenticators upon control system installation, - change/refresh all authenticators, and - protect all authenticators from unauthorized disclosure and modification when stored and transmitted. (*IEC* 62443-3-3/SR 1.5)
5	Wireless access management	The computer-based system is to provide the capability to identify and authenticate all users (humans, software processes or devices) engaged in wireless communication. (*IEC* 62443-3-3/SR 1.6)
6	Strength of password-based authentication	The computer-based system is to provide the capability to enforce configurable password strength based on minimum length and variety of character types. (*IEC* 62443-3-3/SR 1.7)
7	Authenticator feedback	The computer-based system is to obscure feedback during the authentication process. (*IEC* 62443-3-3/SR 1.10)
Protect against casual or coincidental misuse		
8	Authorization enforcement	On all interfaces, human users are to be assigned authorizations in accordance with the principles of segregation of duties and least privilege. (*IEC* 62443-3-3/SR 2.1)
9	Wireless use Control	The computer-based system is to provide the capability to authorize, monitor and enforce usage restrictions for wireless connectivity to the system according to commonly accepted security industry practices. (*IEC* 62443-3-3/SR 2.2)
10	Use control for portable and mobile devices	When the computer-based system supports use of portable and mobile devices, the system is to include the capability to do the following: - limit the use of portable and mobile devices only to those permitted by design, and - restrict code and mobile devices. (*IEC* 62443-3-3/SR 2.3)
11	Mobile code	The computer-based system is to control the use of mobile code such as java scripts, ActiveX and PDF. (*IEC* 62443-3-3/SR 2.4)
12	Session lock	The computer-based system is to be able to prevent further access after a configurable time of inactivity or following activation of manual session lock. (*IEC* 62443-3-3/SR 2.5)
13	Auditable events	The computer-based system is to generate audit records relevant to security for at least the

		following events: access control, operating system events, backup and restore events, configuration changes, loss of communication. (*IEC* 62443-3-3/SR 2.8)
14	Audit storage capacity	The computer-based system is to provide the capability to allocate audit record storage capacity according to commonly recognized recommendations for log management. Auditing mechanisms are to be implemented to reduce the likelihood of such capacity being exceeded. (*IEC* 62443-3-3/SR 2.9)
15	Response to audit processing failures	The computer-based system is to provide the capability to prevent loss of essential services and functions in the event of an audit processing failure. (*IEC* 62443-3-3/SR 2.10)
16	Timestamps	The computer-based system is to timestamp audit records. (*IEC* 62443-3-3/SR 2.11)
Protect the integrity of the computer-based system against casual or coincidental manipulation		
17	Communication integrity	The computer-based system is to protect the integrity of transmitted information. (*IEC* 62443-3-3/SR 3.1)
18	Malicious code protection	The computer-based system is to provide capability to implement suitable protection measures to prevent, detect and mitigate the effects due to malicious code or unauthorized software. It is to have the feature for updating the protection mechanisms. (*IEC* 62443-3-3/SR 3.2)
19	Security functionality verification	The computer-based system is to provide the capability to support verification of the intended operation of security functions and report when anomalies occur during maintenance. (*IEC* 62443-3-3/SR 3.3)
20	Deterministic output	The computer-based system is to provide the capability to set outputs to a predetermined state if normal operation cannot be maintained as a result of an attack. The predetermined state could be the following: - unpowered state, - last-known value, or - fixed value. (*IEC* 62443-3-3/SR 3.6)
Prevent the unauthorized disclosure of information via eavesdropping or casual exposure		
21	Information confidentiality	The computer-based system is to provide the capability to protect the confidentiality of information for which explicit read authorization is supported, whether at rest or in transit. (*IEC* 62443-3-3/SR 4.1)
22	Use of cryptograph	If cryptography is used, the computer-based system is to use cryptographic algorithms, key sizes and mechanisms according to commonly accepted security industry practices and recommendations. (*IEC* 62443-3-3/SR 4.3)
Monitor the operation of the computer-based system and respond to incidents		
23	Audit log accessibility	The computer-based system is to provide the capability for accessing audit logs on read only basis by authorized humans and/or tools. (*IEC* 62443-3-3/SR 6.1)
Ensure that the control system operates reliably under normal production conditions		
24	Denial of service protection	The computer-based system is to provide the minimum capability to maintain essential functions during DoS events. (*IEC* 62443-3-3/SR 7.1)

25	Resource management	The computer-based system is to provide the capability to limit the use of resources by security functions to prevent resource exhaustion. (*IEC* 62443-3-3/SR 7.2)
26	System backup	The identity and location of critical files and the ability to conduct backups of user-level and system-level information (including system state information) are to be supported by the computer-based system without affecting normal operations. (*IEC* 62443-3-3/SR 7.3)
27	System recovery and reconstitution	The computer-based system is to provide the capability to be recovered and reconstituted to a known secure state after a disruption or failure. (*IEC* 62443-3-3/SR 7.4)
28	Alternative power source	The computer-based system is to provide the capability to switch to and from an alternative power source without affecting the existing security state or a documented degraded mode. (*IEC* 62443-3-3/SR 7.5)
29	Network and security configuration settings	The computer-based system traffic is to provide the capability to be configured according to recommended network and security configurations as described in guidelines provided by the supplier. The computer-based system is to provide an interface to the currently deployed network and security configuration settings. (*IEC* 62443-3-3/SR 7.6)
30	Least Functionality	The installation, the availability and the access rights of the following are to be limited to the strict needs of the functions provided by the computer-based system: - operating systems software components, processes and services - network services, ports, protocols, routes and hosts accesses and any software (*IEC* 62443-3-3/SR 7.7)

Table X4.2 Additional Security Capabilities

Item No	Objective	Requirements
31	Multifactor authentication for human users	Multifactor authentication is required for human users when accessing the computer-based system from or via an untrusted network. (*IEC* 62443-3-3/SR 1.1, RE 2)
32	Software process and device identification and authentication	The computer-based system is to identify and authenticate software processes and devices. (*IEC* 62443-3-3/SR 1.2)
33	Unsuccessful login attempts	The computer-based system is to enforce a limit of consecutive invalid login attempts from untrusted networks during a specified time period. (*IEC* 62443-3-3/SR 1.11)
34	System use notification	The computer-based system is to provide the capability to display a system use notification message before authenticating. The system use notification message is to be configurable by authorized personnel. (*IEC* 62443-3-3/SR 1.12)
35	Access via Untrusted Networks	Any access to the computer-based system from or via untrusted networks are to be monitored and controlled. (*IEC* 62443-3-3/SR 1.13)
36	Explicit access request approval	The computer-based system is to deny access from or via untrusted networks unless explicitly approved by authorized personnel on board. (*IEC* 62443-3-3/SR 1.13, RE1)
37	Remote session termination	The computer-based system is to provide the capability to terminate a remote session either automatically after a configurable time period of inactivity or manually by the user who initiated the session. (*IEC* 62443-3-3/SR 2.6)
38	Cryptographic integrity protection	The computer-based system is to employ cryptographic mechanisms to recognize changes to information during communication with or via untrusted networks. (*IEC* 62443-3-3/SR 3.1, RE1)
39	Input validation	The computer-based system is to validate the syntax, length and content of any input data via untrusted networks that is used as process control input or input that directly impacts the action of the computer-based system. (*IEC* 62443-3-3/SR 3.5)
40	Session integrity	The computer-based system is to protect the integrity of sessions. Invalid session IDs are to be rejected. (*IEC* 62443-3-3/SR 3.8)
41	Invalidation of session IDs after session termination	The system is to invalidate session IDs upon user logout or other session termination (including browser sessions). (*IEC* 62443-3-3/SR 3.8, RE1)

4.5 Secure Development Lifecycle Requirements

4.5.1 Data to be Submitted

1 A Secure Development Lifecycle (SDLC) broadly addressing security aspects in the following stages is to be followed for the development of systems or equipment.

(1) requirement analysis phase,

(2) design phase,

(3) implementation phase,

(4) verification phase,

(5) release phase,

(6) maintenance Phase, and

(7) end of life phase.

2 A document is to be produced that records how the security aspects have been addressed in above phases and is to at minimum integrate controlled processes as set out in below 4.5.2 to 4.5.8. The said document is required to be submitted to class for review and approval. In this section, "*IEC* 62443-4-1" and subsequent statements are relevant to the following statements regarding security management (SM), security update management (SUM) or security guidelines (SG) specified in the IEC standards.

IEC 62443-4-1 (2018): Security for industrial automation and control systems Part 4-1: Secure product development lifecycle requirements

4.5.2 Control for Private Key (*IEC* 62443-4-1/SM-8)

The manufacturer is to have procedural and technical controls in place to protect private keys used for code signing, if applicable, from unauthorized access or modification.

4.5.3 Security Update Documentation (*IEC* 62443-4-1/SUM-2)

A process is to be employed to ensure that documentation about product security updates is made available to users (which could be through establishing a cyber security point of contact or periodic publication which can be accessed by the user) that includes but is not limited to the following:

(1) the product version number(s) to which the security patch applies;

(2) instructions on how to apply approved patches manually and via an automated process;

(3) description of any impacts that applying the patch to the product can have, including reboot;

(4) instructions on how to verify that an approved patch has been applied; and

(5) risks of not applying the patch and mediations that can be used for patches that are not approved or deployed by the asset owner.

4.5.4 Dependent Component or Operating System Security Update Documentation (*IEC* 62443-4-1/SUM-2)

A process is to be employed to ensure that documentation about dependent component or operating system security updates is available to users that includes but is not limited to stating whether the product is compatible with the dependent component or operating system security update.

4.5.5 Security Update Delivery (*IEC* 62443-4-1/SUM-4)

A process is to be employed to ensure that security updates for all supported products and product versions are made available to product users in a manner that facilitates verification that the security patch is authentic. The manufacturer is to have QA process to test the updates before releasing.

4.5.6 Product Defence in Depth (*IEC* 62443-4-1/SG-1)

A process is to exist to create product documentation that describes the security defence in depth strategy for the product to support installation, operation and maintenance that includes the following:

(1) security capabilities implemented by the product and their role in the defence in depth strategy;

(2) threats addressed by the defence in depth strategy; and

(3) product user mitigation strategies for known security risks associated with the product, including risks associated with legacy code.

4.5.7 Defence in Depth Measure Expected in the Environment (*IEC* 62443-4-1/SG-2)

A process is to be employed to create product user documentation that describes the security defence in depth measures expected to be provided by the external environment in which the product is to be used.

4.5.8 Security Hardening Guidelines (*IEC* 62443-4-1/SG-3)

A process is to be employed to create product user documentation that includes guidelines for hardening the product when installing and maintaining the product. The guidelines are to include, but are not limited to, instructions, rationale and recommendations for the following:

(1) Integration of the product, including third-party components, with its product security context

(2) Integration of the product's application programming interfaces/protocols with user applications;

(3) Applying and maintaining the product's defence in depth strategy

(4) Configuration and use of security options/capabilities in support of local security policies, and for each security option/capability for the following:

(a) its contribution to the product's defence in depth strategy;

(b) descriptions of configurable and default values that include how each affects security along with any potential impact each has on work practices; and

(c) setting/changing/deleting its value;

(5) Instructions and recommendations for the use of all security-related tools and utilities that support administration, monitoring, incident handling and evaluation of the security of the product;

(6) Instructions and recommendations for periodic security maintenance activities;

(7) Instructions for reporting security incidents for the product to the supplier;

(8) Description of the security best practices for maintenance and administration of the product.

4.6 Demonstration of Compliance

4.6.1 Introduction

1 Suppliers are to in cooperation with the System integrator determine if this Chapter is mandatory for the computer-based system, see **Fig. X4.1**.

2 Compliance with security requirements is to be demonstrated as indicated in **Fig. X4.2**. This classification process is ship-specific and is to result in a System certificate.

3 Approval of use based on **Chapter 10, Part 7 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** is voluntary and applies for computer-based systems that are standard and routinely manufactured. See **3.2.1** and **3.2.2**for definition of System certification and approval of use.

4 The process in **Fig. X4.1** and **Fig. X4.2** applies also if other equivalent standards are applied for navigation and radiocommunication equipment (see **4.1.2**). In such case, the process in **Fig. X4.1** illustrates if the equivalent standard is mandatory (in lieu of this Chapter) and the process in **Fig. X4.2** illustrates that the certification process is lessened if the computer-based system has been approved in accordance with the equivalent standard.

Fig. X4.1 Determination of Application

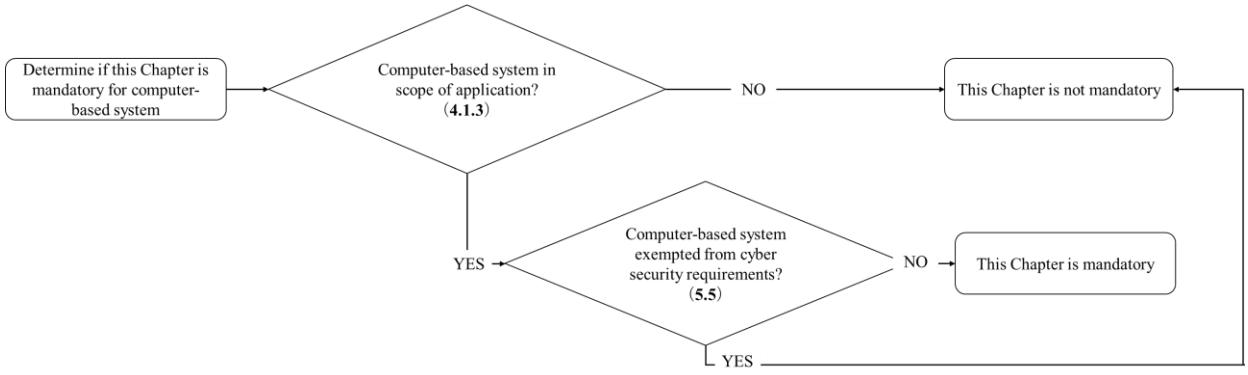
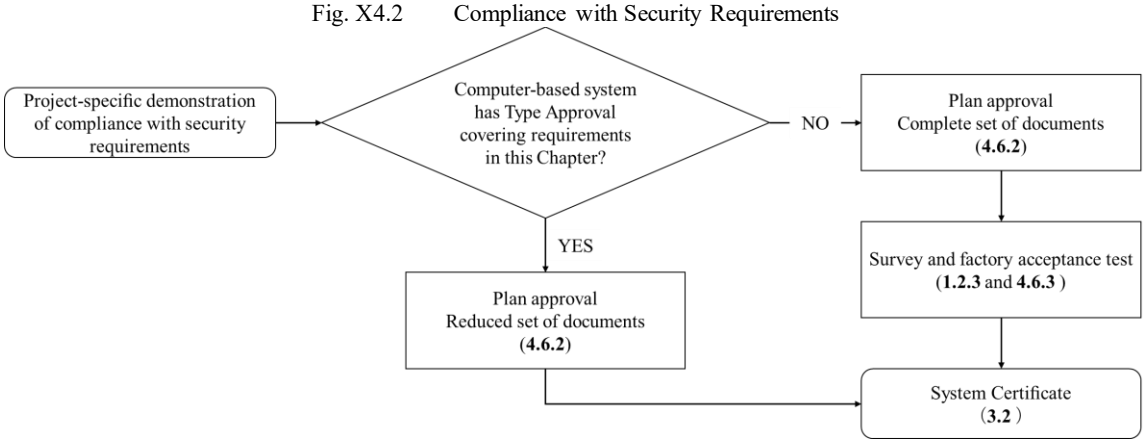


Fig. X4.2 Compliance with Security Requirements



4.6.2 Plan Approval

1 Plan approval is assessment of documents of a computer-based system intended for a specific vessel. The documents in **2.2.3** are required to be submitted by the supplier. The documents are to enable the Society to verify compliance with requirements in this Chapter.

2 If the computer-based system holds a valid approval certificate covering the requirements of this Chapter, subject to approval by the Society, the supplier may submit a reduced set of vessel-specific documents to the Society (see **Table X2.3**).

3 The approved version of the documents are to be included in the delivery of the computer-based system to the system integrator.

4.6.3 Survey and Factory Acceptance Test

1 Survey and factory acceptance test is a vessel-specific verification activity required for computer-based systems that do not hold a valid approval certificate covering the requirements of this Chapter.

2 The objective of the survey and factory acceptance test is to demonstrate by testing and/or analytic evaluation that the computer-based system complies with applicable requirements in this Chapter. The survey and factory acceptance test is to be carried out at the supplier's premises or at other works having the adequate apparatus for testing and inspection.

3 After completed plan approval and survey/factory acceptance test, the Society will issue a System certificate that is to accompany the computer-based system upon delivery to the system integrator.

Chapter 5 CYBER RESILIENCE OF SHIPS

5.1 General

5.1.1 Aim*

1 The aim of this Chapter is to provide a minimum set of requirements for cyber resilience of ships, with the purpose of providing technical means to stakeholders which would lead to cyber resilient ships.

2 This Chapter targets the ship as a collective entity for cyber resilience and is intended as a base for the complementary application of other requirements and industry standards addressing cyber resilience of onboard systems, equipment and components.

3 Minimum requirements for cyber resilience of on-board systems and equipment are given in **Chapter 4**.

5.1.2 Scope

1 The requirements in this Chapter are applicable for computer-based systems subject to **4.1.2**.

2 The cyber incidents considered in this Chapter are events resulting from any offensive manoeuvre that targets OT systems onboard ships as defined in **5.2**.

5.1.3 System Category

System categories are defined in **3.3.1** on the basis of the consequences of a system failure to human safety, safety of the vessel and/or threat to the environment.

5.1.4 Relative requirements on Computer Based Systems and Cyber Resilience

Attention is made to relative requirements on computer-based systems and Cyber Resilience as follows:

(1) **Chapter 3** "Computer Based Systems"

(2) **Chapter 4** "Cyber Resilience of On-board Systems and Equipment"

(3) *IACS* Recommendation 166 Recommendation on Cyber Resilience: non-mandatory recommended technical requirements that stakeholders may reference and apply to assist with the delivery of cyber resilient ships, whose resilience can be maintained throughout their service life. *IACS* Recommendation 166 on Cyber Resilience is intended for ships contracted for construction after its publication and may be used as a reference for ships already in service prior to its publication. For ships to which this Chapter applies as mandatory instrument, when both this Chapter and Recommendation 166 are used, should any difference in requirements addressing the same topic be found between the two instruments, the requirements in this Chapter is to prevail.

5.2 Definitions

5.2.1 Terminology*

The terminology used in this Chapter is as specified in the following **(1)** to **(23)**:

(1) "Annual Survey" means the survey consist of general examinations of hull, machinery, equipment, fire-fighting equipment, etc. as specified in **Chapter 3, Part B**.

(2) "Attack Surface" means the set of all possible points where an unauthorized user can access a system, cause an effect on or extract data from. The attack surface comprises two categories: digital and physical. The digital attack surface encompasses all the hardware and software that connect to an organization's network. These include applications, code, ports, servers and websites. The physical attack surface comprises all endpoint devices that an attacker can gain physical access to, such as desktop computers, hard drives, laptops, mobile phones, removable drives and carelessly discarded hardware.

(3) "Authentication" means provision of assurance that a claimed characteristic of an entity is correct.

(4) "Compensating countermeasure" means an alternate solution to a countermeasure employed in lieu of or in addition to inherent security capabilities to satisfy one or more security requirements.

(5) "Computer-based System" means a programmable electronic device, or interoperable set of programmable electronic devices, organized to achieve one or more specified purposes such as collection, processing, maintenance, use, sharing, dissemination, or disposition of information. computer-based systems onboard include IT and OT systems. A computer-based system may be a combination of subsystems connected via network. Onboard computer-based systems may be connected directly or via public

means of communications (e.g. Internet) to ashore computer-based systems, other vessels' computer-based systems and/or other facilities.

(6) "Cyber incident" means an event resulting from any offensive manoeuvre, either intentional or unintentional, that targets or affects one or more computer-based system onboard, which actually or potentially results in adverse consequences to an onboard system, network and computer or the information that they process, store or transmit, and which may require a response action to mitigate the consequences. Cyber incidents include unauthorized access, misuse, modification, destruction or improper disclosure of the information generated, archived or used in onboard computer-based system or transported in the networks connecting such systems. Cyber incidents do not include system failures.

(7) "Cyber resilience" means the capability to reduce the occurrence and mitigating the effects of cyber incidents arising from the disruption or impairment of operational technology (OT) used for the safe operation of a ship, which potentially lead to dangerous situations for human safety, safety of the vessel and/or threat to the environment.

(8) "Essential services" mean services for propulsion and steering, and safety of the ship. Essential services comprise "Primary Essential Services" and "Secondary Essential Services": Primary Essential Services are those services which need to be in continuous operation to maintain propulsion and steering; Secondary Essential Services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the vessel's safety.

(9) "Information Technology (IT)" mean devices, software and associated networking focusing on the use of data as information, as opposed to Operational Technology (OT).

(10) "Integrated system" means a system combining a number of interacting sub-systems and/or equipment organized to achieve one or more specified purposes.

(11) "Logical network segment" is the same as "Network segment", but where two or more logical network segments share the same physical components.

(12) "Network" means a connection between two or more computers for the purpose of communicating data electronically by means of agreed communication protocols.

(13) "Network segment" means in the context of this Chapter, a network segment is an OSI layer-2 Ethernet segment (a broadcast domain).

(14) "Operational Technology (OT)" means devices, sensors, software and associated networking that monitor and control onboard systems. Operational technology systems may be thought of as focusing on the use of data to control or monitor physical processes.

(15) "Physical network segment" is the same as "Network segment", but where physical components are not shared by other network segments.

(16) "Protocol:" means a common set of rules and signals that computers on the network use to communicate. Protocols allow to perform data communication, network management and security. Onboard networks usually implement protocols based on TCP/IP stacks or various fieldbuses.

(17) "Security zone" means a collection of computer-based systems in the scope of applicability of this Chapter that meet the same security requirements. Each zone consists of a single interface or a group of interfaces, to which an access control policy is applied.

(18) "Shipowner/Company" means the owner of the ship or any other organization or person, such as the manager, agent or bareboat charterer, who has assumed the responsibility for operation of the ship from the shipowner and who on assuming such responsibilities has agreed to take over all the attendant duties and responsibilities. The shipowner could be the Shipyard or systems integrator during initial construction. After vessel delivery, the shipowner may delegate some responsibilities to the vessel management company.

(19) "Special Survey" is the survey consist of detailed examinations of hull, machinery, equipment, fire-fighting equipment, etc. as specified in **Chapter 5, Part B**.

(20) "Supplier" means a manufacturer or provider of hardware and/or software products, system components or equipment (hardware or software) comprising of the application, embedded devices, network devices, host devices etc. working together as system or a subsystem. The supplier is responsible for providing programmable devices, sub-systems or systems to the systems integrator.

(21) "Systems Integrator" means the specific person or organization responsible for the integration of systems and products provided by suppliers into the system invoked by the requirements in the ship specifications and for providing the integrated system. The systems integrator may also be responsible for integration of systems in the ship. Until vessel delivery, this role is to be taken by the Shipyard unless an alternative organization is specifically contracted/assigned this responsibility.

(22) "Untrusted network" means any network outside the scope of applicability of this Chapter.

(23) "Roll-back" is an operation which returns the system to some previous state

5.3 Goals and Organization of Requirements

5.3.1 Primary Goal

1 The primary goal is to support safe and secure shipping, which is operationally resilient to cyber risks.

2 Safe and secure shipping can be achieved through effective cyber risk management system. To support safe and secure shipping resilient to cyber risk, the following sub-goals for the management of cyber risk are defined in the five functional elements listed in 5.3.2 below.

5.3.2 Sub-goals per Functional Element

Following sub-goals and relevant functional elements should be concurrent and considered as parts of a single comprehensive risk management framework.

(1) Identify

Develop an organizational understanding to manage cybersecurity risk to onboard systems, people, assets, data, and capabilities.

(2) Protect

Develop and implement appropriate safeguards to protect the ship against cyber incidents and maximize continuity of shipping operations.

(3) Detect

Develop and implement appropriate measures to detect and identify the occurrence of a cyber incident onboard.

(4) Respond

Develop and implement appropriate measures and activities to take action regarding a detected cyber incident onboard.

(5) Recover

Develop and implement appropriate measures and activities to restore any capabilities or services necessary for shipping operations that were impaired due to a cyber incident.

5.3.3 Organization of Requirements

The requirements specified in this chapter are structured as follows:

(1) The requirements are organized according to a goal-based approach.

(2) Functional/technical requirements are given for the achievement of specific sub-goals of each functional element as specified in 5.3.2.

(3) The requirements are intended to allow a uniform implementation by stakeholders and to make them applicable to all types of vessels, in such a way as to enable an acceptable level of resilience and apply to all classed vessels/units regardless of operational risks and complexity of OT systems.

(4) For each requirement, a rationale is given.

(5) A summary of actions to be carried out and documentation to be made available is also given for each phase of the ship's life and relevant stakeholders participating to such phase.

5.4 Requirements for Cyber Resilience of Ships

5.4.1 General

This section contains the requirements to be satisfied in order to achieve the primary goal defined in 5.3.1, organized according to the five functional elements identified in 5.3.2. The requirements are to be fulfilled by the stakeholders involved in the design, building and operation of the ship. Among them, the following stakeholders can be identified (see also 5.2 for definitions). Whilst the above requirements may be fulfilled by these stakeholders, for the purposes of this Chapter, responsibility to fulfil them will lie with

the stakeholder who has contracted with the Society.

(1) Shipowner/Company

(2) Systems integrator

(3) Supplier

(4) Classification Society

5.4.2 Identify

The requirements for the "Identify" functional element are aimed at identifying, on one side, the computer-based systems onboard, their interdependencies and the relevant information flows; and, on the other side, the key resources involved in their management, operation and governance, their roles and responsibilities.

(1) Vessel asset inventory

(a) Requirement

An inventory of hardware and software (including application programs, operating systems, if any, firmware and other software components) of the computer-based systems in the scope of applicability of this Chapter and of the networks connecting such systems to each other and to other computer-based systems onboard or ashore are to be provided and kept up to date during the entire life of the ship.

(b) Rationale

The inventory of computer-based systems onboard and relevant software used in OT systems, is essential for an effective management of cyber resilience of the ship, the main reason being that every computer-based system becomes a potential point of vulnerability. Cybercriminals can exploit unaccounted and out-of- date hardware and software to hack systems. Moreover, managing computer-based system assets enables Companies understand the criticality of each system to ship safety objectives.

(c) Requirement details

The vessel asset inventory is to include at least the computer-based systems indicated in **5.1.2-1.**, if present onboard. The inventory is to be kept updated during the entire life of the ship. Software and hardware modifications potentially introducing new vulnerabilities or modifying functional dependencies or connections among systems are to be recorded in the inventory. If confidential information is included in the inventory (e.g. IP addresses, protocols, port numbers), special measures are to be adopted to limit the access to such information only to authorized people.

i) Hardware

1) For all hardware devices in the scope of applicability of this Chapter, the vessel asset inventory is to include at least the information in **4.4.1(1)**.

2) In addition, the vessel asset inventory may specify system category and security zone associated with the computer-based system.

ii) Software

1) For all software in the scope of applicability of this Chapter (e.g., application program, operating system, firmware), the vessel asset inventory is to include at least the information in **4.4.1(1)**.

2) The software of the computer-based systems in the scope of applicability of this Chapter are to be maintained and updated in accordance with the shipowner's process for management of software maintenance and update policy in the Ship cyber security and resilience program (see **2.2.3-5(7)**)

(d) Demonstration of compliance

i) Design phase

1) The systems integrator is to submit vessel asset inventory to the Society (see **2.2.3-4**).

2) The vessel asset inventory is to incorporate the asset inventories of all individual computer-based systems falling under the scope of this Chapter. Any equipment in the scope of this Chapter delivered by the systems integrator is also to be included in the vessel asset inventory.

ii) Construction phase

The systems integrator is to keep the vessel asset inventory updated.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following

to the Society:

1) vessel asset inventory is updated and completed at delivery,
2) computer-based systems in the scope of applicability of this Chapter are correctly represented by the vessel asset inventory, and
3) software of the computer-based systems in the scope of applicability of this Chapter has been kept updated, e.g. by vulnerability scanning or by checking the software versions of computer-based systems while switched on.

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).
2) The shipowner is to in the Ship cyber security and resilience program describe the process of management of change (MoC) for the computer-based systems in the scope of applicability of this Chapter, addressing at least the following requirements in this Chapter:
   – management of change (**2.2.3-5**), and
   – hardware and software modifications (**5.4.2(1)(c)**).
3) The shipowner is to in the Ship cyber security and resilience program also describe the management of software updates, addressing at least the following requirements in this Chapter:
   – vulnerabilities and cyber risks (**5.4.2(1)(b)** and **(c)**), and
   – security patching (**5.4.3(6)(c)iii)2)**).
4) First Annual Survey

   The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:
   – the approved management of change process has been adhered to,
   – known vulnerabilities and functional dependencies have been considered for the software in the computer-based systems, and
   – the Vessel asset inventory has been kept updated.
5) Subsequent Annual Surveys

   The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.
6) Special Survey

   The shipowner is to demonstrate to the Society the activities in **5.4.2(1)(d)iii)** as per the Ship cyber resilience test procedure.

5.4.3 Protect*

The requirements for the Protect functional element are aimed at the development and implementation of appropriate safeguards supporting the ability to limit or contain the impact of a potential incident.

(1) Security zones and network segmentation

(a) Requirement

i) All computer-based systems in the scope of applicability of this Chapter are to be grouped into security zones with well-defined security policies and security capabilities. Security zones are to either be isolated (i.e. air gapped) or connected to other security zones or networks by means providing control of data communicated between the zones (e.g. firewalls/routers, simplex serial links, TCP/IP diodes, dry contacts, etc.)

ii) Only explicitly allowed traffic are to traverse a security zone boundary.

(b) Rationale

i) While networks may be protected by firewall perimeter and include Intrusion Detection Systems (IDS) or Intrusion Prevention Systems (IPS) to monitor traffic coming in, breaching that perimeter is always possible. Network segmentation makes it more difficult for an attacker to perpetrate an attack throughout the entire network.

ii) The main benefits of security zones and network segmentation are to reduce the extent of the attack surface, prevent attackers from achieving lateral movement through systems, and improve network performance. The concept of allocating the computer-based systems into security zones allows grouping the computer-based systems in accordance with their risk profile.

(c) Requirement details

i) A security zone may contain multiple computer-based systems and networks, all of which are to comply with

applicable security requirements given in this Chapter and **Chapter 4**.

ii) The network(s) of a security zone are to be logically or physically segmented from other zones or networks (see also **5.4.3(6)(c)**).

iii) Computer-based systems providing required safety functions are to be grouped into separate security zones and are to be physically segmented from other security zones.

iv) Navigational and communication systems are not to be in same security zone as machinery or cargo systems. If navigation and/or radiocommunication systems are approved in accordance with other equivalent standard(s) (see **4.1.2-2(1)(k)**), these systems should be in a dedicated security zone.

v) Wireless devices are to be in dedicated security zones (see also **5.4.3(5)**).

vi) Systems, networks or computer-based systems outside the scope of applicability of this Chapter are considered untrusted networks and are to be physically segmented from security zones required by this Chapter. Alternatively, it is accepted that such systems are part of a security zone if these OT- systems meet the same requirements as demanded by the zone.

vii) It is to be possible to isolate a security zone without affecting the primary functionality of the computer-based systems in the zone (see also **5.4.5(3)**).

(d) Demonstration of compliance

i) Design phase

1) The systems integrator is to submit Zones and conduit diagram and the Cyber security design description (see **2.2.3-3(4)** and **(5)**).

2) The Zones and conduit diagram is to illustrate the computer-based systems in the scope of applicability of this Chapter, how they are grouped into security zones, and include the following information:
– clear indication of the security zones,
– simplified illustration of each computer-based system in scope of applicability of this Chapter, and indication of the security zone in which the computer-based system is allocated, and indication of physical location of the computer-based system/equipment,
– reference to the approved version of the computer-based system topology diagrams provided by the suppliers (**4.4.1(2)**),
– illustration of network communication between systems in a security zone
– illustration of any network communication between systems in different security zones (conduits), and
– illustration of any communication between systems in a security zone and untrusted networks (conduits).

3) The systems integrator is to include the following information in the cyber security design description:
– a short description of the computer-based systems allocated to the security zone. It is to be possible to identify each computer-based system in the Zones and conduit diagram,
– network communication between computer-based systems in the same security zone. The description is to include purpose and characteristics (i.e. protocols and data flows) of the communication,
– network communication between computer-based systems in different security zones. The description is to include purpose and characteristics (i.e. protocols and data flows) of the communication. The description is to also include zone boundary devices and specify the traffic that is permitted to traverse the zone boundary (e.g. firewall rules), and
– any communication between computer-based systems in security zones and untrusted networks. The description is to include discrete signals, serial communication, and the purpose and characteristics (i.e. protocols and data flows) of IP-based network communication. The description is to also include zone boundary devices and specify the traffic that is permitted to traverse the zone boundary (e.g. firewall rules).

ii) Construction phase

The systems integrator is to keep the Zones and conduit diagram updated.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society:

1) The security zones on board are implemented in accordance with the approved documents (i.e. zones and conduit diagram, cyber security design description, asset inventory, and relevant documents provided by the supplier). This may be done by e.g., inspection of the physical installation, network scanning and/or other methods providing the Surveyor assurance that the installed equipment is grouped in security zones according to the

approved design.

2) Security zone boundaries allow only the traffic that has been documented in the approved Cyber security description. This may be done by e.g., evaluation of firewall rules or port scanning.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management of security zone boundary devices (e.g., firewalls), addressing at least the following requirements in this Chapter:
– principle of Least Functionality (**5.4.3(2)(a)**),
– explicitly allowed traffic (**5.4.3(1)(a)**),
– protection against denial of service (DoS) events (**5.4.3(2)(a)**), and
– inspection of security audit records (**5.4.4(1)(c)**).

2) First Annual Survey

The shipowner is to demonstrate to the Society that the Zones and conduit diagram has been kept updated and present records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that security zone boundaries are managed in accordance with the above requirements.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

4) Special Survey

The shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(2) Network protection safeguards

(a) Requirement

i) Security zones are to be protected by firewalls or equivalent means as specified in **5.1.1**.

ii) The networks are to also be protected against the occurrence of excessive data flow rate and other events which could impair the quality of service of network resources.

iii) The computer-based systems in scope of this Chapter are to be implemented in accordance with the principle of Least Functionality, i.e. configured to provide only essential capabilities and to prohibit or restrict the use of non-essential functions, where unnecessary functions, ports, protocols and services are disabled or otherwise prohibited.

(b) Rationale

i) Network protection covers a multitude of technologies, rules and configurations designed to protect the integrity, confidentiality and availability of networks. The threat environment is always changing, and attackers are always trying to find and exploit vulnerabilities.

ii) There are many layers to consider when addressing network protection. Attacks can happen at any layer in the network layers model, so network hardware, software and policies must be designed to address each area.

iii) While physical and technical security controls are designed to prevent unauthorized personnel from gaining physical access to network components and protect data stored on or in transit across the network, procedural security controls consist of security policies and processes that control user behaviour.

(c) Requirement details

The design of network are to include means to meet the intended data flow through the network and minimize the risk of denial of service (DoS) and network storm/high rate of traffic. Estimation of data flow rate is to at least consider the capacity of network, data speed requirement for intended application and data format.

(d) Demonstration of compliance

i) Design phase

No requirements.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society. The tests specified in **2)** and **3)** may be omitted if performed during the certification of computer-based

systems as per 2.2.3-4(2).

1) Test denial of service (DoS) attacks targeting zone boundary protection devices, as applicable.

2) Test denial of service (DoS) to ensure protection against excessive data flow rate, originating from inside each network segment. Such denial of service (DoS) tests are to cover flooding of network (i.e., attempt to consume the available capacity on the network segment), and application layer attack (i.e., attempt to consume the processing capacity of selected endpoints in the network)

3) Test e.g. by analytic evaluation and port scanning that unnecessary functions, ports, protocols and services in the computer-based systems have been removed or prohibited in accordance with hardening guidelines provided by the suppliers (see 4.5.8 and 2.2.2-5(7)).

iv) Operation phase

1) For general requirements to surveys in the operation phase (see 2.2.3-5).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(3) Antivirus, antimalware, antispam and other protections from malicious code

(a) Requirement

Computer-based systems in the scope of applicability of this Chapter are to be protected against malicious code such as viruses, worms, trojan horses, spyware, etc.

(b) Rationale

i) A virus or any unwanted program that enters a user's system without his/her knowledge can self-replicate and spread, perform unwanted and malicious actions that end up affecting the system's performance, user's data/files, and/or circumvent data security measures.

ii) Antivirus, antimalware, antispam software will act as a closed door with a security guard fending off the malicious intruding viruses performing a prophylactic function. It detects potential virus and then works to remove it, mostly before the virus gets to harm the system.

iii) Common means for malicious code to enter computer-based systems are electronic mail, electronic mail attachments, websites, removable media (for example, universal serial bus (USB) devices, diskettes or compact disks), PDF documents, web services, network connections and infected laptops.

(c) Requirement details

i) Malware protection is to be implemented on computer-based systems in the scope of applicability of this Chapter. On computer-based systems having an operating system for which industrial-standard anti-virus and anti-malware software is available and maintained up-to-date, anti-virus and/or anti-malware software is to be installed, maintained and regularly updated, unless the installation of such software impairs the ability of computer-based system to provide the functionality and level of service required (e.g. for Category II and Category III computer-based systems performing real-time tasks).

ii) On computer-based systems where anti-virus and anti-malware software cannot be installed, malware protection is to be implemented in the form of operational procedures, physical safeguards, or according to manufacturer's recommendations.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the following information in the Cyber security design description:

1) For each computer-based system, summary of the approved mechanisms provided by the supplier for protection against malicious code or unauthorized software.

2) For computer-based systems with anti-malware software, information about how to keep the software updated.

3) Any operational conditions or necessary physical safeguards to be implemented in the shipowner's management system.

ii) Construction phase

The systems integrator is to ensure that malware protection is kept updated during the construction phase.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

1) Approved anti-malware software or other compensating countermeasures is effective (e.g. test with a trustworthy anti-malware test file).

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management of malware protection, addressing at least the following requirements in this Chapter:
   – Maintenance/update (**5.4.3(3)(c)**)
   – Operational procedures, physical safeguards (**5.4.3(3)(c)**)
   – Use of mobile, portable, removable media (**5.4.3(4)(c)iv**) and **5.4.3(7)(c)**)
   – Access control (**5.4.3(4)**)

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:
   – any anti-malware software has been maintained and updated,
   – procedures for use of portable, mobile or removable devices have been followed,
   – policies and procedures for access control have been followed, and
   – physical safeguards are maintained.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

4) Special Survey

The shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(4) Access control

(a) Requirement

Computer-based systems and networks in the scope of applicability of this Chapter are to provide physical and/or logical/digital measures to selectively limit the ability and means to communicate with or otherwise interact with the system itself, to use system resources to handle information, to gain knowledge of the information the system contains or to control system components and functions. Such measures are to be such as not to hamper the ability of authorized personnel to access computer-based system for their level of access according to the least privilege principle.

(b) Rationale

i) Attackers may attempt to access the ship's systems and data from either onboard the ship, within the company, or remotely through connectivity with the internet. Physical and logical access controls to cyber assets, networks etc. should then be implemented to ensure safety of the ship and its cargo.

ii) Physical threats and relevant countermeasures are also considered in the ISPS Code. Similarly, the ISM Code contains guidelines to ensure safe operation of ships and protection of the environment. Implementation of ISPS and ISM Codes may imply inclusion in the Ship Security Plan (SSP) and Safety Management System (SMS) of instructions and procedures for access control to safety critical assets.

(c) Requirement details

Access to computer-based systems and networks in the scope of applicability of this Chapter and all information stored on such systems are to only be allowed to authorized personnel, based on their need to access the information as a part of their responsibilities or their intended functionality.

i) Physical access control

Computer-based systems of Category II and Category III are to generally be located in rooms that can normally be locked or in controlled space to prevent unauthorized access or are to be installed in lockable cabinets or consoles. Such locations or lockable cabinets/consoles are to be however easy to access to the crew and various stakeholders who need to access to computer-based systems for installation, integration, operation, maintenance, repair,

replacement, disposal etc. so as not to hamper effective and efficient operation of the ship.

ii) Physical access control for visitors

Visitors such as authorities, technicians, agents, port and terminal officials, and shipowner representatives are to be restricted regarding access to computer-based systems onboard whilst on board, e.g. by allowing access under supervision.

iii) Physical access control of network access points

Access points to onboard networks connecting Category II and/or Category III computer-based systems are to be physically and/or logically blocked except when connection occurs under supervision or according to documented procedures, e.g. for maintenance. Independent computers isolated from all onboard networks, or other networks, such as dedicated guest access networks, or networks dedicated to passenger recreational activities, are to be used in case of occasional connection requested by a visitor (e.g. for printing documents).

iv) Removable media controls

A policy for the use of removable media devices are to be established, with procedures to check removable media for malware and/or validate legitimate software by digital signatures and watermarks and scan prior to permitting the uploading of files onto a ship's system or downloading data from the ship's system (see also **5.4.3(7)**).

v) Management of credentials

1) Computer-based systems and relevant information are to be protected with file system, network, application, or database specific Access Control Lists (ACL). Accounts for onboard and onshore personnel are to be left active only for a limited period according to the role and responsibility of the account holder and are to be removed when no longer needed.

2) Onboard computer-based systems are to be provided with appropriate access control that fits to the policy of their Security Zone but does not adversely affect their primary purpose. computer-based systems which require strong access control may need to be secured using a strong encryption key or multi-factor authentication.

3) Administrator privileges are to be managed in accordance with the policy for access control, allowing only authorized and appropriately trained personnel full access to the computer-based system, who as part of their role in the company or onboard need to log on to systems using these privileges.

vi) Least privilege principle

1) Any human user allowed to access computer-based system and networks in the scope of applicability of this Chapter are to have only the bare minimum privileges necessary to perform its function.

2) The default configuration for all new account privileges are to be set as low as possible. Wherever possible, raised privileges are to be restricted only to moments when they are needed, e.g. using only expiring privileges and one-time-use credentials. Accumulation of privileges over time are to be avoided, e.g. by regular auditing of user accounts.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the information related to location and physical access controls for the computer-based systems in the Cyber security design description. Devices providing Human Machine Interface (HMI) for operators needing immediate access need not enforce user identification and authentication provided they are located in an area with physical access control. Such devices are to be specified.

ii) Construction phase

The systems integrator is to prevent unauthorised access to the computer-based systems during the construction phase.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society:

1) Components of the computer-based systems are located in areas or enclosures where physical access can be controlled to authorised personnel.

2) User accounts are configured according to the principles of segregation of duties and least privilege and that temporary accounts have been removed (may be omitted based on certification of computer-based systems as

per **2.2.3-4(2)**)

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management of logical and physical access, addressing at least the following requirements in this Chapter:
– physical access control (**5.4.3(4)(c)i)**),
– physical access control for visitors (**5.4.3(4)(c)ii)**),
– physical access control of network access points (**5.4.3(4)(c)iii)**),
– management of credentials (**5.4.3(4)(c)v)**), and
– least privilege policy (**5.4.3(4)(c)vi)**).

2) The shipowner is to in the Ship cyber security and resilience program describe the management of confidential information, addressing at least the following requirements in this Chapter:
– confidential information (**5.4.2(1)(c)**),
– information allowed to authorized personnel (**5.4.3(4)(c)**), and
– information transmitted on the wireless network (**5.4.3(5)(c)**).

3) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:
– Personnel are authorized to access the computer-based systems in accordance with their responsibilities.
– Only authorised devices are connected to the computer-based systems.
– Visitors are given access to the computer-based systems according to relevant policies and procedures.
– Physical access controls are maintained and applied.
– Credentials, keys, secrets, certificates, relevant computer-based system documentation, and other sensitive information is managed and kept confidential according to relevant policies and procedures.

4) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

(5) Wireless communication

(a) Requirement

Wireless communication networks in the scope of this Chapter are to be designed, implemented and maintained to ensure the following:

i) cyber incidents will not propagate to other control systems.

ii) only authorised human users will gain access to the wireless network.

iii) only authorised processes and devices will be allowed to communicate on the wireless network.

iv) information in transit on the wireless network cannot be manipulated or disclosed.

(b) Rationale

i) Wireless networks give rise to additional or different cybersecurity risks than wired networks. This is mainly due to less physical protection of the devices and the use of the radio frequency communication.

ii) Inadequate physical access control may lead to unauthorised personnel gaining access to the physical devices, which in turn could lead to circumventing logical access restrictions or deployment of rogue devices on the network.

iii) Signal transmission by radio frequency introduces risks related to jamming as well as eavesdropping which in turn could cater for attacks such as Piggybacking or Evil twin attacks (see https://us-cert.cisa.gov/ncas/tips/ST05-003).

(c) Requirement details

i) Cryptographic mechanisms such as encryption algorithms and key lengths in accordance with industry standards and best practices are to be applied to ensure integrity and confidentiality of the information transmitted on the wireless network.

ii) Devices on the wireless network are to only communicate on the wireless network (i.e. they are not to be “dual-homed”)

iii) Wireless networks are to be designed as separate segments in accordance with **5.4.3(1)** and protected as per **5.4.3(2)**.

iv) Wireless access points and other devices in the network are to be installed and configured such that access to the network can be controlled.

v) The network device or system utilizing wireless communication is to provide the capability to identify and authenticate all users (humans, software processes or devices) engaged in that communication.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the description of wireless networks in the scope of applicability of this Chapter and how these are implemented as separate security zones in the Cyber security design description. The description is to include zone boundary devices and specify the traffic that is permitted to traverse the zone boundary (e.g. firewall rules)

ii) Construction phase

The systems integrator is to prevent unauthorised access to the wireless networks during the construction phase.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

1) Only authorised devices can access the wireless network.

2) Secure wireless communication protocol is used as per approved documentation by the respective supplier (demonstrate e.g. by use of a network protocol analyser tool).

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).

2) Special Survey

Subject to modifications of the wireless networks in the scope of applicability of this Chapter, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(6) Remote access control and communication with untrusted networks

(a) Requirement

Computer-based systems in scope of this Chapter are to be protected against unauthorized access and other cyber threats from untrusted networks.

(b) Rationale

Onboard computer-based systems have become increasingly digitalized and connected to the internet to perform a wide variety of legitimate functions. The use of digital systems to monitor and control onboard computer-based systems makes them vulnerable to cyber incidents. Attackers may attempt to access onboard computer-based systems through connectivity with the internet and may be able to make changes that affect a computer-based system's operation or even achieve full control of the computer-based system or attempt to download information from the ship's computer-based system. In addition, since use of legacy IT and OT systems that are no longer supported and/or rely on obsolete operating systems affects cyber resilience, special care should be put to relevant hardware and software installations on board to help maintain a sufficient level of cyber resilience when such systems can be remotely accessed, also keeping in mind that not all cyber incidents are a result of a deliberate attack.

(c) Requirement details

i) User's manual is to be delivered for control of remote access to onboard IT and OT systems. Clear guidelines are to identify roles and permissions with functions.

ii) For computer-based systems in the scope of applicability of this Chapter, no IP address is to be exposed to untrusted networks.

iii) Communication with or via untrusted networks requires secure connections (e.g. tunnels) with endpoint authentication, protection of integrity and authentication and encryption at network or transport layer. Confidentiality are to be ensured for information that is subject to read authorization.

1) Design

Computer-based systems in the scope of applicability of this Chapter are to :

– have the capability to terminate a connection from the onboard connection endpoint. Any remote access are not to be possible until explicitly accepted by a responsible role on board.

– be capable of managing interruptions during remote sessions so as not to compromise the safe functionality

of OT systems or the integrity and availability of data used by OT systems.
– provide a logging function to record all remote access events and retain for a period of time sufficient for offline review of remote connections, e.g. after detection of a cyber incident.

2) Additional requirements for remote maintenance

When remote access is used for maintenance, the following requirements are to be complied with in addition to those in **1)**:

– Documentation is to be provided to show how they connect and integrate with the shore side.
– Security patches and software updates are to be tested and evaluated before they are installed to ensure they are effective and do not result in side effects or cyber events that cannot be tolerated. A confirmation report from the software supplier towards above are to be obtained, prior to undertaking remote update.
– Suppliers are to provide plans for- and make security updates available to the shipowner (see **4.5.3**, **4.5.4** and **4.5.5**).
– At any time, during remote maintenance activities, authorized personnel is to have the possibility to interrupt and abort the activity and roll back to a previous safe configuration of the computer-based system and systems involved.
– Multi-factor authentication is required for any access by human users to computer-based system's in scope from an untrusted network.
– After a configurable number of failed remote access attempts, the next attempt is to be blocked for a predetermined length of time.
– If the connection to the remote maintenance location is disrupted for some reason, access to the system is to be terminated by an automatic logout function.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the following information in the Cyber security design description:

1) Identification of each computer-based system in the scope of applicability of this Chapter that can be remotely accessed or that otherwise communicates through the security zone boundary with untrusted networks.
2) For each computer-based system, a description of compliance with requirements in **5.4.3(6)c)**, as applicable

ii) Construction phase

The systems integrator is to ensure that any communication with untrusted networks is only temporarily enabled and used in accordance with the requirements of this Chapter.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate the following to the Society:

1) Communication with untrusted networks is secured in accordance with **4.4.3** and that the communication protocols cannot be negotiated to a less secure version (demonstrate e.g., by use of a network protocol analyzer tool).
2) Remote access requires multifactor authentication of the remote user.
3) A limit of unsuccessful login attempts is implemented, and that a notification message is provided for the remote user before session is established.
4) Remote connections must be explicitly accepted by responsible personnel on board.
5) Remote sessions can be manually terminated by personnel on board or that the session will automatically terminate after a period of inactivity.
6) Remote sessions are logged (see No.**13** in **Table X4.1**).
7) Instructions or procedures are provided by the respective product suppliers (see **4.4.1(3)**).

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management of remote access and communication with/via untrusted networks, addressing at least the following requirements in this Chapter:
– user's manual (**5.4.3(6)(c)**),
– roles and permissions (**5.4.3(6)(c)**),
– patches and updates (**5.4.3(6)(c)iii)2)**),
– confirmation prior to undertaking remote software update (**5.4.3(6)(c)iii)2)**), and
– interrupt, abort, roll back (**5.4.3(6)(c)iii)2)**).

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:

– remote access sessions have been recorded or logged and carried out as per relevant policies and user manuals, and

– installation of security patches and other software updates have been carried out in accordance with Management of change procedures and in cooperation with the supplier.

3) Subsequent Annual Survey

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

4) Special Survey

The shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(7) Use of mobile and portable devices

(a) Requirement

The use of mobile and portable devices in computer-based systems in the scope of applicability of this Chapter are to be limited to only necessary activities and be controlled in accordance with No.**10** in **Table X4.1**. For any computer-based system that cannot fully meet these requirements, the interface ports are to be physically blocked.

(b) Rationale

It is generally known that computer-based systems can be impaired due to malware infection via a mobile or a portable device. Therefore, connection of mobile and portable devices should be carefully considered. In addition, mobile equipment that is required to be used for the operation and maintenance of the ship should be under the control of the shipowner.

(c) Requirement details

Mobile and portable devices are to only be used by authorised personnel. Only authorised devices may be connected to the computer-based systems. All use of such devices are to be in accordance with the shipowner's policy for use of mobile and portable devices, taking into account the risk of introducing malware in the computer-based system.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the information related to any computer-based systems in the scope of applicability that do not meet the requirements in No.**10** in **Table X4.1**, i.e., that are to have protection of interface ports by physical means such as port blockers in the Cyber security design description.

ii) Construction phase

The systems integrator is to ensure that use of physical interface ports in the computer-based systems is controlled in accordance with No.**10** in **Table X4.1**, and that any use of such devices follows procedures to prevent malware from being introduced in the computer-based system.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society that capabilities to control use of mobile and portable devices are implemented correctly, the following countermeasures are to be demonstrated as relevant:

1) use of mobile and portable devices is restricted to authorised users,
2) interface ports can only be used by specific device types,
3) files cannot be transferred to the system from such devices,
4) files on such devices will not be automatically executed (by disabling autorun),
5) network access is limited to specific MAC or IP addresses,
6) unused interface ports are disabled, and
7) unused interface ports are physically blocked.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management of mobile and

portable devices, addressing at least the following requirements in this Chapter:
– policy and procedures (5.4.3(4)(c)iv)),
– physical block of interface ports (5.4.3(7)(a)),
– use by authorized personnel (5.4.3(7)(c)),
– connect only authorized devices (5.4.3(7)(c)), and
– consider risk of introducing malware (5.4.3(7)(c)).

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:
– The use of mobile, portable or removable media is restricted to authorised personnel and follows relevant policies and procedures.
– Only authorised devices are connected to the computer-based systems.
– Means to restrict use of physical interface ports are implemented as per approved design documentation.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

4) Special Survey

The shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

5.4.4 Detect

The requirements for the Detect functional element are aimed at the development and implementation of appropriate means supporting the ability to reveal and recognize anomalous activity on computer-based systems and networks onboard and identify cyber incidents.

(1) Network operation monitoring

(a) Requirement

Networks in scope of this Chapter are to be continuously monitored, and alarms are to be generated if malfunctions or reduced/degraded capacity occurs.

(b) Rationale

Cyber-attacks are becoming increasingly sophisticated, and attacks that target vulnerabilities that were unknown at the time of construction could result in incidents where the vessel is ill-prepared for the threat. To enable an early response to attacks targeting these types of unknown vulnerabilities, technology capable of detecting unusual events is required. A monitoring system that can detect anomalies in networks and that can use post-incident analysis provides the ability to appropriately respond and further recover from a cyber event.

(c) Requirement details

i) Measures to monitor networks in the scope of applicability of this Chapter are to have the following capabilities:
1) monitoring and protection against excessive traffic,
2) monitoring of network connections,
3) monitoring and recording of device management activities,
4) protection against connection of unauthorized devices, and
5) generate alarm if utilization of the network's bandwidth exceeds a threshold specified as abnormal by the supplier (see 3.7.2-1).

ii) Intrusion detection systems (IDS) may be implemented, subject to the following:
1) The IDS is to be qualified by the supplier of the respective computer-based system
2) The IDS is to be passive and not activate protection functions that may affect the performance of the computer-based system
3) Relevant personnel should be trained and qualified for using the IDS

(d) Demonstration of compliance

i) Design phase

No requirements.

ii) Construction phase

No requirements.

iii) Commissioning phase

1) The systems integrator is to specify in the Ship cyber resilience test procedure and demonstrate to the Society the network monitoring and protection mechanisms in the computer-based systems. The following tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

– Test that disconnected network connections will activate alarm and that the event is recorded.
– Test that abnormally high network traffic is detected, and that alarm and audit record is generated. This test may be carried on together with the test in **5.4.5(4)(d)iii)**.
– Demonstrate that the computer-based system will respond in a safe manner to network storm scenarios, considering both unicast and broadcast messages (see also **5.4.3(2)(d)iii)**)
– Demonstrate generation of audit records (logging of security-related events)
– If Intrusion detection systems are implemented, demonstrate that this is passive and will not activate protection functions that may affect intended operation of the computer-based systems.

2) Any Intrusion detection systems in the computer-based systems in scope of applicability to be implemented are to be subject to verification by the Society. Relevant documentation are to be submitted for approval, and survey/tests are to be carried out on board.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management activities to detect anomalies in the computer-based systems and networks, addressing at least the following requirements in this Chapter. The following activities may be addressed together with incident response in **5.4.5(1)**.

– reveal and recognize anomalous activity (**5.4.4**),
– inspection of security audit records (**5.4.4(1)(c)**), and
– instructions or procedures to detect incidents (**5.4.5(1)(a)**).

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:

– The computer-based systems are routinely monitored for anomalies by inspection of security audit records and investigation of alerts in the computer-based systems.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

4) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(2) Verification and diagnostic functions of computer-based system and networks

(a) Requirement

Computer-based systems and networks in the scope of applicability of this Chapter are to be capable to check performance and functionality of security functions required by this Chapter. Diagnostic functions are to provide adequate information on computer-based systems integrity and status for the use of the intended user and means for maintaining their functionality for a safe operation of the ship.

(b) Rationale

The ability to verify intended operation of the security functions is important to support management of cyber resilience in the lifetime of the ship. Tools for diagnostic functions may comprise automatic or manual functions such as self-diagnostics capabilities of each device, or tools for network monitoring (such as ping, traceroute, ipconfig, netstat, nslookup, Wireshark, nmap, etc.). It should be noted however that execution of diagnostic functions may sometimes impact the operational performance of the computer-based system.

(c) Requirement details

Computer-based systems and networks' diagnostics functionality are to be available to verify the intended operation of all required security functions during test and maintenance phases of the ship.

(d) Demonstration of compliance

i) Design phase

No requirements.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society the effectiveness of the procedures for verification of security functions provided by the suppliers. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe the management activities to verify correct operation of the security functions in the computer-based systems and networks, addressing at least the following requirements in this Chapter:
– test and maintenance periods (**5.4.4(2)(c)**) and
– periodic maintenance (**2.2.3-5(9)**).

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:
– The security functions in the computer-based systems are periodically tested or verified.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

5.4.5 Respond

The requirements for the Respond functional element are aimed at the development and implementation of appropriate means supporting the ability to minimize the impact of cyber incidents, containing the extension of possible impairment of computer-based systems and networks onboard.

(1) Incident response plan

(a) Requirement

An incident response plan is to be developed by the shipowner covering relevant contingencies and specifying how to react to cyber security incidents. The Incident response plan is to contain documentation of a predetermined set of instructions or procedures to detect, respond to, and limit consequences of incidents against computer-based systems in the scope of applicability of this Chapter.

(b) Rationale

An incident response plan is an instrument aimed to help responsible persons respond to cyber incidents. As such, the Incident response plan is as effective as it is simple and carefully designed. When developing the Incident response plan, it is important to understand the significance of any cyber incident and prioritize response actions accordingly. Means for maintaining as much as possible the functionality and a level of service for a safe operation of the ship, e.g. transfer active execution to a standby redundant unit, should also be indicated. Designated personnel ashore should be integrated with the ship in the event of a cyber incident.

(c) Requirement details

i) The various stakeholders involved in the design and construction phases of the ship are to provide information to the shipowner for the preparation of the Incident Response Plan to be placed onboard at the first Annual Survey.

ii) The Incident Response Plan is to be kept up-to-date (e.g. upon maintenance) during the operational life of the ship. The Incident response plan is to be provide procedures to respond to detected cyber incidents on networks by notifying the proper authority, reporting needed evidence of the incidents and taking timely corrective actions, to limit the cyber incident impact to the network segment of origin.

iii) The incident response plan is to, as a minimum, include the following information. The Incident response plan is to be kept in hard copy in the event of complete loss of electronic devices enabling access to it.

1) Breakpoints for the isolation of compromised systems

2) A description of alarms and indicators signalling detected ongoing cyber events or abnormal symptoms caused

by cyber events

3) A description of expected major consequences related to cyber incidents

4) Response options, prioritizing those which do not rely on either shut down or transfer to independent or local control, if any

5) Independent and local control information for operating independently from the system that failed due to the cyber incident, as applicable

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the references to information provided by the suppliers (see **4.4.1(8)**) that may be applied by the shipowner to establish plans for incident response in the Cyber security design description.

ii) Construction phase

No requirements.

iii) Commissioning phase

No requirements.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe incident response plans. The plans are to cover the computer-based systems in scope of applicability of this Chapter and are to address at least the following requirements in this Chapter:

– Description of who, when and how to respond to cyber incidents in accordance with requirements of **5.4.5(1)**

– Procedures or instructions for local/manual control in accordance with requirements in **5.4.5(2)**

– Procedures or instructions for isolation of security zones in accordance with requirements in **5.4.5(3)**

– Description of expected behaviour of the computer-based systems in the event of cyber incidents in accordance with requirements in **5.4.5(4)**

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:

– The incident response plans are available for the responsible personnel onboard.

– Procedures or instructions for local/manual controls are available for responsible personnel onboard.

– Procedures or instructions for disconnection/isolation of security zones are available for responsible personnel onboard.

– Any cyber incidents have been responded to in accordance with the incident response plans.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

(2) Local, independent and/or manual operation

(a) Requirement

Any computer-based system needed for local backup control as required by Regulation 31, Chapter II-1, *SOLAS* are to be independent of the primary control system. This includes also necessary Human Machine Interface (HMI) for effective local operation.

(b) Rationale

Independent local controls of machinery and equipment needed to maintain safe operation is a fundamental principle for manned vessels. The objective of this requirement has traditionally been to ensure that personnel can cope with failures and other incidents by performing manual operations in close vicinity of the machinery. Since incidents caused by malicious cyber events should also be considered, this principle of independent local control is no less important.

(c) Requirement details

i) The computer-based system for local control and monitoring are to be self-contained and not depend on communication with other computer-based system for its intended operation.

ii) If communication to the remote control system or other computer-based system's is arranged by networks,

segmentation and protection safeguards as described in 5.4.3(1) and 5.4.3(2) are to be implemented. This implies that the local control and monitoring system are to be considered a separate security zone. Notwithstanding the above, special considerations can be given to computer-based systems with different concepts on case by case basis.

iii) The computer-based system for local control and monitoring are to otherwise comply with requirements in this Chapter.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the description of how the local controls specified in Regulation 31, Chapter II-1, *SOLAS* are protected from cyber incidents in any connected remote or automatic control systems in the Cyber security design description.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see 2.2.3-4(2)) and demonstrate to the Society that the required local controls in the scope of applicability of this Chapter needed for safety of the ship can be operated independently of any remote or automatic control systems. The tests are to be carried out by disconnecting all networks from the local control system to other systems/devices. The above tests may be omitted if performed during the certification of computer-based systems as per 2.2.3-4(2).

iv) Operation phase

1) For general requirements to surveys in the operation phase, (see 2.2.3-5).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(3) Network isolation

(a) Requirement

It is to be possible to terminate network-based communication to or from a security zone.

(b) Rationale

In the event that a security breach has occurred and is detected, it is likely that the incident response plan includes actions to prevent further propagation and effects of the incident. Such actions could be to isolate network segments and control systems supporting essential functions.

(c) Requirement details

i) Where the Incident Response Plan indicates network isolation as an action to be done, it is to be possible to isolate security zones according to the indicated procedure, e.g. by operating a physical ON/OFF switch on the network device or similar actions such as disconnecting a cable to the router/firewall. There are to be available instructions and clear marking on the device that allows the personnel to isolate the network in an efficient manner.

ii) Individual system's data dependencies that may affect function and correct operation, including safety, are to be identified, clearly showing where systems must have compensations for data or functional inputs if isolated during a contingency.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the information related to Specification of how to isolate each security zone from other zones or networks in the Cyber security design description. The effects of such isolation is also to be described, demonstrating that the computer-based systems in a security zone do not rely on data transmitted by IP-networks from other zones or networks.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see2.2.3-4(2)) and demonstrate to the Society

by disconnecting all networks traversing security zone boundaries, that the computer-based systems in the security zone will maintain adequate operational functionality without network communication with other security zones or networks. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(4) Fallback to a minimal risk condition

(a) Requirement

In the event of a cyber incident impairing the ability of a computer-based system or network in the scope of applicability of this Chapter to provide its intended service, the affected system or network is to fall back to a minimal risk condition, i.e. bring itself in a stable, stopped condition to reduce the risk of possible safety issues.

(b) Rationale

i) The ability of a computer-based system and integrated systems to fallback to one or more minimal risk conditions to be reached in case of unexpected or unmanageable failures or events is a safety measure aimed to keep the system in a consistent, known and safe state.

ii) Fallback to a minimal risk condition usually implies the capability of a system to abort the current operation and signal the need for assistance, and may be different depending on the environmental conditions, the voyage phase of the ship (e.g. port depart/arrival vs. open sea passage) and the events occurred.

(c) Requirement details

i) As soon as a cyber incident affecting the computer-based system or network is detected, compromising the system's ability to provide the intended service as required, the system is to fall back to a condition in which a reasonably safe state can be achieved. Fall-back actions may include the following:

1) bringing the system to a complete stop or other safe state,

2) disengaging the system,

3) transferring control to another system or human operator, and

4) other compensating actions.

ii) Fall-back to minimum risk conditions are to occur in a time frame adequate to keep the ship in a safe condition.

iii) The ability of a system to fall back to a minimal risk condition is to be considered from the design phase by the supplier and the systems integrator.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the information related to specification of safe state for the control functions in the computer-based systems in the scope of applicability of this Chapter in the Cyber security design description.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society that computer-based systems in the scope of applicability of this Chapter respond to cyber incidents in a safe manner (as per **5.4.5(4)(d)i)**), e.g. by maintaining its outputs to essential services and allowing operators to carry out control and monitoring functions by alternative means. The tests are to at least include denial of service (DoS) attacks and may be done together with related test in **5.4.4(1)(d)iii)**. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

5.4.6 Recover

The requirements for the Recover functional element are aimed at the development and implementation of appropriate means supporting the ability to restore computer-based systems and networks onboard affected by cyber incidents.

(1) Recovery plan

(a) Requirement

A recovery plan is to be made by the shipowner to support restoring computer-based systems under the scope of applicability of this Chapter to an operational state after a disruption or failure caused by a cyber incident. Details of where assistance is available and by whom are to be part of the recovery plan.

(b) Rationale

i) Incident response procedures are an essential part of system recovery. Responsible personnel should consider carefully and be aware of the implications of recovery actions (such as wiping of drives) and execute them carefully. It should be noted, however, that some recovery actions may result in the destruction of evidence that could provide valuable information on the causes of an incident.

ii) Where appropriate, external cyber incident response support should be obtained to assist in preservation of evidence whilst restoring operational capability.

(c) Requirement details

i) The various stakeholders involved in the design and construction phases of the ship are to provide information to the shipowner for the preparation of the recovery plan to be placed onboard at the first Annual Survey. The recovery plan is to be kept up-to-date (e.g. upon maintenance) during the operational life of the ship.

ii) Recovery plans are to be easily understandable by the crew and external personnel and include essential instructions and procedures to ensure the recovery of a failed system and how to get external assistance if the support from ashore is necessary. In addition, software recovery medium or tools essential for recovery on board are to be available.

iii) When developing recovery plans, the various systems and subsystems involved are to be specified. The following recovery objectives are also to be specified:

l) System recovery: methods and procedures to recover communication capabilities are to be specified in terms of Recovery Time Objective (RTO). This is defined as the time required to recover the required communication links and processing capabilities.

2) Data recovery: methods and procedures to recover data necessary to restore safe state of OT systems and safe ship operation are to be specified in terms of Recovery Point Objective (RPO). This is defined as the longest period of time for which an absence of data can be tolerated.

iv) Once the recovery objectives are defined, a list of potential cyber incidents is to be created, and the recovery procedure developed and described. Recovery plans are to include, or refer to the following information;

l) Instructions and procedures for restoring the failed system without disrupting the operation from the redundant, independent or local operation.

2) Processes and procedures for the backup and secure storage of information.

3) Complete and up-to-date logical network diagram.

4) The list of personnel responsible for restoring the failed system.

5) Communication procedure and list of personnel to contact for external technical support including system support vendors, network administrators, etc.

6) Current configuration information for all components.

v) The operation and navigation of the ship are to be prioritized in the plan in order to help ensure the safety of onboard personnel.

vi) Recovery plans in hard copy onboard and ashore are to be available to personnel responsible for cyber security and who are tasked with assisting in cyber incidents.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the references to information provided by the suppliers (**4.4.1(8)**) that may be applied by the shipowner to establish plans to recover from cyber incidents in the Cyber security design description.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society the effectiveness of the procedures and instructions provided by the suppliers to respond to cyber incidents as specified in **5.4.6(2)** and **(3)** The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

For general requirements to surveys in the operation phase (see **2.2.3-5**).

1) The shipowner is to in the Ship cyber security and resilience program describe incident recovery plans. The plans are to cover the computer-based systems in scope of applicability of this Chapter and are to address at least the following requirements in this Chapter:

– Description of who, when and how to restore and recover from cyber incidents in accordance with requirements in **5.4.6(1)**

– Policy for backup addressing frequency, maintenance and testing of the backups, considering acceptable downtime, availability of alternative means for control, vendor support arrangements and criticality of the computer-based systems in accordance with requirements in **5.4.6(2)**.

– Reference to user manuals or procedures for backup, shutdown, reset, restore and restart of the computer-based systems in accordance with requirements in **5.4.6(2)** and **5.4.6(3)**.

2) First Annual Survey

The shipowner is to present to the Society records or other documented evidence demonstrating implementation of the Ship cyber security and resilience program, i.e., that:

– Instructions and/or procedures for incident recovery are available for the responsible personnel onboard.

– Equipment, tools, documentation, and/or necessary software and data needed for recovery is available for the responsible personnel onboard.

– Backup of the computer-based systems have been taken in accordance with the policies and procedures.

– Manuals and procedures for shutdown, reset, restore and restart are available for the responsible personnel onboard.

3) Subsequent Annual Surveys

The shipowner is to upon request by the Society demonstrate implementation of the Ship cyber security and resilience program by presenting records or other documented evidence as specified for the first Annual Survey.

(2) Backup and restore capability

(a) Requirement

Computer-based systems and networks in the scope of applicability of this Chapter are to have the capability to support back-up and restore in a timely, complete and safe manner. Backups are to be regularly maintained and tested.

(b) Rationale

In general, the purpose of a backup and restore strategy should protect against data loss and reconstruct the database after data loss. Typically, backup administration tasks include the following:

i) planning and testing responses to different kinds of failures,

ii) configuring the database environment for backup and recovery,

iii) setting up a backup schedule,

iv) monitoring the backup and recovery environment,

v) creating a database copy for long-term storage,

vi) moving data from one database or one host to another, etc.

(c) Requirement details

i) Restore capability

1) Computer-based systems in the scope of applicability of this Chapter are to have backup and restore capabilities to enable the ship to safely regain navigational and operational state after a cyber incident.

2) Data are to be restorable from a secure copy or image.

3) Information and backup facilities are to be sufficient to recover from a cyber incident.

ii) Backup

1) Computer-based systems and networks in the scope of applicability of this Chapter are to provide backup for data. The use of offline backups is to also be considered to improve tolerance against ransomware and worms affecting online backup appliances.

2) Backup plans are to be developed, including scope, mode and frequency, storage medium and retention period.

(d) Demonstration of compliance

i) Design phase

No requirements.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society the procedures and instructions for backup and restore provided by the suppliers for computer-based systems in the scope of applicability of this Chapter. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

(3) Controlled shutdown, reset, roll-back and restart

(a) Requirement

i) Computer-based system and networks in the scope of applicability of this Chapter are to be capable of controlled shutdown, reset to an initial state, roll-back to a safe state and restart from a power-off condition in such state, in order to allow fast and safe recovery from a possible impairment due to a cyber incident.

ii) Suitable documentation on how to execute the above-mentioned operations are to be available to onboard personnel.

(b) Rationale

i) Controlled shutdown consists in turning a computer-based system or network off by software function allowing other connected systems to commit/rollback pending transactions, terminating processes, closing connections, etc. leaving the entire integrated system in a safe and known state. Controlled shutdown is opposed to hard shutdown, which occurs for example when the computer is forcibly shut down by interruption of power.

ii) While in the case of some cyber incidents hard shutdowns may be considered as a safety precaution, controlled shutdown is preferable in case of integrated systems to keep them in a consistent and known state with predictable behaviour. When standard shutdown procedures are not done, data or program and operating system files corruption may occur. In case of OT systems, the result of corruption can be instability, incorrect functioning or failure to provide the intended service.

iii) The reset operation would typically kick off a soft boot, instructing the system to go through the process of shutting down, clear memory and reset devices to their initialized state. Depending on system considered, the reset operation might have different effects.

iv) Rollback is an operation which returns the system to some previous state. Rollbacks are important for data and system integrity, because they mean that the system data and programs can be restored to a clean copy even after erroneous operations are performed. They are crucial for recovering from crashes ad cyber incidents, restoring the system to a consistent state.

v) Restarting a system and reloading a fresh image of all the software and data (e.g. after a rollback operation) from a read-only source appears to be an effective approach to recover from unexpected faults or cyber incidents. Restart operations should be however controlled in particular for integrated systems, where unexpected restart of a single component can result in inconsistent system state or unpredictable behaviour.

(c) Requirement details

i) Computer-based system and networks in the scope of applicability of this Chapter are to be capable of the following:

1) controlled shutdown allowing other connected systems to commit/rollback pending transactions, terminating processes, closing connections, etc. leaving the entire integrated system in a safe, consistent and known state.

2) resetting themselves, instructing the system to go through the process of shutting down, clear memory and reset devices to their initialized state.

3) rolling back to a previous configuration and/or state, to restore system integrity and consistency.

4) restarting and reloading a fresh image of all the software and data (e.g. after a rollback operation) from a read-only source. Restart time is to be compatible with the system's intended service and is not to bring other connected systems, or the integrated system it is part of, to an inconsistent or unsafe state.

ii) Documentation are to be available to onboard personnel on how to execute the above- mentioned operations in case of a system affected by a cyber incident.

(d) Demonstration of compliance

i) Design phase

The systems integrator is to include the references to product manuals or procedures describing how to safely shut down, reset, restore and restart the computer-based systems in the scope of applicability of this Chapter in the Cyber security design description.

ii) Construction phase

No requirements.

iii) Commissioning phase

The systems integrator is to submit Ship cyber resilience test procedure (see **2.2.3-4(2)**) and demonstrate to the Society that manuals or procedures are established for shutdown, reset and restore of the computer-based systems in the scope of applicability of this Chapter. These manuals/procedures are to be provided to the shipowner. The above tests may be omitted if performed during the certification of computer-based systems as per **2.2.3-4(2)**.

iv) Operation phase

1) For general requirements to surveys in the operation phase (see **2.2.3-5**).

2) Special Survey

Subject to modifications of the computer-based systems, the shipowner is to demonstrate to the Society the activities in **iii)** as per the Ship cyber resilience test procedure.

5.5 Risk Assessment for Exclusion of Computer-based System from the Application of Requirements

5.5.1 Requirement

A risk assessment is to be carried out in case any of the computer-based systems falling under the scope of applicability of this Chapter is excluded from the application of relevant requirements. The risk assessment is to provide evidence of the acceptable risk level associated to the excluded computer-based systems.

5.5.2 Rationale

1 Exclusion of a computer-based system falling under the scope of applicability of this Chapter from the application of relevant requirements needs to be duly justified and documented. Such exclusion can be accepted by the Society only if evidence is given that the risk level associated to the operation of the computer-based system is under an acceptable threshold by means of specific risk assessment.

2 The risk assessment is to be based on available knowledge bases and experience on similar designs, if any, considering the computer-based system category, connectivity and the functional requirements and specifications of the ship and of the computer-based system. Cyber threat information from internal and external sources may be used to gain a better understanding of the likelihood and impact of cybersecurity events.

5.5.3 Requirement Details

1 Risk assessment is to be made and kept up to date by the System integrator during the design and building phase considering possible variations of the original design and newly discovered threats and/or vulnerabilities not known from the beginning.

2 During the operational life of the ship, the shipowner is to update the risk assessment considering the constant changes in the cyber scenario and new weaknesses identified in computer-based system onboard in a process of continuous improvement.

3 Should new risks be identified, the shipowner is to update existing, or implement new risk mitigation measures. Should the changes in the cyber scenario be such as to elevate the risk level associated to the computer-based system under examination above the acceptable risk threshold, the shipowner is to inform the Society and submit the updated risk assessment for evaluation.

4 The envisaged operational environments for the computer-based system under examination are to be analyzed in the risk assessment to discern the likelihood of cyber incidents and the impact they could have on the human safety, the safety of the vessel or the marine environment, taking into account the category of the computer-based system. The attack surface is to be analyzed, taking into account the connectivity of the computer-based system, possible interfaces for portable devices, logical access restrictions, etc.

5 Emerging risks related to the specific configuration of the computer-based system under examination is to be also identified. In the risk assessment, the following elements are to be considered:

(1) asset vulnerabilities,

(2) threats, both internal and external,

(3) potential impacts of cyber incidents affecting the asset on human safety, safety of the vessel and/or threat to the environment, and

(4) possible effects related to integration of systems, or interfaces among systems, including systems not onboard (e.g. if remote access to onboard systems is provided).

5.5.4 Acceptance Criteria

1 Exclusion of a computer-based system falling under the scope of applicability of this Chapter from the application of relevant requirements can be accepted by the Society only if assurance is given that the operation of the computer-based system has no impact on the safety of operations regarding cyber risk. The said exclusion may be accepted for a computer-based system which does not fully meet the additional criteria listed below but is provided with a rational explanation together with evidence and is found satisfactory by the Society. The Society may also require submittal of additional documents to consider the said exclusion.

2 The following criteria are to be met to exclude a system from the scope of applicability of this Chapter:

(1) The computer-based system is to be isolated (i.e, have no IP-network connections to other systems or networks).

(2) The computer-based system is to have no accessible physical interface ports. Unused interfaces are to be logically disabled. It is not to be possible to connect unauthorised devices to the computer-based system.

(3) The computer-based system is to be located in areas to which physical access is controlled.

(4) The computer-based system is not to be an integrated control system serving multiple ship functions as specified in the scope of applicability of this Chapter.

3 The following additional criteria are to be considered for the evaluation of risk level acceptability:

(1) The computer-based system should not serve ship functions of category III.

(2) Known vulnerabilities, threats, potential impacts deriving from a cyber incident affecting the computer-based system have been duly considered in the risk assessment.

(3) The attack surface for the computer-based system is minimized, having considered its complexity, connectivity, physical and logical access points, including wireless access points.

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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 of the Guidance**.

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.

X4 Cyber resilience of on-board systems and equipment

X4.1 General

X4.1.1 General

1 Technological evolution of vessels, ports, container terminals, etc. and increased reliance upon Operational Technology (OT) and Information Technology (IT) has created an increased possibility of cyber-attacks to affect business, personnel data, human safety, the safety of the ship, and also possibly threaten the marine environment. Safeguarding shipping from current and emerging threats must involve a range of controls that are continually evolving which would require incorporating security features in the equipment and systems at design and manufacturing stage. It is therefore necessary to establish a common set of minimum requirements to deliver systems and equipment that can be described as cyber resilient.

2 Attention is made to the requirements on Computer-Based Systems and Cyber Resilience as follows:

(1) Requirements on computer-based systems specified in **Chapter 3, Part X of the Rules**

(2) Requirements on cyber resilience of ships specified in **Chapter 5, Part X of the Rules**

(3) *IACS* Recommendation 166 on Cyber Resilience: non-mandatory recommended technical requirements that stakeholders may reference and apply to assist with the delivery of cyber resilient ships, whose resilience can be maintained throughout their service life.

X4.4 Requirements for Cyber resilience of on-board systems and equipment

X4.4.2 Required Security Capabilities

1 In applying No.**10** in **Table X4.1, Part X of the Rules**, port limits/blockers (and silicone) could be accepted for a specific system.

2 In applying No.**17** in **Table X4.1, Part X of the Rules**, cryptographic mechanisms are to be employed for wireless networks.

3 In applying No.**21** in **Table X4.1, Part X of the Rules**, for wireless network, cryptographic mechanisms are to be employed to protect confidentiality of all information in transit.

4 In applying No.**24** in **Table X4.1, Part X of the Rules**, it is acceptable that the computer-based system may operate in a degraded mode upon DoS events, but it is not to fail in a manner which may cause hazardous situations. Overload-based DoS events should be considered, i.e. where the networks capacity is attempted flooded, and where the resources of a computer is attempted consumed.

X5 CYBER RESILIENCE OF SHIPS

X5.1 General

X5.1.1 Aim

1 Interconnection of computer systems on ships, together with the widespread use onboard of commercial-off-the-shelf (COTS) products, open the possibility for attacks to affect personnel data, human safety, the safety of the ship, and threaten the marine environment. Attackers may target any combination of people and technology to achieve their aim, wherever there is a network connection or any other interface between onboard systems and the external world. Safeguarding ships, and shipping in general, from current and emerging threats involves a range of measures that are continually evolving. It is then necessary to establish a common set of minimum functional and performance criteria to deliver a ship that can indeed be described as cyber resilient. IACS considers that minimum requirements applied consistently to the full threat surface using a goal-based approach is necessary to make cyber resilient ships.

2 The content of **Chapter 5, Part X of the Rules** is to be in accordance with **Table X5.1.1-1**.

Table X5.1.1-1 The content of Chapter 5, Part X of the Rules

Introductory Part	5.1 Introduction
	5.2 Definitions
	5.3 Goals and Organization of Requirements
Main Part	5.4 Requirements 5.4.1 General 5.4.2 Identify 5.4.3 Protect 5.4.4 Detect 5.4.5 Respond 5.4.6 Recover
Supplementary Part	5.5 Risk assessment for exclusion of computer-based system from the application of requirements

X5.2 Definitions

X5.2.1 Terminology

In “Network segment” referred to in **5.2.1(13), Part X of the Rules**, network address plan is prefixed by their IP addresses and the network mask. Communication between network segments is only possible by the use of routing service at network layer (OSI Layer 3).

X5.4 Requirements for Cyber Resilience of Ships

X5.4.3 Protect

In **5.4.3(4)(c)v), Part X of the Rules**, computer-based systems are required to identify and authenticate human users as per Item No.**1** in **Table X4.1, Part X of the Rules**. In other words, it is not necessary to “uniquely” identify and authenticate each human user.