Industry Standard on
Software Maintenance of Shipboard Equipment

Version 1.0

Produced by the CIRM/BIMCO Joint Working Group

Foreword

This Industry Standard was developed by a Joint Working Group ("the JWG") comprising members of Comité International Radio-Maritime (CIRM), the international association of marine electronics companies, and BIMCO, the world's largest shipping association.

Participants in the work of the JWG included representatives of shipowners, bridge equipment manufacturers, service providers, and system integrators. A list of companies represented within the JWG can be obtained on request to the Secretariats of CIRM or BIMCO.

The Industry Standard was developed between 2014 and 2017. The work encompassed a pilot project wherein a draft version of the standard was implemented on board ships on a trial basis, the results of which were used to amend the contents of the standard. The following companies participated in the pilot project: BP Shipping, Emarat Maritime, Furuno, Kongsberg Maritime, Maersk Line, MAN Diesel & Turbo, Radio Holland, and Sperry Marine.

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Terms of Use

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Contents

1. Purpose

As shipboard equipment becomes increasingly dependent on software, effective maintenance of this software is essential to ensure safe and efficient operation of the ship.

Effective maintenance of software depends on the identification, planning and execution of measures necessary to support maintenance activities throughout the full software lifecycle.

This standard therefore harmonizes requirements for the stakeholders involved in the software maintenance process.

2. Scope

This standard specifies requirements for stakeholders involved in software maintenance of shipboard equipment and associated integrated systems, including but not limited to:

- Power generation systems;
- Propulsion systems;
- Control and alarm systems;
- Navigation and communication systems;

- Steering control systems;
- Ship management systems;
- Performance systems;
- Fire and water mist systems;
- Auxiliary systems.

3. Applicability

Whilst software maintenance is performed on in-service equipment after delivery, the requirements of this standard apply to stakeholders across the full software lifecycle (as identified in section 5).

Note: by way of example, during the development phase software may be designed to facilitate effective maintenance and to include measures supporting cybersecurity.

Typically, an instance of software maintenance takes one or more of the following forms:

- **Onboard maintenance**, whereby the software maintenance is performed on board the ship by the Service Role;
- **Onshore maintenance**, whereby the shipboard equipment is sent for software maintenance to the premises of the Service Role;
- **Remote maintenance**, whereby the software maintenance is performed by accessing the shipboard equipment from a location external to the ship, via communication link(s).

The requirements of this standard apply to all such forms of software maintenance.

4. Definitions and abbreviations

4.1 Definitions

Category of update	Classification assigned to a software update based upon the reason for undertaking the update, which may be any one of the below or some combination of the five: • Bug Fix (resolving software bugs); • Feature Release (adding additional functionality); • Compliance Update (maintaining conformity with regulations); • Security Update (protecting against cyber threats); • Obsolescence Update (addressing software and/or hardware that is no longer supported).
Controlled network	Shipboard network that has been designed to operate such that it does not pose any unacceptable safety and security risks to any connected network nodes.
Critical update	Software update identified as critical to restoring proper performance of the shipboard equipment.
Data	The quantities, characters, or symbols on which operations are performed by computers of shipboard equipment.
Data Provider Role	The stakeholder that supplies data necessary for the functioning of the shipboard equipment.

Integrated system	Interconnected system combining a number of different shipboard equipment.
Method of update	Method by which a software update is undertaken, which may be: by remote access, on board, and/or automatically.
Plan of Approach	Detailed description of the work to be undertaken in support of software maintenance.
Producer Role	The stakeholder that manufactures the shipboard equipment.
Removable media/storage devices	Portable equipment used during software maintenance.
Root trainer	The original trainer in the train-the-trainer model of education.
Service Role	The stakeholder that performs the software maintenance.
Shipboard equipment	System comprising a combination of hardware, software and data, performing a specific function on board a ship.
Shipowner Role	The owner of the ship or any other organization or person such as the Manager, or the Bareboat Charterer who has assumed responsibility for operation of the ship and who is responsible for initiating software maintenance of the shipboard equipment.
Software	Programs and operating instructions used in shipboard equipment, including firmware.
Software maintenance	Checking, updating, re-configuring, or upgrading the software of shipboard equipment in order to prevent or correct faults, maintain regulatory compliance, and/or improve performance.
System Integrator Role	The stakeholder that combines shipboard equipment into an integrated system.
Train-the-trainer	Education model whereby individuals are trained by a Root Trainer to teach, mentor or train others.
Uncontrolled equipment	Device that is not part of a controlled network.
Uncontrolled network	Shipboard network that does not meet the definition of a controlled network.

4.2 Abbreviations

IEC	International Electrotechnical Commission
IMO	International Maritime Organization
QA	Quality Assurance

5. Identification of Roles

This standard introduces the concept of "Roles".

Various stakeholders are involved in the software maintenance of shipboard equipment, and all have responsibilities which must be met in order for the software maintenance to be successful. The list of stakeholders includes, but is not limited to:

- manufacturers;
- software houses;
- IT subcontractors;
- data suppliers;
- service providers;
- servicing companies;
- technicians;
- shipowners;
- masters and crews.

For practical purposes this standard groups these stakeholders into five Roles, including the Producer Role, the System Integrator Role, the Data Provider Role, the Service Role, and the Shipowner Role. These Roles and their associated requirements are listed in section 7 of this standard.

It is possible for an individual stakeholder to perform more than one Role in the software maintenance process. Where a body performs multiple Roles, the requirements of those Roles apply *mutatis mutandis*.

Note: by way of example, if a company technician comes on board to perform software maintenance on an in-service ECDIS that was also manufactured by that company, then the company is acting as both the Producer Role and the Service Role, and should meet the requirements of both Roles as appropriate.

6. Software maintenance process flow

This standard presents the shipboard software maintenance process as a flow comprising four distinct sub-processes, as outlined in Figure 1.

Recognition of this process flow is important because the various Roles involved in software maintenance of shipboard equipment have particular requirements that apply under the different sub-processes.
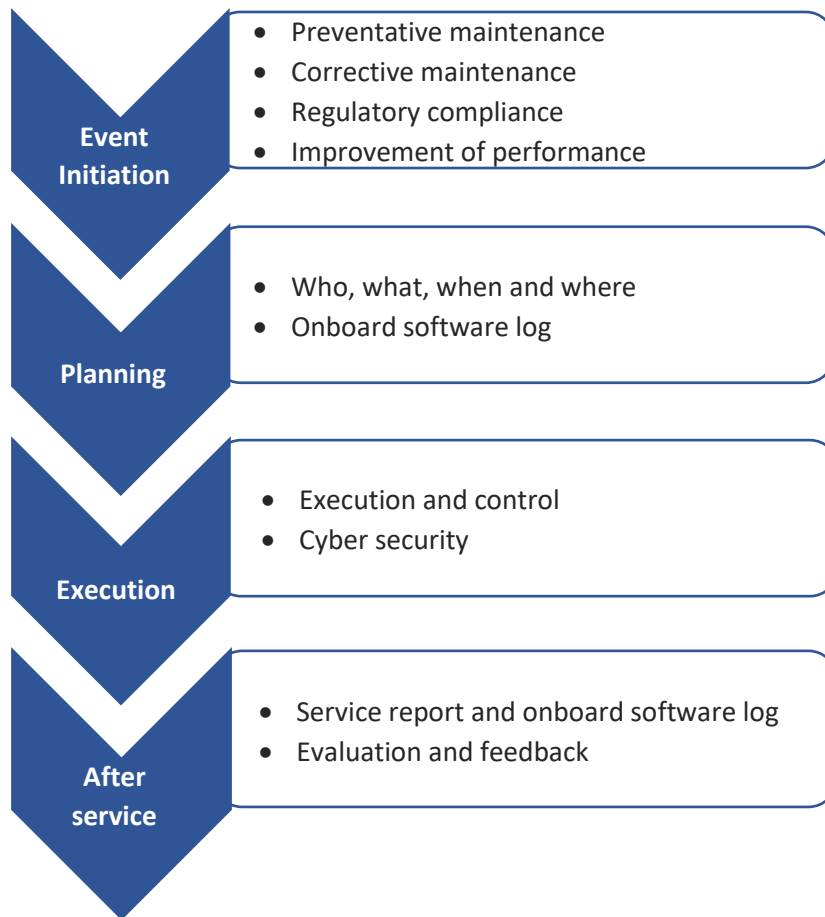
Figure 1: Overview of the software maintenance process flow

Below follows a high-level description of each of the four sub-processes within the flow, which are described in further detail in Section 7 below.

Event initiation
The first process in the flow is the initiation of the shipboard software maintenance "Event".

Planning
The Event must, if time allows, be properly planned before it is executed in order to optimise software maintenance arrangements and to ensure the best possible outcome. The Planning process involves close communication between all relevant Roles.

Execution
The Execution process is when the software maintenance is actually carried out on shipboard equipment, and it is essential that this process is conducted in accordance with the Planning process. During the Execution process it is imperative to protect shipboard equipment against cyber security threats.

After-service
Following completion of the Execution process it is important that communication between the relevant Roles continues in order to monitor the success of the Event, and to provide information which can be used to increase the effectiveness of future Planning processes and ultimately the success of future Events.

7. Requirements for the Software Maintenance of Shipboard Equipment

The Roles involved in software maintenance of shipboard equipment have requirements that apply at various stages of the software maintenance flow identified in section 6 of this standard. In addition, each Role has general requirements that apply more broadly across the full software maintenance flow.

7.1 Producer Role

7.1.1 General requirements

7.1.1.1 The Producer Role should have a QA system for software lifecycle activities, which documents relevant procedures, responsibilities and configuration management, including deliveries from sub-suppliers, taking into account cyber-security considerations.

7.1.1.2 Maintenance requirements for shipboard equipment should be specified in maintenance manuals. Timely access to maintenance manuals and any other relevant technical documentation should be provided to the Service Role.

7.1.1.3 Training in the updating procedures and functions of equipment should be provided to the body performing the Service Role.

7.1.1.4 Timely access should be provided to the Service and Shipowner Roles to information pertaining to availability of new shipboard equipment software updates, together with the Category of update.

7.1.1.5 Shipboard equipment should provide the means to display, on demand, the current software version.

7.1.2 Event initiation

7.1.2.1 In the event that the Producer Role has identified the need for an update, this information should be relayed to the System Integrator, Service and Shipowner Roles as necessary. Means for updating should be made available.

Note: The Producer Role may not know where the equipment is installed, and therefore unable to relay the information to the System Integrator, Service and/or Shipowner Roles. In such cases the Producer Role must relay the information to the known purchaser of the equipment.

7.1.2.2 If an update is designated as a critical update by the Producer Role, this information should be accompanied by a recommendation that the update should be performed as soon as possible. Means should be provided for undertaking the update in a way that ensures minimal downtime of the shipboard equipment.

7.1.3 Planning

7.1.3.1 When a software update for shipboard equipment is released, information pertaining to the update should be made available, including the Category of update and the Method of update supported for undertaking it.

Note: "Made available" in this context could be, for example, by website or email/bulletin.

7.1.3.2 Each software update should be assessed to determine and describe new functionalities, changes and improvements. A summary of new functionalities, changes and improvements should be provided to the Service and Shipowner Roles as necessary.

7.1.3.3 If a software update is to be executed by the crew, it should be accompanied by detailed step-by-step instructions. Provision of remote assistance should be considered.

7.1.4 Execution

7.1.4.1 Shipboard equipment should allow access for maintenance purposes and should provide protection against unauthorized access.

Note: IEC 60945 imposes limitations on access to shipboard equipment by the end user.

7.1.4.2 Shipboard equipment should support procedures to roll back to a previous software version and configuration during software maintenance, after a software update has been attempted.

Note: Roll back procedures could be based on a previous software version stored in the shipboard equipment or on previous software versions that can be uploaded by the Service Role.

7.1.4.3 Where applicable, shipboard equipment should include a mechanism to generate an on-the-spot diagnostic report after maintenance has been performed, which also identifies the software version running on the equipment. The equipment should also provide a means to check that interfaces and functionality are operating as expected after an update has been completed. This mechanism should be described in the Producer Role's maintenance manual, including the method of execution.

Note: The phrase "where applicable" is included as there are types of shipboard equipment which cannot feasibly support this requirement.

7.1.5 After-service

7.1.5.1 Any information received from the Shipowner Role regarding the result of the maintenance should, if appropriate, be addressed and used for improving maintenance procedures.

7.2 System Integrator Role

7.2.1 General requirements

7.2.1.1 The System Integrator should have a QA system for software lifecycle activities, which documents relevant procedures, responsibilities and configuration management, including deliveries from sub-suppliers, taking into account cyber-security considerations. In particular the QA system should specify how to ensure continuity of compatibility of individual shipboard equipment within the integrated system in case any individual equipment is required to undergo a software update based on information provided by the Producer Role.

7.2.1.2 Maintenance requirements for an integrated system should be specified in the integrated system's maintenance manual and provided to the ship.

7.2.1.3 Training in the updating procedures and functions of integrated systems should be provided to the Service Role. Focus should be given to checking the compatibility of individual shipboard equipment within the integrated system.

7.2.1.4 Timely access should be provided to the Service and Shipowner Roles to information pertaining to availability of new integrated system software updates, including those resulting from changes to regulations and Class requirements, together with the Category of update.

7.2.1.5   Individual equipment within the integrated system should provide the means to display, on demand, the current software and versions.

7.2.2   Event initiation

7.2.2.1   In the event that the System Integrator Role has identified the need for an update, this information should be relayed to the Service and Shipowner Roles as necessary. Means for updating should be made available.

Note: The System Integrator Role may not know where the equipment is installed, and therefore unable to relay the information to the Service and/or Shipowner Roles. In such cases the System Integrator Role must relay the information to the known purchaser of the equipment.

7.2.2.2   If an update has been designated as a critical update by the System Integrator Role, this information should be accompanied by a recommendation that the update should be performed as soon as possible. Means should be provided for undertaking the update in a way that ensures minimal downtime of the shipboard equipment or integrated system.

7.2.3   Planning

7.2.3.1   When a software update for an integrated system is released, information pertaining to the update should be made available, including which individual shipboard equipment within the integrated system requires the software update, the Category of update and the Method of update supported for undertaking it.

Note: "Made available" in this context could be, for example, by website or email/bulletin.

7.2.3.2   Each software update should be assessed to determine and describe new functionalities, changes and improvements. A summary of new functionalities, changes and improvements should be provided to the Service and Shipowner Roles as necessary.

7.2.3.3   Each software update to be performed on an integrated system should be assessed to determine and describe any impacts or effects on existing software installed on any individual shipboard equipment within the System Integrator's scope of supply of the integrated system.

7.2.3.4   If a software update is to be executed by the crew, it should be accompanied by detailed step-by-step instructions. Provision of remote assistance should be considered.

7.2.4   Execution

7.2.4.1   Where practicable, integrated systems should include a mechanism to generate an on-the-spot diagnostic report(s) after maintenance has been performed, which identifies the software version of software added for the purpose of integration. The integrated system should also provide a means to check that interfaces and functionality within the integrated system and functionality in its external interfaces are operating as expected after an update has been completed. This mechanism should be covered in the System Integrator Role's maintenance manual, including the method for execution, instructions for use, and procedure.

7.2.4.2   Integrated systems holding software added for the purpose of integration should support procedures to roll back to a previous software version and configuration.

Note: Roll back procedures could be based on a previous software version stored in the shipboard equipment or on previous software versions that can be uploaded by the Service Role

7.2.5   After-service

7.2.5.1   Any information received from the Shipowner Role regarding the result of the maintenance should, if appropriate, be addressed and used for improving maintenance procedures.

7.3   Data Provider Role

7.3.1   General requirements

7.3.1.1   Data production and distribution operations should be carried out in accordance with a QA System, covering:

- Data quality (production, delivery, testing and integration);
- Standardisation of data import;
- How to ensure the continuous availability of data updates;
- Prevention/detection of unauthorised modification;
- Prevention of the distribution of malware.

7.3.1.2   Compliance with relevant international standards should be ensured.

7.3.1.3   Data should be provided to relevant Roles by suitable means.

7.3.1.4   Timely access should be provided to information about the requirements of the software running the data.

7.3.1.5   Timely access to information about relevant changes to data, including those resulting from changes to regulations and Class requirements, should be provided to the Producer, System Integrator, Service and Shipowner Roles.

7.3.2   Event initiation

7.3.2.1   In the event that the Data Provider Role has identified the need for an update of data and/or the software using the data, this information should be made available to the bodies performing the Producer, System Integrator, Service and Shipowner Roles as necessary. Means for updating should be made available.

7.3.2.2   If an update has been designated as a critical update by the Data Provider Role, this information should be accompanied by **a** recommendation that the update is performed as soon as possible. Means should be provided for undertaking the update in a way that ensures minimal downtime of the shipboard equipment.

7.3.3   After-service

7.3.3.1   Any information received regarding the result of the maintenance should, if appropriate, be addressed and used for improving maintenance procedures and/or data production.

7.4 Service Role

7.4.1 General requirements

7.4.1.1 Maintenance-related operations should be carried out in accordance with a QA System, covering:

- Competence management;
- Coordination and call-entrance procedures;
- Remote maintenance procedures (if applicable);
- Reporting procedures;
- Shipboard operations safety briefing;
- Cyber-security.

7.4.1.2 Quality standards and internal training for technicians should be established in line with maintenance and competency requirements of the Producer Role and/or System Integrator Role (as laid out in the Producer or System Integrator Role's maintenance manuals) and specified in a quality manual of the Service Role.

7.4.1.3 Training of Service Role technicians is based on the *train-the-trainer* model. The root trainer may be a representative of the Producer, System Integrator, or Service Role. For certain types of shipboard equipment, technicians that have been trained by the root trainer may require additional testing and/or certification by the Producer Role and/or System Integrator Role.

7.4.2 Planning

7.4.2.1 When planning the Event a Plan of Approach should be created, providing a description of the work expected to be undertaken. This should include information on any risks to the Service Role, Shipowner Role and shipboard equipment, alongside associated mitigations. The Plan of Approach should adhere to the Health, Safety, Security and Environment (HSSE) instructions provided by the Shipowner Role, to ensure that the specific HSSE requirements are known, understood and followed.

7.4.2.2 Planning for remote maintenance should be coordinated with the Shipowner Role and Master. In case of remote maintenance a time slot for when the shipboard equipment is connected and powered up should be agreed. Procedures to ensure the identity of the Service Role should be in place. After concluding the maintenance procedures for how to determine when the shipboard connection can be closed should be agreed.

7.4.2.3 Before arriving on board to perform software maintenance, time, place and maintenance requirements should be planned and agreed between the Service and Shipowner Roles. A competent technician should be appointed in accordance with the required software maintenance work scope (see Appendix 1), and the basis of the appointment should be documented and shared with the Shipowner Role.

7.4.2.4 Before arriving on board to perform software maintenance, the Shipowner Role should send information to the Service Role about the ship's equipment and connections, and related configurations and software version(s). Furthermore necessary port information and agent details should be included. The Service Role should send confirmation to the Shipowner Role that the information has been received and is sufficient.

7.4.2.5 Before arriving on board to perform software maintenance, shipboard operations safety briefing for Service Role personnel should ensure that any special requirements related to safety, security and

environmental protection that have been communicated by the Shipowner Role are understood by the technician(s) who will be performing the maintenance.

7.4.2.6   Before arriving on board to perform a software update, the applicable software version(s) for the shipboard equipment should be identified by the Service Role and prepared for installation.

7.4.2.7   Before arriving on board to perform software maintenance, the Service Role should acknowledge and confirm the agreed port and time to the Shipowner Role. Further, the identity of the technician assigned to the job should be forwarded to the ship for ISPS clearance. If the assigned technician is subsequently unable to come on board, the Service Role should inform the Shipowner Role in advance about any replacement technician or about cancellation in case a qualified technician is not available.

7.4.2.8   Before arriving on board to perform software maintenance, all necessary tools and resources needed to access the shipboard equipment for software maintenance should be prepared (for example: laptop, media device, specific tools recommended by the Producer or System Integrator Roles, etc.).

7.4.2.9   When the Producer, System Integrator or Data Provider Role has determined the need for an critical update and provided the necessary means, this update should be planned between the Service Role and Shipowner Role to ensure that it will be undertaken as soon as possible and that downtime of the shipboard equipment is minimised.

7.4.3 Execution

7.4.3.1   Where shipboard equipment has been designed with restoration procedures, these should be utilised when required (i.e. if errors are occurred during software updating).

7.4.3.2   Maintenance operations should not lead to malware infection of shipboard equipment. Removable media/storage devices may be used in the maintenance process provided they are authorised by the Shipowner Role. Where appropriate, a malware check should be performed on the device to be used before the maintenance is carried out and confirmation that this check has been performed should be provided to the Shipowner Role.

7.4.3.3   Where practicable, uncontrolled equipment used for maintenance other than removable media/storage devices (as defined in this standard) may not be directly connected to a controlled network. Such devices should be connected to a controlled network through e.g. a firewall.

Note – For example, International standard IEC 61162-460 specifies a device called a -460 Gateway for the purpose of connecting controlled and uncontrolled networks.

7.4.3.4   Authorisation should be obtained from Shipowner Role before carrying out remote maintenance. Additionally, authorisation should be obtained from the ship's Master before every remote maintenance session.

7.4.3.5   Where the shipboard equipment provides a mechanism to generate an on-the-spot diagnostic report, this process should be executed after software maintenance has concluded and the resulting diagnostic report should be appended to the electronic service report.

7.4.3.6   It is the Service Role's responsibility to ensure that the system functions as intended after the software maintenance has been concluded. Based on agreement with the Shipowner Role the Service Role may remain onboard to verify correct operation of the shipboard equipment during sailing.

7.4.4 After-service

7.4.4.1 After software maintenance has concluded, an electronic service report should be completed, in accordance with Appendix 4, and a copy of the associated electronic file passed to the Shipowner Role for adding to the onboard software log.

7.5 Shipowner Role

7.5.1 General requirements

7.5.1.1 Maintenance-related operations should be carried out in accordance with an appropriate International Safety Management (ISM) Code system and operational procedures.

7.5.1.2 Procedures should be in place to ensure that software is up to date in accordance with the latest regulatory requirements.

7.5.1.3 The Shipowner Role should ensure safe practices for the ship's safe navigation and operation during software maintenance and assess identified possible risks to the ship.

7.5.2 Event initiation

7.5.2.1 Software maintenance can be initiated by the Shipowner Role:

- As part of the after-sales support for the shipboard equipment;
- As a preventative or corrective maintenance operation;
- Due to operational anomalies;
- For the purpose of maintaining regulatory compliance;
- In response to a request by the Data Provider Role, Producer Role, System Integrator Role, or Service Role.

7.5.3 Planning

7.5.3.1 Procedures should be in place to ensure that software is kept up to date with the requirements of the Producer Role, System Integrator Role, or Data Provider Role. The following types of checks should be included in these procedures:

- Automatic updates and how to ensure these are carried out in a secure, cost-effective, coordinated and safe manner;
- Scheduled maintenance (e.g. Annual Performance Tests, clean-ups, diagnostics) and instructions for when this should take place and how the traffic should be enabled;
- Remote access configuration of the downloading computer to locally distribute to other computers on the shipboard network(s).

7.5.3.2 An onboard software log should be maintained on board listing the current and previous software versions installed on shipboard equipment, in accordance with Appendix 5.

7.5.3.3 When the Producer Role, System Integrator Role, or Data Provider Role has advised of the need for a software update, including the Category of update and Method of update, or an update has been requested by the Shipowner Role, an update plan should be prepared in accordance with the type of update in question. The following considerations should be included in the update plan:

- Identification of the need for additional familiarization, changes to operating procedures, and changes to on board documentation;
- Description of how to avoid security risks including unauthorised access and spread of malware;
- Identification of the software, shipboard equipment, and network to be updated;
- Identification of all shipboard equipment affected due to their interface connections to the shipboard equipment requiring the software update;
- Identification of individual responsible for the update and possible supervision of Service Role personnel;
- Procedures for restoring previous stable software version in the event that errors are encountered during update;
- Preparation for remote access if this is required during the update;
- Authorization of appropriate crew member(s) to conduct or assist with the update;
- Authorization of Service Role personnel to conduct the update;
- Procedures for validating the update after completion;
- Coordination with the Master to ensure safety of navigation.

7.5.3.4   When an operational anomaly has been identified, information should be provided about the equipment and connections used on board, and related configurations and software versions, to the body performing the Service role. An example checklist of information to be communicated is provided in Appendix 3.

7.5.3.5   Maintenance requirements for the equipment at hand should be planned and agreed upon with the Service Role.

7.5.3.6   When the Producer, System Integrator or Data Provider Role has determined the need for a critical update and provided the necessary means, this update should be planned between the Service Role and Shipowner Role to ensure that it will be undertaken as soon as possible and that downtime of the shipboard equipment is minimised. .

7.5.3.7   The Shipowner Role should send information to the Service Role about the ship's equipment and connections, and related configurations and software version(s). Necessary port information and agent details should be provided.

7.5.3.8   The Shipowner Role should communicate any specific Health, Safety, Security and Environment (HSSE) instructions to the Service Role so that these may be adhered to in the Service Role's Plan of Approach.

7.5.3.9   When appropriate, authorisation should be provided to the Service Role to undertake remote maintenance. This authorisation should specify who has access, when they have access, and what equipment they have access to. Additionally, authorisation should be obtained from the ship's Master before every remote maintenance session.

7.5.3.10 Procedures should be in place to ensure that those persons authorised to remotely access shipboard equipment for the purposes of software maintenance are able to do so.

7.5.3.11 Procedures should be in place to ensure that remote maintenance of shipboard equipment takes place during safe and suitable conditions.

7.5.3.12 Procedures should be in place to ensure the remote maintenance process is ended safely, once completed.

7.5.4 Execution

7.5.4.1 Procedures should be in place to protect shipboard equipment from malicious or unintentional security threats. Safety procedures should include the following considerations:

- Service Role selection and use of competent technicians;
- Ensuring secure communications and remote access;
- Identification of Service Role person(s) coming on board;
- Service Role person(s) access management.

7.5.4.2 If removable media/storage devices are to be used in the maintenance process, confirmation should be received from the Service Role that such devices have been subject to a malware check before the maintenance is carried out.

7.5.4.3 Where practicable, uncontrolled equipment used for maintenance other than removable media/storage devices (as defined in this standard), may not be directly connected to a controlled network. Such devices should be connected to a controlled network through a firewall.

Note – For example, International standard IEC 61162-460 specifies a device called a -460 Gateway for the purpose of connecting controlled and uncontrolled networks.

7.5.5 After-service

7.5.5.1 Each software update performed on shipboard equipment should be recorded in the onboard software log and linked to the associated electronic service report provided by the Service Role, in accordance with Appendix 4. Such recordings may be made available on request by the Service Role in support of future software maintenance.

7.5.5.2 Following an update, if the Producer Role or System Integrator Role has confirmed that new functionalities, changes or improvements have been implemented, crew familiarization with the shipboard equipment should be ensured.

8. Bibliography

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ISM Code, Chapter 5, Section 10, *Maintenance of the Ship & Equipment*

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ISO/IEC 12207, *Systems and software engineering – Software lifecycle processes*

ISO/IEC 15288, *Systems and software engineering – System life cycle processes*

ISO/IEC 25010, *Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- System and software quality models*

Appendix 1 – Software maintenance competency requirements

The following table indicates the competencies required by Service Role personnel for undertaking different types of software maintenance. Its purpose is to provide guidance for the Shipowner Role.

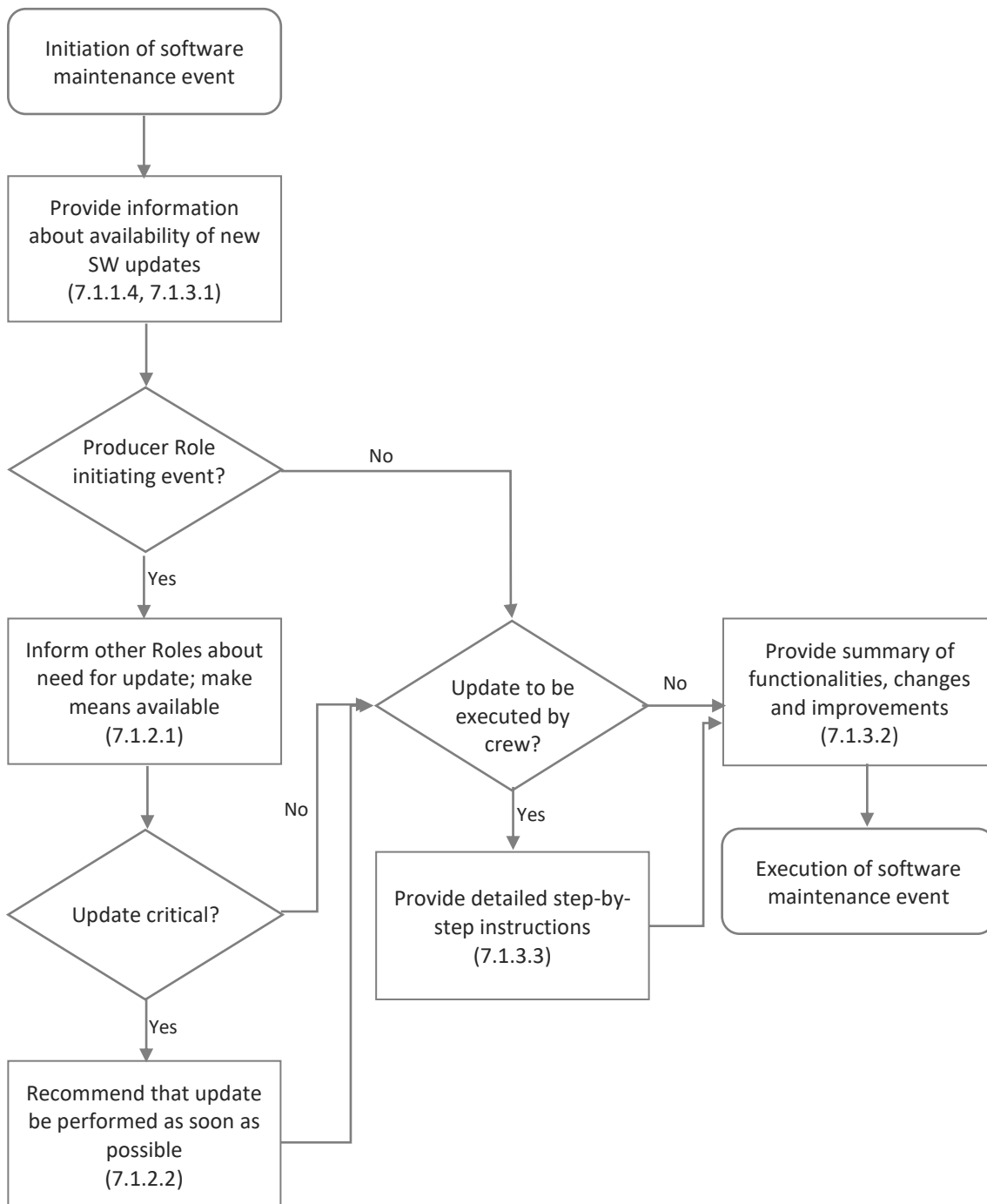| Type	Scope of job	Competencies
1	Simple software maintenance activities such as operational inspection and execution of minor software updates.	Crew level -General basic technical knowledge
2	Minor software maintenance activities such as adjusting configuration settings and conducting basic performance testing. Replacement of software to address bugs, add new features, maintain compliance with changing rules/regulations, etc.	Technician level -General basic technical knowledge -Specific technical product knowledge
3	General and emergency software maintenance activities such as trouble-shooting, advanced performance testing such as Annual Performance Tests, and advanced diagnosis of operational anomalies.	Senior Technician level -General basic technical knowledge -Specific product knowledge -Specific system knowledge
4	Major or complex software maintenance activities such as major software upgrading that require knowledge beyond that held by the Service Role.	Specialist level -General technical knowledge -Specific product knowledge -Specific system knowledge -Technical system specialization
+i	When action performed may affect the functionality of equipment beyond the equipment undergoing the change (i.e. performed on integrated systems).	Integrator level -General basic technical knowledge -Specific product knowledge -Specific system knowledge -Multi-disciplinary system knowledge

Table 1 - Software maintenance competency requirements

Training and certification of Service Role personnel should be conducted in accordance with the relevant clauses in this standard (7.4.1.2, 7.4.1.3).
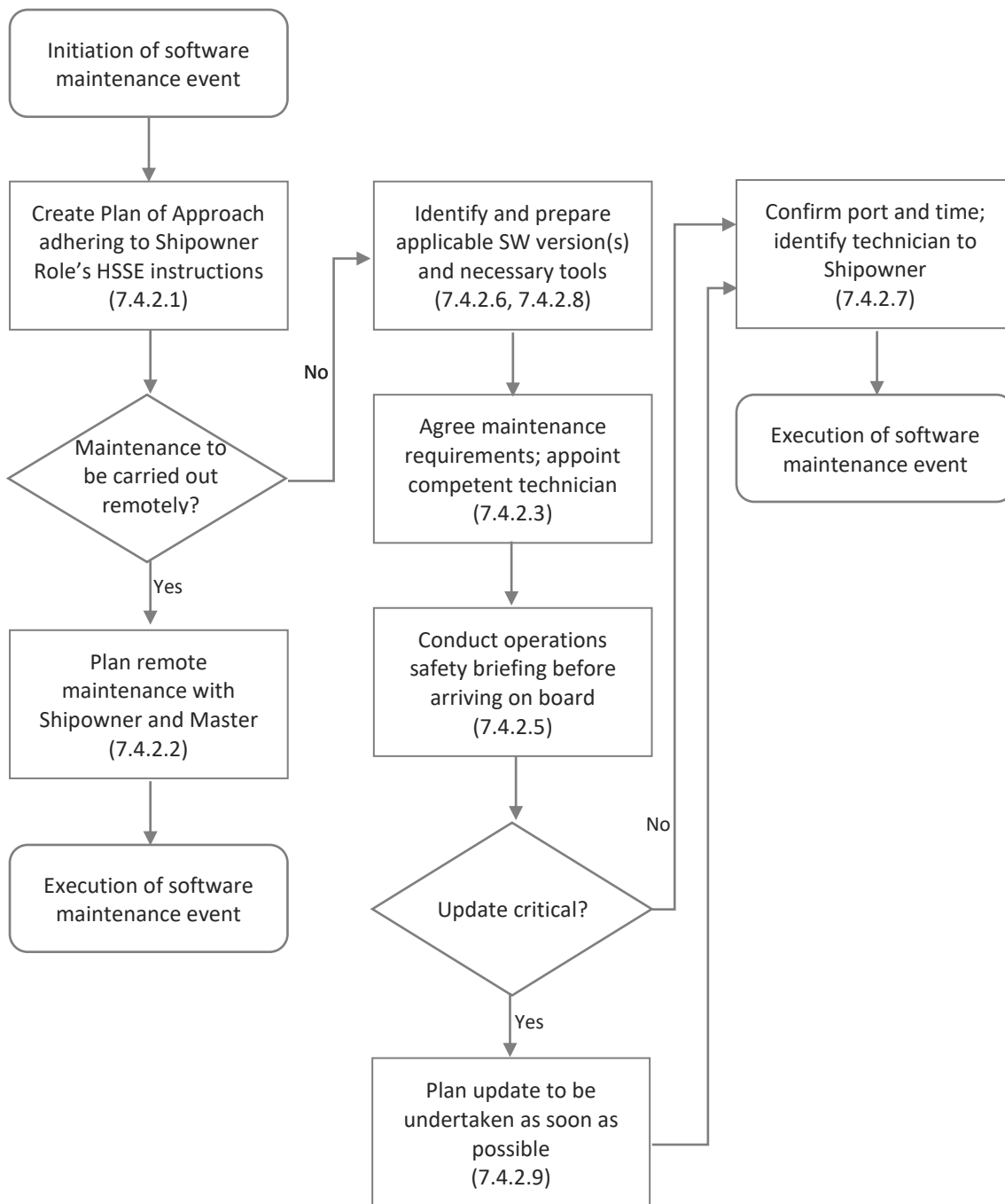
Appendix 2 – Software maintenance planning flowcharts

This appendix provides a diagrammatical representation of the event planning requirements applying to the different Roles involved in shipboard software maintenance.
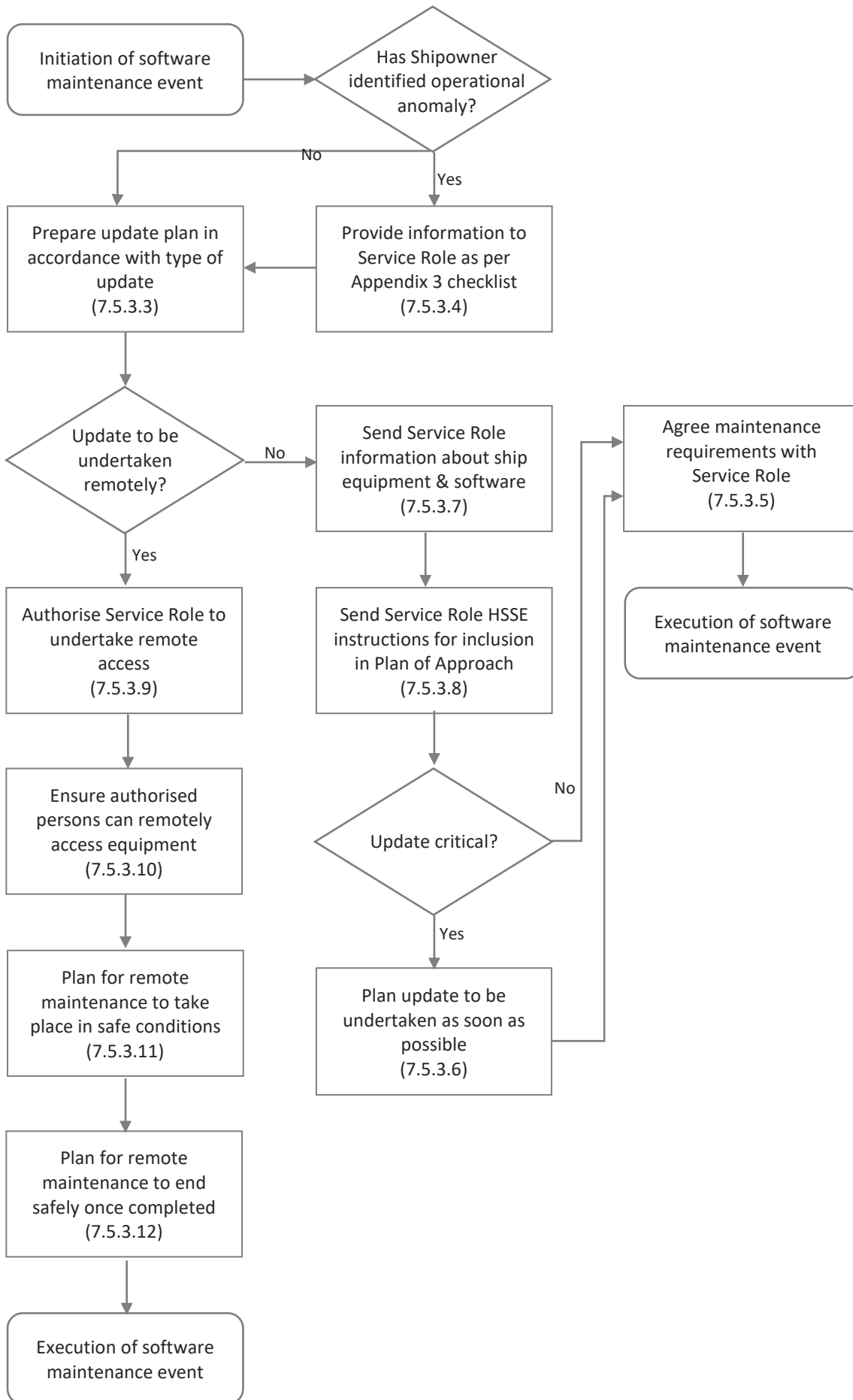
Producer & System Integrator Roles

```
┌─────────────────────────┐
│  Initiation of software │
│   maintenance event     │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│  Provide information    │
│ about availability of new│
│      SW updates         │
│   (7.1.1.4, 7.1.3.1)    │
└─────────────────────────┘
             │
             ▼
        ◇ Producer Role          No
          initiating event? ──────────────┐
             │                             │
             │ Yes                         ▼
             ▼                        ◇ Update to be      No   ┌──────────────────────┐
┌─────────────────────────┐            executed by ──────────► │ Provide summary of   │
│ Inform other Roles about│            crew?                   │ functionalities,     │
│  need for update; make  │             │                      │ changes and          │
│    means available      │             │ Yes                  │ improvements         │
│      (7.1.2.1)          │             ▼                      │   (7.1.3.2)          │
└─────────────────────────┘    ┌──────────────────────┐        └──────────────────────┘
             │                 │ Provide detailed     │                   │
             ▼        No       │ step-by-step         │                   ▼
        ◇ Update critical? ──► │ instructions         │        ┌──────────────────────┐
             │                 │   (7.1.3.3)          │        │ Execution of software│
             │ Yes            └──────────────────────┘        │  maintenance event   │
             ▼                                                 └──────────────────────┘
┌─────────────────────────┐
│ Recommend that update   │
│ be performed as soon as │
│       possible          │
│      (7.1.2.2)          │
└─────────────────────────┘
```

Service Role

Shipowner Role

Appendix 3 – Checklist for communicating a software problem

The following details are recommended to be communicated by the Shipowner Role to relevant stakeholders.

- IMO number and date
- Make, type, serial number and model of shipboard equipment
- Details of interconnection to other shipboard equipment
- Detailed description of failure
- Any particular conditions experienced before development of failure
- Detailed test result from the built-in test system (if available)
- Troubleshooting performed and results obtained
- Attempts to correct the failure and results
- Software version in accordance with the onboard software log (if available)
- Estimated requirements of spare parts (e.g. CPU)
- Urgency of service
- Name of port for service ETA/ ETD
- Name of alternative port for service ETA/ ETD
- Agent information (name and telephone number)
- Service requisition number (unless the equipment already covered by a Service Agreement)
- Casualty report / Guarantee number to be used where the equipment is under warranty or part of a casualty
- An indication if it is a follow up service

Whenever service arrangements are in place, the requirements for requesting service or assistance should comply with the contract to ensure that all responsible stakeholders are informed in the most efficient and cost-effective way.

Appendix 4 – Electronic Service Reports

This appendix specifies the format and minimum content of the electronic service report which is to be completed by the Service Role at the end of a software maintenance job.

Format

The format of the electronic service report documents is not standardized as their detailed content is dependent on the business system used by the service role. The format of the electronic service report shall be suitable for electronic filing and its content should be searchable. As minimum it shall be possible to store these electronic service report documents in individual electronic folders.

Content

The following template identifies the minimum content of a service report. Pages should be numbered (as for example: 1 of 10)

1. **General information**

   Information about the ship

   - Shipowner
   - Ship name
   - IMO number
   - MMSI number

   Information about the company performing the Service Role

   - Name of company
   - Name of technician
   - Employee ID

2. **Information about the shipboard equipment and software**

   - Equipment manufacturer
   - Equipment model
   - Equipment type
   - Equipment serial number
   - Current software version
   - Last update applied

3. **Purpose of maintenance event**

   - Date
   - Location of ship at the time of service
   - Time of start and end of service
   - Local or remote maintenance
   - Category of update (indicate as appropriate):

    o Bug Fix

    o Feature Release

    o Compliance Update

    o Security Update

    o Obsolescence Update

    o Combination of the above (specify)

4. **Cyber security**

The following information should be recorded for any removable media/storage device used to perform maintenance:

- Version and make of the anti-virus/malware software used
- Last update of the anti-virus/malware database
- Confirmation and date of clean anti-virus/malware scan

5. **Technical report**

- Detailed description of the work performed
- Outcome of the maintenance event

6. **Hardware changes**

- Equipment make and serial number
- Old hardware
- New hardware

7. **Operational status after maintenance event**

- Demonstration in the presence of the ship's representative that the shipboard equipment functions and operates as intended after the software maintenance
- If an appropriate self-test mechanism is provided on the shipboard equipment, an on-the-spot diagnostic report should be generated after software maintenance job completion and appended to the electronic service report
- New software version
- Should a follow-up be deemed necessary, provide reason/details

8. **Post-event acceptance**

- Has the upgrade been completed to the satisfaction of the Shipowner's representative (Yes/No)
- Capture feedback comments from the Shipowner's representative about the maintenance event

Appendix 5 – Onboard software log

The onboard software log is a record of the previous and current software versions installed on shipboard equipment, including a repository of related electronic service report documents (specified in Appendix 4). This repository is implemented and maintained by the Shipowner Role and made available on board.

The onboard software log should include the following fields as a minimum:

- **Ship details** (Shipowner; Ship name; IMO number; Maritime Mobile Service Identity MMSI);
- **Service Role details** (Name of company; Name of technician, Employee ID);
- **Shipboard equipment details** (Make; Type; Serial number; Model);
- **Software details** (Previous software version, Current software version, Last update applied, Last error generated);
- **Initiator** (Producer/System Integrator/Service/Shipowner Role);
- **Criticality** (Rating);
- **Status** (Description of the equipment and software on arrival and after job completion).