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DEPARTMENT OF DEFENSE
STANDARD PRACTICE
RELIABILITY-CENTERED MAINTENANCE (RCM) PROCESS



FOREWORD

1. This standard is approved for use by the Department of the Navy and is available for use by all Departments and Agencies of the Department of Defense.

2. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.daps.dla.mil>.

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1. SCOPE

1.1 Scope. Maintenance (preventive, corrective, and inactive) (see 3.13.1, 3.13.2, and 3.13.5) is the action of performing tasks (time-directed, condition-directed, failure-finding, servicing, and lubrication) (see 3.20.2, 3.20.5, 3.20.6, 3.20.7, and 3.20.8) at periodicities (periodic, situational, and unscheduled) to ensure the item's functions (active, passive, evident, and hidden) (see 3.11.1, 3.11.2, 3.11.3, and 3.11.4) are available until the next scheduled maintenance period. This standard describes the Reliability-Centered Maintenance (RCM) methodology used for the determination of maintenance requirements. It applies to all levels of system or equipment grouping, and to all scheduled maintenance, whether equipment is in use, ready for use, or in standby or lay-up condition. RCM addresses the total scheduled maintenance program for an enterprise, irrespective of the maintenance echelon possessing the capability to perform the maintenance; that is, organizational, intermediate, and depot level maintenance. This standard provides the procedure to develop preventive, corrective, and inactive equipment maintenance (see 3.13.1, 3.13.2, and 3.13.5) within a planned maintenance management system. Specific maintenance procedures may be developed, after the application of the RCM procedure outlined in this standard, for inclusion in class maintenance plans, and depot, intermediate, and organizational maintenance systems. This standard supersedes Phases 1 through 11 of MIL-P-24534A Amendment 1.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

- | | | |
|---------------|---|---|
| MIL-PRF-6086 | - | Lubricating Oil, Gear, Petroleum Base |
| MIL-P-24534 | - | Planned Maintenance System: Development of Maintenance Requirement Cards, Maintenance Index Pages, and Associated Documentation |
| MIL-DTL-24784 | - | Manuals, Technical: General Acquisition and Development Requirements, General Specifications for |

DEPARTMENT OF DEFENSE HANDBOOKS

- | | | |
|--------------|---|---|
| MIL-HDBK-267 | - | Guide for Selection of Lubricants and Hydraulic Fluids for Use in Shipboard Equipment |
|--------------|---|---|

(Copies of these documents are available online at <https://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE ISSUANCES

- DoDI 4151.22 - Condition Based Maintenance Plus (CBM⁺) for Materiel Maintenance
- DoDD 5000.01 - The Defense Acquisition System
- DoD 5010.12 - M - Procedures for the Acquisition and Management of Technical Data

(Copies of these documents are available online at <http://www.dtic.mil/whs/directives/>.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

- S9081-AB-GIB-010 - Reliability-Centered Maintenance (RCM) Handbook
- ST000-AG-IDX-010 - Test, Measurement and Diagnostics Equipment Index (TMDEI)

(Copies of these documents are available on line at <https://mercury.tdmis.navy.mil>.)

NAVAL SUPPLY SYSTEMS COMMAND (NAVSUP) PUBLICATIONS

- NAVSUP P - 4400 - The Afloat Shopping Guide (ASG)

Copies of this document are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at http://www.dlis.dla.mil/navy/asg_guide.asp.)

NAVSEA INSTRUCTIONS

- NAVSEAINST 4790.1 - Expanded Ship Work Breakdown Structure (ESWBS) Hierarchical Structure Codes (HSC) for Ships, Ship Systems & Surface Combatant Systems
- NAVSEAINST 4790.8 - Ships' Maintenance and Material Management Manual (3-M)

(Copies of these documents are available online at <http://www.navsea.navy.mil>.)

OPNAV INSTRUCTIONS

- OPNAVINST 4700.7 - Maintenance Policy for U.S. Navy Ships
- OPNAVINST 4790.16 - Condition-Based Maintenance (CBM) Policy
- OPNAVINST 5100.19 (Series) - Navy Safety and Occupational Health (SOH) Program Manual for Forces Afloat
- OPNAVINST 5513.1 (Series) - Department of the Navy Security Classification Guides

(Copies of these documents are available from the Department of the Navy Issuances, SECNAV/OPNAV Directives Control Office (DNS-5), Washington Navy Yard, Bldg. 36, 720 Kennon Street, SE Rm. 203, Washington Navy Yard, DC 20374-5074 or online at <http://doni.daps.dla.mil/default.aspx>.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Age-reliability characteristics. The characteristics exhibited by the relationship between the age of an item and its conditional probability of failure.

3.2 Conditional probability of failure. The probability that a failure will occur in a specific period provided that the item concerned has survived to the beginning of that period.

3.3 Consequence.

3.3.1 Economic/mission consequence. A measure of the economic or mission impact due to a functional failure which results in the loss of mission essential equipment or high-repair costs, and does not affect personnel safety or ship survivability.

3.3.2 Failure consequence. A measure of the safety, environmental, mission, and economic impact of an item's functional failure caused by a specific failure mode.

3.3.3 Hidden failure consequence. The measure of the impact of the loss of a protective or secondary function due to the undetected failure of a hidden function.

3.3.4 Safety consequence. A measure of the direct threat to life, limb, and/or health of persons due to the loss of a function.

3.4 Default answer. In a binary decision process, the answer to be chosen in case of uncertainty; employed in the development of an initial preventive maintenance program to arrive at a course of action in the absence of complete information.

3.5 Development. The act of researching, examining, and writing maintenance documentation.

3.6 Item.

3.6.1 End item. An assembly of hardware elements that is not used to assemble a higher level physical item, and is ready for its intended use.

3.6.2 Functionally significant item. An item whose functional failure has safety, mission, or major economic consequences.

3.7 Fail-safe system. A device or feature which, in the event of failure, responds in a way that will cause no harm or at least a minimum of harm to machinery or personnel.

3.8 Failure. The presence of an unsatisfactory condition. What constitutes an unsatisfactory condition must be specifically identified for each function.

3.8.1 Functional failure. The inability of an item to perform a specific function within specified limits.

3.8.2 Potential failure. A definable and measurable condition that indicates a functional failure is imminent.

3.9 Failure effects. Failure effects describe what happens when a failure mode occurs if no other action is taken to otherwise address the failure.

3.10 Failure mode. The specific condition causing a functional failure (often best described by the material condition at the point of failure).

3.10.1 Dominant failure mode. A cause of failure that is important because of its frequent occurrence or the serious consequences of the failure.

3.11 Function. Any action or operation which an item is intended to perform.

3.11.1 Active function. A function provided by activity of an item.

3.11.2 Evident function. A function provided by an item whose loss is observable to the operating crew during the performance of their routine duties.

3.11.3 Hidden function. A function provided by an item for which there is no immediate indication of malfunction or failure. The demand for such functions usually follows another failure or unexpected event.

3.11.4 Passive function. A function that does not require activity of an item.

3.12 Indenture level. A level of relative importance in a hierarchical set. The levels progress from the general to the specific.

3.13 Maintenance. Actions taken to ensure components, equipment and systems provide their intended functions when required.

3.13.1 Corrective maintenance. Maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-service operations.

3.13.2 Inactive equipment maintenance (IEM). Tasks performed while equipment is in a lay-up status to ensure equipment is fully operational when it is returned to service.

3.13.3 Lay-up maintenance. Tasks performed to prepare equipment for a period of inactivity.

3.13.4 Planned maintenance. Maintenance carried out according to a fixed and standardized plan.

3.13.5 Preventive maintenance. An action that reduces the probability of occurrence of a particular failure mode, or discovers a hidden failure.

3.13.6 Reliability-centered maintenance (RCM). A method for determining maintenance requirements based on the analysis of the likely functional failures of systems/equipment having a significant impact on safety, operations, and lifecycle cost. RCM supports the failure-management strategy for any system based on its inherent reliability and operating context.

3.13.7 Situational maintenance. Requirements which cannot be scheduled on a calendar basis.

3.13.8 Start-up maintenance. Tasks performed to prepare equipment for operation after a period of inactivity.

3.13.9 Unscheduled maintenance. Consists of unplanned actions performed when triggered by other scheduled maintenance actions.

3.14 Maintenance coordinating activity (MCA). Activity which funds, authorizes, manages, monitors, or coordinates maintenance management documentation developed by commercial contractor, In-service Engineering Agents (ISEAs), Naval Sea Logistics Center (NAVSEALOGCEN), etc. The MCA has review authority for the phases of RCM development.

3.15 Maintenance development activity (MDA). Activity (commercial contractors, ISEAs, NAVSEA field activities, etc.) which develop maintenance documentation. The MDA is the activity to which the maintenance developer is assigned.

3.16 Master system and subsystem index (MSSI). Documents the hierarchical breakdown of a development.

3.17 Periodicity. Delineates how frequently the maintenance requirement must be performed.

3.18 Redundancy. The design practice of duplicating the sources of a function so that the function remains available in the same quality and quantity required after the failure of one or more items. Redundancy can be designed into any indentured level.

3.19 Reliability. The probability that an item will perform its intended function for a specified interval under stated conditions.

3.20 Task.

3.20.1 Applicable task. A task which reduces the probability of the occurrence of a failure mode.

3.20.2 Condition-directed (CD) task. CD tasks are periodic tests or inspections to compare the existing conditions or performance of an item with established standards to determine the need for a follow-on renewal, restoration or repair to prevent the loss of function.

3.20.3 Discard task. The scheduled removal and discard of all units of an item or one of its parts at a specified life limit.

3.20.4 Effective task. A task which reduces the probability of the occurrence of a failure mode to an acceptable level based on the consequences of failure.

3.20.5 Failure-finding task. A test or inspection performed at a specified interval to determine whether equipment providing a hidden function has failed.

3.20.6 Lubrication task. A task that adds or replenishes a lubrication film (oil or grease) that exists solely to reduce the wear that results from the friction of two surfaces moving in relation to one another.

3.20.7 Servicing task. The replenishment of consumable materials that are depleted during normal operations. Filters are also included under servicing tasks.

3.20.8 Time-directed (TD) task. Task performed at a specified interval without consideration of other variables. This interval may be based on calendar, operation, or number of recurring events, etc.

4. GENERAL REQUIREMENTS

4.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life-cycle costs.

4.2 Security classification. The security classification of materials to be used in maintenance requirements development shall be governed by the applicable enclosure of OPNAVINST 5513.1 (Series) security classification guides. The applicable enclosure of the OPNAVINST 5513.1 (Series) is based upon program, project, weapon or ship for which maintenance requirements are being prepared. Security classification shall be based on data actually extracted for the maintenance rather than the overall classification of the source document (see 6.2). Inquiries concerning appropriate security classification or markings should be referred to the Commander, Naval Sea Systems Command (COMNAVSEASYS COM) (SEA 104).

4.3 Certification requirements. Maintenance developers using the RCM methodology contained in this standard shall be Naval Sea Systems Command (NAVSEA) RCM Level II certified. NAVSEA will not accept RCM analysis packages from those not RCM Level II certified. Certification training information can be obtained from the MCA.

4.4 Maintenance requirements. Maintenance requirements shall be developed using the RCM methodology as specified herein. The contractual documents for each development shall include the name and address of the MCA which will coordinate the development and preparation of the maintenance documentation. The designation of this activity will be made by NAVSEA. Corrective maintenance task identification (Phase 8) will only be accomplished when specified and directed by the acquisition document. Figure 1 depicts the relationship between the MDA, and the MCA for maintenance development using the RCM methodology contained in this standard. Figure 1 depicts the required review and approval points in the analysis process. This workflow shall be used by maintenance developers in the process of submitting deliverable RCM analysis packages to NAVSEA. The MCA, as designated by NAVSEA, shall determine the conformance of the deliverable items with respect to the requirements of this standard (see 6.2).

NAVSEA RCM ANALYSIS PROCESS

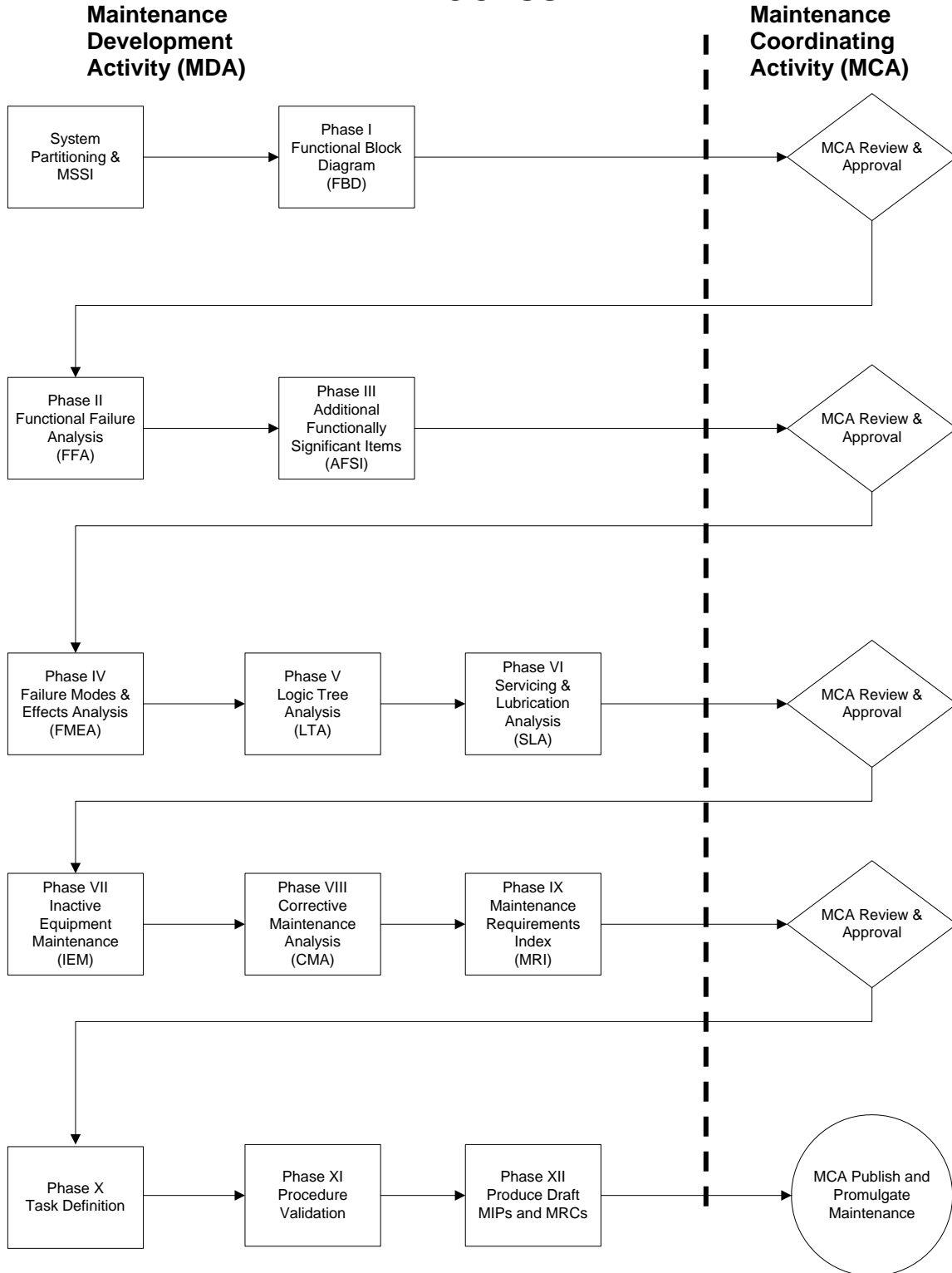


FIGURE 1. NAVSEA RCM analysis process.

5. DETAILED REQUIREMENTS

5.1 RCM process. RCM is the process used to determine the maintenance requirements for new and in-service equipment or systems. The process is composed of up to twelve phases. RCM development in structured phases ensures that every maintenance action specified in a maintenance package can be justified in accordance with the fundamental RCM principles used by both DoD and commercial entities.

The initial maintenance package provides the baseline for system expectations. As operational experience is developed (failure data, inspection results, etc.), the maintenance package will be monitored and improved as required.

RCM development shall be accomplished in phases as specified in the acquisition document. The twelve phases of the RCM development process are:

- a. Phase 1 – System partitioning and functional block diagram (FBD). Partitioning along major system and subsystem boundaries to facilitate analysis and specify analysis boundaries (scope) and approach (see 5.1.1).
- b. Phase 2 – Functional failure analysis (FFA). Analysis of the functions of systems and subsystems and of the ways in which those functions can fail (see 5.1.2).
- c. Phase 3 – Additional functionally significant item selection (AFSI). Selection of the additional functionally significant items (AFSIs) (see 5.1.3).
- d. Phase 4 – Failure modes and effects analysis (FMEA). Analysis of the failure modes and effects of failure (see 5.1.4) of the FSIs.
- e. Phase 5 – Decision logic tree analysis (LTA) (see 5.1.5).
- f. Phase 6 – Servicing and lubrication analysis. Analysis of servicing and lubrication task requirements (see 5.1.6).
- g. Phase 7 – Inactive equipment maintenance (IEM) task identification (see 5.1.7).
- h. Phase 8 – Corrective maintenance task identification (see 5.1.8).
- i. Phase 9 – Maintenance requirements index (MRI) (see 5.1.9).
- j. Phase 10 – Maintenance requirement task definition (see 5.1.10).
- k. Phase 11 – Maintenance procedure validation (see 5.1.11).
- l. Phase 12 – Maintenance requirement card (MRC) and maintenance index page (MIP). Development and preparation of MRCs and formulation into MIPs (see 5.1.12).

5.1.1 RCM Phase 1 – System partitioning and functional block diagram. The assigned boundaries of an RCM analysis may encompass anywhere from a single sub-assembly to an entire subsystem. Large multi-subsystem assignments are typically split along boundaries as defined in the Expanded Ships Work Breakdown Structure (ESWBS) before beginning the detailed RCM analysis. This level of partitioning is typically accomplished at the programmatic level. Care must be taken when defining what the boundaries of a single development will encompass so that no items are forgotten or are covered within multiple developments (see figure 2). The RCM process, as described in Phases 1 through 12, is usually performed within a boundary that encompasses at most a single subsystem. Within this process the assigned developer(s) may still find it advantageous to subdivide the subsystem to simplify the analysis. This hierarchical approach to dividing subsystems enables the identification of an optimum level for the actual performance of the RCM process steps (see 6.2).

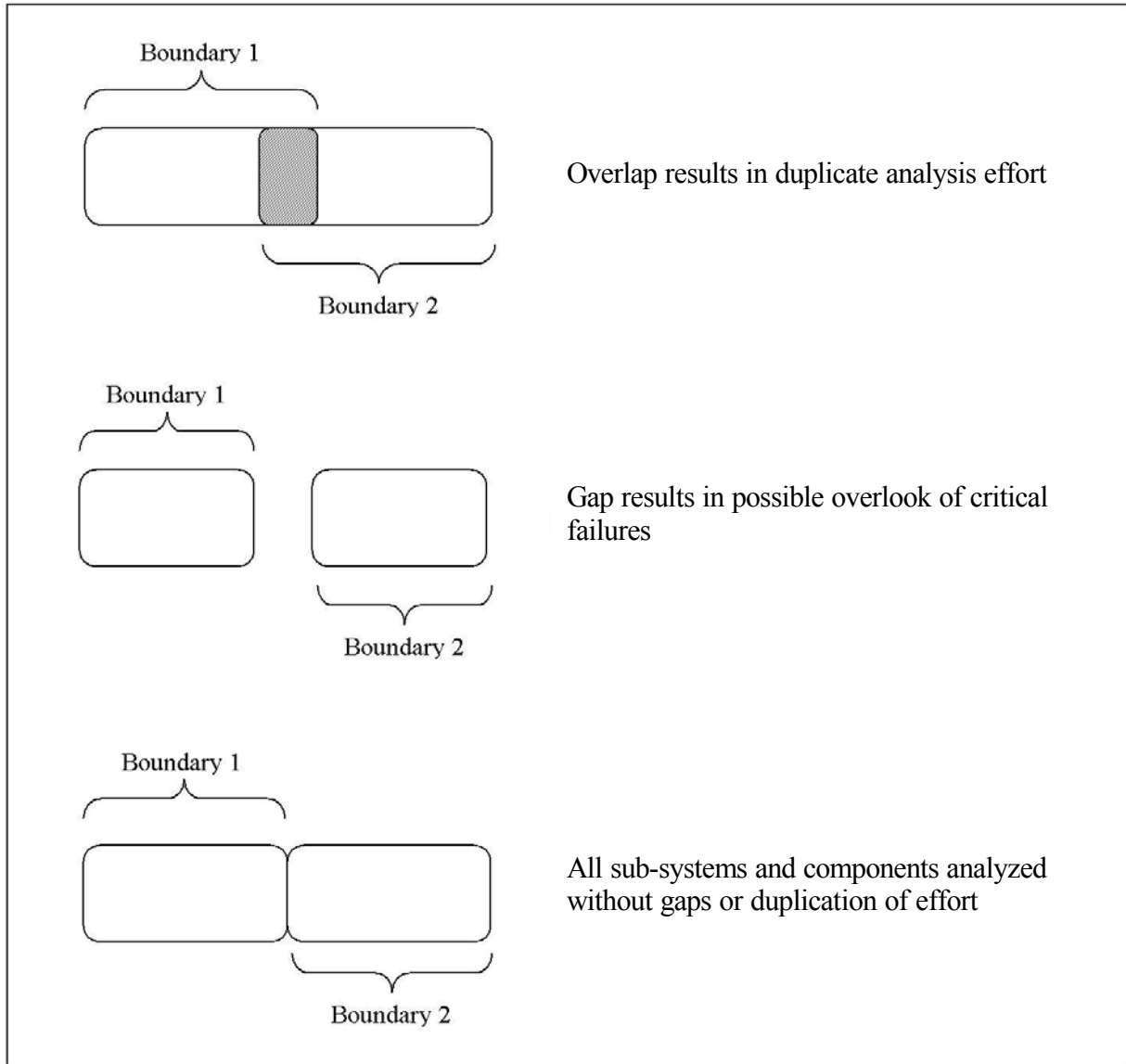


FIGURE 2. Partition boundary considerations.

In general, an analysis performed at too high a level tends to omit important functions, which causes the failure modes that impact those functions to be overlooked. This often results in gaps in the maintenance program. An analysis performed at too low a level makes it difficult to identify meaningful functions and associated performance standards. This complicates the analysis process and often results in the identification of trivial failure modes and unnecessary maintenance actions. Careful thought should be put into deciding what the optimal level is for the performance of the RCM analysis such that the number of failure modes that will be identified and the assessment of their consequences and required actions are manageable.

The ESWBS and/or the Hierarchical Structure Codes (HSC) provide a method to integrate design, configuration, and logistics standard coding of the breakdown structure for aircraft carriers, submarines, surface combatants, and associated ship systems. ESWBS provides an indented listing of all ships systems, subsystems, and components with the highest level of indenture defined along major functional lines (see table I and table II). Figure 3 illustrates a typical ESWBS breakdown.

TABLE I. ESWBS functional groups.

ESWBS group number	Functional group nomenclature
100	Hull structure group
200	Propulsion plant group
300	Electrical plant group
400	Command and surveillance group
500	Auxiliary group
600	Outfit and furnishings, general
700	Armament group
800	Integration/engineering

Successive levels of indenture break each major functional group into major sub-groups (ESWBS Level II), systems (Level III), and subsystem/component boundaries (Level IV and lower).

TABLE II. Example ESWBS breakdown.

ESWBS indenture level	ESWBS number	ESWBS nomenclature
Level I	400	Command and surveillance, general
Level II	440	Exterior communications
Level III	441	Radio systems
Level IV	4413	T-1322()/SRC Communications Transmitter
Level V	44131	AM-6675/URT Amplifier

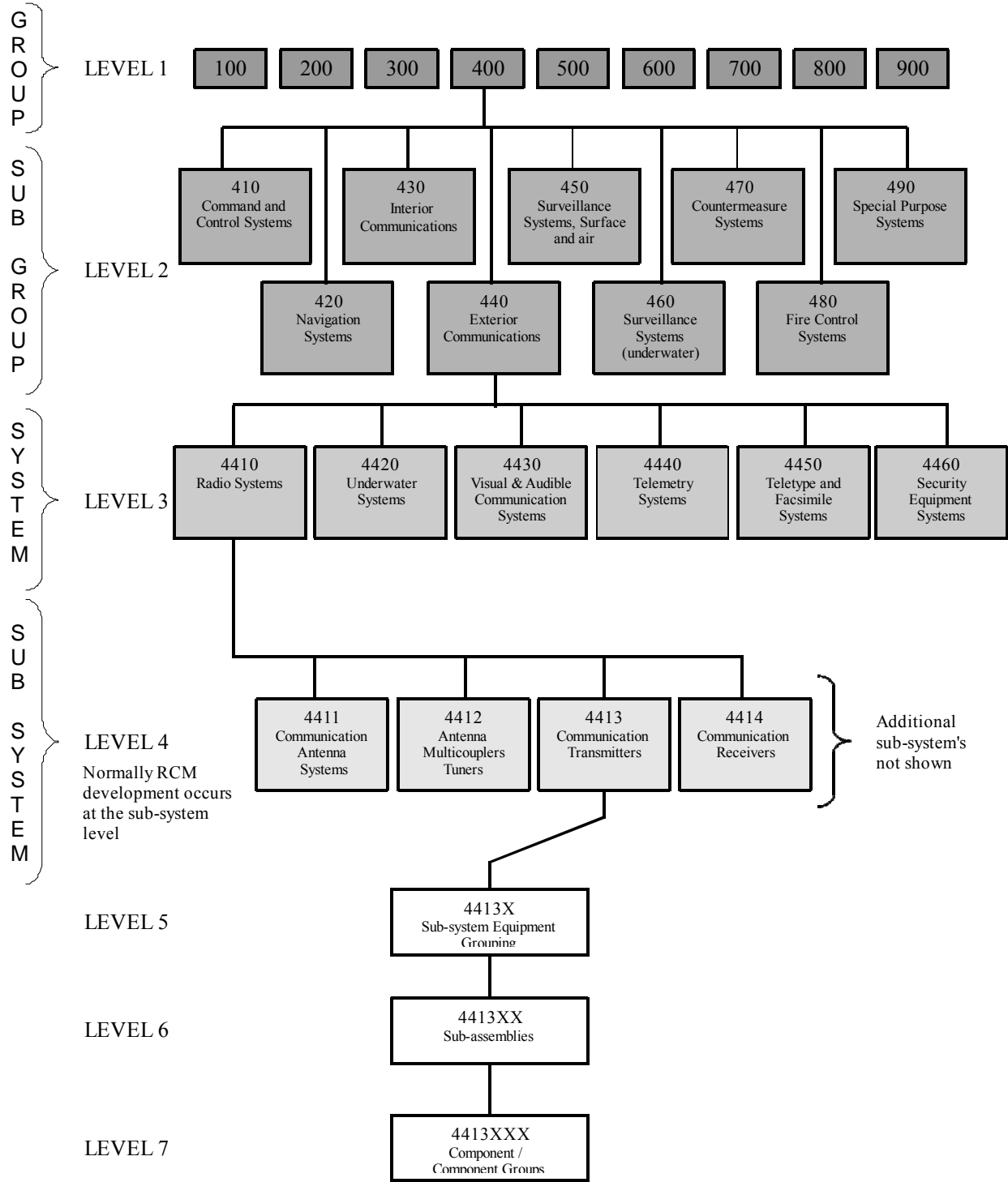


FIGURE 3. Illustrated ESWBS breakdown.

5.1.1.1 Level of development. RCM analysis should take place at a level that makes the identification of functions, failure modes, consequences and actions meaningful and manageable. This standard is typically met when the indenture level assigned for a development focuses on a single equipment procurement subsystem as defined by the Hierarchical Structure Code (HSC)/Functional Group Code (FGC) and will be referred to throughout this publication as ESWBS (ESWBS group level 4). Assignment for development at ESWBS group levels above 4 (1, 2, or 3) typically results in boundaries that are too complex to manage all the associated functions, failure modes, and actions adequately. Only on rare occasions should analysis occur at ESWBS indenture level 3 or above without further indenturing within the Master Systems and Subsystems Index (MSSI) (i.e., indenture level 4 or below). Once ESWBS group 4 is reached on the MSSI, indenturing more than one (or in some cases, two) more levels rapidly results in analysis at too low a level as discussed earlier. For indenturing past the system level (ESWBS indenture level 4) the hierarchical structure of the ESWBS is abandoned in favor of a hierarchical structure unique to the development (see table III).

Maintenance is typically developed for an entire subsystem.

TABLE III. Partitioning example of two subsystem equipment groupings.

ESWBS manual	Nomenclature	Development hierarchy
100	Major functional group	100
120	Functional subgroup	120
123	System functional group	123
1234	Subsystem	1234
1234X	Subsystem Equipment Group (A)	1234A
	Sub-assembly	1234AA
	Component	1234AAA
1234X	Subsystem Equipment Group (B)	1234B
	Sub-assembly	1234BA
	Component	1234BAA

5.1.1.2 Documenting analysis boundaries and subdivisions. Boundary documentation consists of the Functional Block Diagram (FBD) and the MSSI. The developer shall secure or prepare a FBD encompassing the entire assigned development boundary. The MSSI documents the development hierarchical breakdown approach used to identify the system functional group, the assigned subsystem boundaries, and relationships to lower indentured equipment, assemblies and components. Along with the FBD, the MSSI identifies the highest indenture level that the analysis will include. Items found higher in the hierarchical structure or on other legs of the hierarchical structure are either not being analyzed or the documentation for their analysis is contained within the boundaries identified by the MSSI and FBD for a different assignment.

When the developer(s) decides to subdivide the assigned indenture level into smaller subsystems, the MSSI is expanded to document the hierarchical approach used to subdivide the subsystem. In addition, each new indenture level shall have a FBD that identifies its boundaries in relation to the subsystem. Each of the subdivisions is, by definition, an indenture level of the assigned development. Each of the identified indenture levels shall be analyzed separately during the RCM process. Unique failure modes shall be analyzed at the lowest indenture level where they occur (e.g., for a fluid flow system, the pumps are also defined as their own level of indenture. While pumps are part of the higher system, items unique to the pump are only addressed once at the pump level analysis. The system level will then address everything except the failure modes for the pumps which have already been covered at the lower level).

Determining level of partitioning and detail should be agreed upon with the MCA prior to finalizing the block diagram layout.

5.1.1.3 Functional block diagrams (DI-SESS-80994A). The format of the functional block diagram shall be orderly but unrestrictive. When approved by the Maintenance Coordinating Activity, system schematics or line drawings reproduced from appropriate technical manuals or ship information books may be used with applicable additions and annotations.

The FBD shall display all components of the subsystem, their functional relationships to one another, and in and out interfaces with other subsystems. Generally, some components of a subsystem, although identified separately, may actually be grouped together to form higher assemblies. Assemblies may be appropriately labeled as a single box on the functional block diagram. Label components and assemblies in the subsystem by their common name, including generic name, MK, MOD, and AN nomenclature or other identifier. Hardware such as switchboards or valve manifolds, that are not actually part of the system under analysis, may be included to simplify the diagram and to enhance meaningfulness. Such hardware may be identified by descriptor or nomenclature including assigned ESWBS number.

The components and assemblies of a subsystem are connected to each other and interface with other subsystems through electrical, fluid, gas, or mechanical linkages. Linkages on the functional block diagram shall be shown as heavy lines. Each connection shall identify the connection and the normal parameter value or range of values. In addition to parameter labels, interface connections shall be labeled with the ESWBS number of the system, subsystem or equipment from which the connection originates or which receives the out interfaces. Flow directional arrows shall be required on connection lines.

5.1.1.4 Completing MSSSI data collection (DI-SESS-80979A/figure A-1).

- a. Block 1 – ESWBS group number. Enter the ESWBS group level 1 number, a three-digit number containing two zeros.
- b. Block 2 – Group nomenclature. Enter the associated group nomenclature.
- c. Block 3 – Ship class. Enter the ship class and the hull number on which the analysis is based.
- d. Block 4 – Prepared by. Enter the analyst's name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer's name and the date.
- f. Block 6 – Approved by. Reserved for maintenance coordinating activity approval signature and date.
- g. Block 7 – Revision. Enter ORIGINAL, or A, B, or C, sequentially, and the date.
- h. Block 8 – ESWBS subgroup/system/subsystem number. Enter a number identifying each subdivision through ESWBS level 4. If the level 4 ESWBS number cannot uniquely identify the subsystem specified for development or the developer wishes to further divide the subsystem to enhance development add a suffix character to the level 4 ESWBS to create a development specific hierarchical structure.
- i. Block 9 – Subgroup/system/subsystem nomenclature. Enter the nomenclature of each ESWBS subdivision identified.
- j. Block 10 – Serial number. Enter a serial number for this form as follows:
 - (1) Segment 1 – enter the developing organization abbreviation, followed by a slant (/).
 - (2) Segment 2 – for developers, enter the development authorization number, followed by a slant (/); for other development activities, assign a development number followed by a slant (/).
 - (3) Segment 3 – enter the number 114 to indicate the MSSSI form, followed by a slant (/).
 - (4) Segment 4 – enter the highest indenture level ESWBS for the development group assigned. If an entire group is assigned, this number is a level 1 ESWBS number – a three-digit number containing two zeros; for example, “100”, “200”.

5.1.1.5 Submission to MCA. Upon completion of Phase 1 the developer will submit the FBD and MSSSI to the MCA for approval with consideration to the following:

- a. Boundaries appropriate for the analysis
- b. Approach for subdividing within the assigned boundary

- (1) Single indenture for subsystem level
- (2) Multiple indentures at both the subsystem and subsystem equipment/component levels.

c. Adequacy of the associated Functional Block Diagram(s).

5.1.2 Phase 2 – Functional failure analysis (FFA). Following approval of Phase 1 and at the direction of the maintenance coordinating activity, the developer shall perform an FFA at the same and lower level of subsystem being analyzed as defined by the MSSSI.

5.1.2.1 Purpose of the FFA. The FFA is performed to determine and to document:

a. A functional description of the system/subsystem including protective features, installed monitoring and testing devices, redundancy provided, and any other information associated with the maintenance needs of the system and visibility of failures.

b. The specific functions of the system

c. The interfaces of the system/subsystem with other systems

d. The functional failures of the system/subsystem.

5.1.2.2 FFA preparation guidelines. One FFA shall be required for each indenture level identified in Phase 1 and listed on the MSSSI. If a subsystem is simple, only a single FFA shall be required. The FFA, when completed, shall describe the characteristics of the subsystem that must be considered for potential preventive maintenance tasks. If the MSSSI identifies multiple subsystem equipment groupings (i.e., multiple indenture levels); an FFA shall be completed for each subsystem equipment grouping.

The functional block diagrams from Phase 1, technical manuals, and other pertinent references shall be used as the basis for the FFA.

5.1.2.2.1 FFA information gathering. FFA information gathering should focus on what the equipment does at the specific indenture level addressing the installed configuration and required applications. The description should be developed in conjunction with a thorough investigation of equipment requirements. The discovery process should provide the developer with a detailed understanding of the equipment including:

a. How the equipment is installed and how the installation may affect reliability.

b. How the equipment is to be used.

c. Design features of the equipment which improves reliability, safety, or maintainability.

d. Identify design parameters such as set-points and tolerances.

Special attention should be given to discovering things about the equipment that could influence the decision process for maintenance development.

Investigate if some degree of redundancy has been designed into the subsystem. Redundancy exists when the function in question can be obtained in the same quality and quantity following functional failure. Redundancy provides increased system availability. Redundancy is evaluated within the boundaries of the FFA.

5.1.2.2.2 **Functions.** Maintenance is intended to preserve the required functions of a subsystem. A fundamental step, therefore, is to ensure that all functions of the subsystem are identified, and documented. A subsystem may provide a function by providing information, providing flow and pressure of a fluid, or converting stored energy to motion. Functions of this type are called “active functions” because they provide a commodity or stimulus as an output. Loss or degradation of that activity is a functional failure. A subsystem may also provide a function by not doing something actively, such as a tank holding fluid. Functions of this type are called “passive functions” because they are inactive. An event such as a leak in the tank is a functional failure. When a function fails, alarms or performance of the system may alert the operating crew immediately that the function has been lost. This type of function is called an evident or visible function since its loss is visible to the crew. Functions that give no immediate indication that they have failed are called hidden functions. *Hidden functions may require a special procedure to determine if the function is available.* In a combatant ship, some systems are infrequently used (e.g., missile launcher, oxygen breathing apparatus). The functions of these infrequently used systems are hidden functions. Some systems have co-functions, which are functions that are physically or environmentally closely associated. Failures in one function will adversely affect other functions, even though these functions are normally independent. All functions of the system shall be determined and documented. Document all functions of the subsystem including:

- a. Functions of safety and protective devices.
- b. Required outputs of the subsystem (primary functions).
- c. Any secondary functional requirements of the subsystem such as:
 - (1) Environmental integrity (threat to environment)
 - (2) Structural integrity (structurally significant items)
 - (3) Containment

5.1.2.2.3 **Interfaces.** Subsystems usually receive input from other subsystems and provide output to other subsystems. Loss of input can cause failure in the subsystem and loss of output can cause failure in other subsystems. Subsystem interfaces are addressed separately in the FFA process because they are easily overlooked and vary widely for different configurations of the same basic subsystem. “In” interfaces shall be assumed available. “Out” interfaces shall be identified as functions.

5.1.2.2.4 **Functional failures.** A functional failure exists when a system or subsystem ceases to provide a required function; whether the function is active, passive, evident, or hidden. The definition of what constitutes a failure is of primary importance. Whenever a failure is defined by some level of performance, condition, or dimension, the appropriate standards must be stated to provide the basis for establishing whether a failure has occurred. Where applicable, these definitions of failures in terms of system parameters or performance standards are required. When defining functional failures or functions provided by redundant items, the failure shall be clearly defined as a failure of all redundant items.

5.1.2.2.5 **Documenting the functional failure analysis (DI-SESS-80981A/figure A-2).** The FFA data/form shall comprise the following:

- a. Block 1 – ESWBS number. Duplicate the relevant entry from the MSSSI form, block 8.
- b. Block 2 – Nomenclature. Enter the nomenclature used on the MSSSI form, block 9, for the selected system or subsystem.
- c. Block 3 – Ship class. Duplicate the entries on the MSSSI form, block 3.
- d. Block 4 – Prepared by. Enter the analyst’s name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer’s name and the date.
- f. Block 6 – Approved by. Reserved for maintenance coordinating activity.
- g. Block 7 – Revision. Enter ORIGINAL, or A, B, or C, sequentially, and the date.
- h. Block 8 – Sources of information. Enter the drawing, manual, document, and report numbers. Enter titles of reference material used in this analysis.

i. Block 9 – Description. Referring to the Functional Block Diagram prepared in Phase 1, enter a brief physical and functional description of the subdivision. Focus on what the hardware is and how it functions, oriented toward preventive maintenance needs. After this narrative, document the following specific information about the system, using the format below (parenthetical statements describe the information to be documented):

- (1) Redundancy: Enter none or describe the redundant relationship.
- (2) Protective devices: List the protective devices and the circumstances under which they operate; for example, “Circuit breaker – 30 AMP”, “Casing relief valve – lifts at 150 pounds per square inch (1b/in²), reseats at 135 (1b/in²).”
- (3) Safety features: Describe special safety features such as interlocks.
- (4) Fail safe or unsafe features: State whether system is fail safe or unsafe; describe any fail safe features.
- (5) Condition indicators: Document type, indicates, and to whom in a single group for each indicator.
 - (a) Type: Enter gage, thermometer, meter, bite, indicator light, audible visual alarms, as appropriate.
 - (b) Indicates: Describe what the indicator tells about the system.
 - (c) To whom: List the watch station or the title of the operator who observes the indicator. Specify the conditions when that station is manned.
- (6) Environment: Describe the environment to which the system is exposed; for example, “Exposed to weather”, “Exposed to high humidity”, “Exposed to high heat”, or other.
- (7) Duty cycle: Describe the particulars of normal operational practices and estimated operational time per year. For example, “The system is normally on line when underway and is automatically controlled.” “Air compressors cycle on and off under control of associated receiver pressure switches. Compressors run about 250 hours per year, depending on demand.”
- (8) Use restrictions: Enter any special restrictions on the operation of the system; for example, “Cannot be safely activated in port.”
- (9) Special maintenance features: Describe any special provisions for maintenance installed; for example, “System is equipped with external test connections enabling full diagnostic while on line.”
- (10) Regulatory: Enter any regulations (Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), etc.) requiring maintenance tasks.

j. Block 10 – Functions and out interfaces. Enter a description of functions of the system. Include safety, regulatory, and protective features, out interfaces and all co-functions. State function minimum operational parameters or performance standards if appropriate. Number functions sequentially; for example, “1.0”, “2.0”, and “3.0”.

k. Block 11 – System in interfaces. Enter sources of input and critical values. Specify the ESWBS number for each source.

l. Block 12 – Functional failures. Enter the definition of what constitutes a failure for each function and output interface listed in block 10. There may be several functional failures for each function; all functional failures must be identified. Number each functional failure e.g., 1.1, 1.2, 1.3; 2.1, 2.2, and 2.3, to correspond to the function number in block 10.

m. Block 13 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – see 5.1.1.4.j (1).
- (2) Segment 2 – see 5.1.1.4.j (2).
- (3) Segment 3 – enter the number 116, indicating the FFA Form followed by a slant (/).
- (4) Segment 4 – enter the ESWBS number from block 1.

5.1.3 Phase 3 – Additional functionally significant item selection (AFSI). Items listed on the MSSSI are FSIs. Additional FSIs may be selected by this analysis. The AFSI selection process identifies items other than the entire system or subsystem that merit separate analysis because of their importance or complexity. This process determines and documents a brief description of the candidate FSIs similar to that prepared in subsystem and lower indented level FFAs. The functions and functional failures of the FSI are determined and list specifying values of parameters or performance standards where applicable. A series of yes or no questions, based on the analyst's judgment of the FSI in question, are used to determine the validity of the analyst's decision. Equipment and repairable or replaceable assemblies are potential candidates. In the case of simple subsystems, it is sometimes practical to consider an entire subsystem as the only FSI. Ultimately, an FMEA will be required for each FSI. Functionally significant items should be selected at such a level that the FMEA is meaningful and simple. The developer shall prepare the additional FSI selection forms for items considered to be candidates for selection as additional FSIs. Careful review of the system block diagram is required to determine which of the following approaches will be used.

- a. A single FSI for the entire subsystem.
- b. Functionally significant items assigned at subsystem and equipment grouping level but not to equipment sub-assemblies.
- c. Functionally significant items can sometimes be assigned at sub-assembly level and subsystem levels. This approach permits "hybrid" solutions; for example, relatively few subsystem equipment groupings may be considered for selection as additional FSIs. The functions and failures of items not selected as additional FSIs are considered in the analysis of the related subsystem.

5.1.3.1 Beginning development at Phase 3. The maintenance coordinating activity may authorize development to begin at Phase 3. Beginning development at Phase 3 is advantageous when alterations are installed on an existing subsystem, current subsystems or equipment is repurposed, or the subsystem or equipment is a self contained unit. Functionally significant items that may have been overlooked in the FBD or FFA, such as filters, may be designated for beginning analysis at Phase 3.

5.1.3.2 Completing the AFSI selection form (DI-SESS-80983A/figure A-3). When an AFSI is required, the AFSI data/form shall be completed as follows:

- a. Block 1 – ESWBS number. Enter the ESWBS number for the FSI candidate. If the candidate is below level 4 and does not have a unique ESWBS number, add a suffix character to the level 4 ESWBS number and use this throughout the analysis.
- b. Block 2 – Nomenclature FSI candidate. Enter the nomenclature of the FSI candidate. Nomenclature without military designation should include CAGE code, part number, and proper name as extracted from drawings or technical manual.
- c. Block 3 – Ship class. Duplicate the entries on the MSSSI form block 3.
- d. Block 4 – Prepared by, block 5 – Reviewed by, block 6 – Approved by, and block 7 – Revision. See instructions for MSSSI 5.1.1.4.
- e. Block 8 – Description. Enter a brief functional description of this item keyed to its maintenance needs and provisions for maintenance. After this narrative document the following specific information about the system:
 - (1) Redundancy: Enter NONE or describe a redundant relationship.
 - (2) Interfaces: Enter sources of input and critical values. Specify the ESWBS number for each source.
 - (3) Built In Test Equipment (BITE): Enter NONE or describe the BITE.
 - (4) Regulatory: Enter any regulations (EPA, OSHA, etc.) requiring maintenance tasks, if not addressed at higher partitioned level. Enter NONE or briefly describe the regulations that apply.
 - (5) Indicators: Document indication, to whom, and conditions when observed.
 - (a) Indication: Describe what the indicator tells about the system.
 - (b) To whom: List the watch station or the title of the operator who observes the indicator.
 - (c) Observed: Specify the conditions when the watch station is manned or the indication is observed.

- f. Block 9 – Location. Enter the compartment numbers of spaces where this item is located.
 - g. Block 10 – Quantity. Enter the quantity of items installed in this system.
 - h. Block 11 – Function(s). Enter a description of functions of the system. Include safety, regulatory, and protective features, out interfaces and all co-functions. State function minimum operational parameters or performance standards if appropriate. Number functions sequentially; for example, “1.0”, “2.0”, and “3.0”. Under the impact column, block 11a, enter a yes or no in answer to the question, “Are any of these functions necessary for safety, mobility, or mission?”
 - i. Block 12 – Functional failures. Enter the definition of the failure for each of the functions listed in block 11. Number each 1.1, 1.2, 1.3, 2.1, 2.2, and 2.3 corresponding to the appropriate function. Under the impact column, block 12a, enter a yes or no in answer to the question, “Do any of these failures have a direct adverse impact on safety?”
 - j. Block 13 – Reliability.
 - (1) Enter data for estimated corrective maintenance rate. This data may be mean time between failures (MTBF), requisitions, technical feedback reports, or other data showing a corrective maintenance trend.
 - (2) Block 13a: Under the Impact column, block 13a, enter a yes or no in answer to the question, “Is the estimated corrective maintenance rate greater than 1 per year?”
 - k. Block 14 – Cost. Under the Impact column, block 14a, enter a yes or no in answer to the question, “Is this item’s purchase cost greater than \$5,000?”
 - l. Block 15 – Functionally Significant Item (FSI)? If there is a yes in the impact column for any block (11a through 14a), then this item is an FSI. Enter yes and designate this item for further analysis via FMEA.
 - m. Block 16 – Serial number. Enter a four-segment serial number as follows:
 - (1) Segment 1 – see 5.1.1.4.j (1).
 - (2) Segment 2 – see 5.1.1.4.j (2).
 - (3) Segment 3 – enter the number 117, indicating the additional FSI selection form, followed by a slant (/).
 - (4) Segment 4 – enter the ESWBS number from block 1.
- 5.1.3.3 Completing the FSI index form (DI-SESS-80982A/figure A-3A). The FSI Index form will be completed as follows:
- a. Block 1 – System/subsystem ESWBS number. Enter the highest level ESWBS number to be covered by the index.
 - b. Block 2 – System/subsystem nomenclature. Enter the associated system/subsystem nomenclature for the ESWBS number specified in block 1.
 - c. Block 3 – Ship class. Enter the ship class and hull number to which the analysis applies.
 - d. Block 4 – Prepared by, block 5 – Reviewed by, block 6 – Approved by, block 7 – Revision. See instructions MSSI form.
 - e. Block 8 – ESWBS number. Duplicate the entry on each FFA form, block 1, and each Additional FSI Selection form, block 1 that had a “YES” in block 15.
 - f. Block 9 – Nomenclature. Duplicate the entry on each FFA form, block 2, or Additional FSI Selection form, block 2.
 - g. Block 10 – Location. Duplicate the entries in block 9 of the Additional FSI Selection form for the item (Equipment only).
 - h. Block 11 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – see 5.1.1.4.j (1).
- (2) Segment 2 – see 5.1.1.4.j (2).
- (3) Segment 3 – enter the number 118, indicating the FSI index form, followed by a slant (/).
- (4) Segment 4 – enter the ESWBS number from block 1.

5.1.4 Phase 4 – Failure modes and effects analysis (FMEA). Upon direction from the MCA, the developer shall perform an FMEA and complete the FMEA data/form for each FSI identified and approved on the FSI index. An FMEA shall be required to determine the basic information needed for applying the decision logic. The specific purpose of the FMEA is to determine the dominant failure modes and to determine the effects of each failure mode on the item where it occurs and on higher levels. Analysts should initiate an FMEA at the lowest levels first such that identified failure modes do not have to be repeated at a higher indenture level analysis.

5.1.4.1 Failure modes. Failure modes should be written such that they describe the state of the failure with enough detail to enable further decision making to take place. At the very least, a failure mode should contain a subject of the failure (noun) and a description of what has happened to the item, expressed as either an adjective or a verb. Care should be taken to choose descriptions which accurately reflect the expected failure. For example, a “failed pipe” can be more accurately described as a “corroded pipe” or a “cracked pipe”. Either “corrosion” or “cracks” (or both) may result in failure of a piping system; however each has different causation and requires different maintenance strategies.

A failure mode should give enough information about the problem to enable the analyst to pick the appropriate maintenance strategy during the logic tree analysis. If a simple subject/modifier failure mode is inadequate to describe the failure, more detail should be added as necessary (i.e., does the item fail “open” or “closed”). Additionally, more detail may be required if the failure can happen in a multiple of ways (e.g., “valve sticks closed due to corroded seats” vice “valve sticks closed because of salt buildup on valve stem”). Each of these failure modes may be valid for a given valve type but which failure is going to occur is dependent on what type of system the valve is installed in and what operating and environmental conditions the valve experiences. There may be some systems where both failures are valid. However, the maintenance actions chosen to address one failure may be different from those chosen to address the other. It is up to the analyst to decide the level of detail required to adequately describe the failure mode such that subsequent phases of the process can be completed without having to “refine” the description and its understanding. Care should be taken to avoid adding complexity that could cause the RCM process to take longer than is necessary.

5.1.4.2 Failure effects. Each of the failure modes documented for the system shall be analyzed to determine its failure effects. Failure effects describe what happens when a failure mode occurs if no other action is taken to otherwise address the failure. The description of the failure effects provides all the information the analyst needs in later phases to determine the consequences of the failure and to aid in the decision making process as to what actions must or should be taken and how good those actions are at reducing the impact of the failure.

In order to ensure the analyst does not fixate on one area of effects (for example, organizational level impact), the effects shall be described starting at the point of the failure mode and continuing up through the levels of subsystem and system to the end effect on the ship or mission. The description of “what happens” (effects) at each level should include as appropriate:

- a. What hazards are posed to operators, other nearby personnel, or the environment?
- b. What damage is caused to other equipment as a direct result of the failure or as an indirect result of the loss function?
- c. What is the extent of the effect on operations at both the equipment level and at the organization level?

5.1.4.3 Dominant failures. Only those failures deemed to be “dominant” by the analyst need to be listed as part of the FMEA. Dominant failure modes are those failures which, in the view of the analyst, are important because of the frequency of their occurrence or because of the seriousness of their consequences. By concentrating on “dominant failure modes” the FMEA provides a means to filter out unimportant or unlikely failure modes. Only the dominant failure modes listed on the FMEA and marked for transfer shall be subjected to further analysis to determine appropriate maintenance actions. When considering dominant failure modes, consider what is likely to cause equipment failure during its life cycle.

5.1.4.4 Documenting the failure modes and effects analysis (DI-SESS-80980A/figure A-4). The FMEA data/form shall be completed as follows:

- a. Block 1 – ESWBS number. Duplicate entry from the FFA form, block 1.
- b. Block 2 – Nomenclature. Duplicate entry from FFA form, block 2.
- c. Block 3 – Ship class. Duplicate the entry from FFA form, block 3.
- d. Block 4 – Prepared by. Enter the analyst’s name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer’s name and the date.
- f. Block 6 – Approved by. Reserved for maintenance coordinating activity.
- g. Block 7 – Revision. See instructions for MSSSI form in 5.1.1.4.
- h. Block 8 – Function(s). Duplicate entries from the FFA form, block 10, or the additional FSI selection form, block 11.
- i. Block 9 – Functional failures. Duplicate entries from FFA form, block 12, or additional FSI selection form, block 12, as applicable.
- j. Block 10 – Dominant failure modes. Enter the dominant failure mode for each functional failure. Number sequentially to correspond to the appropriate functional failure and function; for example, “1.1a”, “1.1b”, “1.2a”. Failure modes should be identified at the level at which the analysis is made. If there are no dominant failure modes, enter “None”.
- k. Block 11 – Failure effects (local, subsystem, end effect). Enter the details of the effects of each failure mode on the FSI where the failure mode occurs; at local (point of failure), subsystem, and the end effect (ship or mission). If the failure mode has no effect on a particular level, enter “none” in the appropriate column. If the particulars of the effects are such that a safety hazard or reduction in mission capability results, indicate (for example):
 - (1) Safety hazard to operators.
 - (2) Safety hazard to personnel in vicinity.
 - (3) Partial loss of capability to detect and track surface contacts with radar.
 - (4) Total loss of mobility capability.
 - (5) Threat to environment.
 - (6) Violation of regulatory requirement.
 - (7) If the details of the effects are such that only a redundant item is lost, indicate using the phrase, “loss of redundancy”.
- l. Block 12 – Transfer (yes or no). Enter “yes” if the failure mode indicates further analysis should take place. If the failure mode has insignificant effects, or it is unlikely to occur during the lifecycle of the equipment, enter “no” and provide rationale for this decision on clearly labeled backup sheets. For failure modes of redundant items, the likelihood of failure of redundant items must be considered. The MCA shall scrutinize this area during the review process. Justification and rationale is not required for a “yes” answer.
- m. Block 13 – Serial number. Enter a four-segment serial number as follows:
 - (1) Segment 1 – see 5.1.1.4.j (1).
 - (2) Segment 2 – see 5.1.1.4.j (2).
 - (3) Segment 3 – enter the number 119, indicating the FMEA form, followed by a slant (/).
 - (4) Segment 4 – enter the ESWBS number for the item.

5.1.5 Phase 5 – Decision logic tree analysis (LTA) (figure 4). The decision logic tree analysis (LTA) (see figure 4) is a series of yes or no questions that assist the analyst in determining the need for and availability of applicable and effective preventive maintenance tasks. When there is no appropriate task that is both applicable and effective at preventing the failure the decision logic tree directs secondary failure management policies (actions) that are appropriate to risk associated with the failure. The analysis of servicing and lubrication task requirements (see 3.20.7) will be addressed in Phase 6.

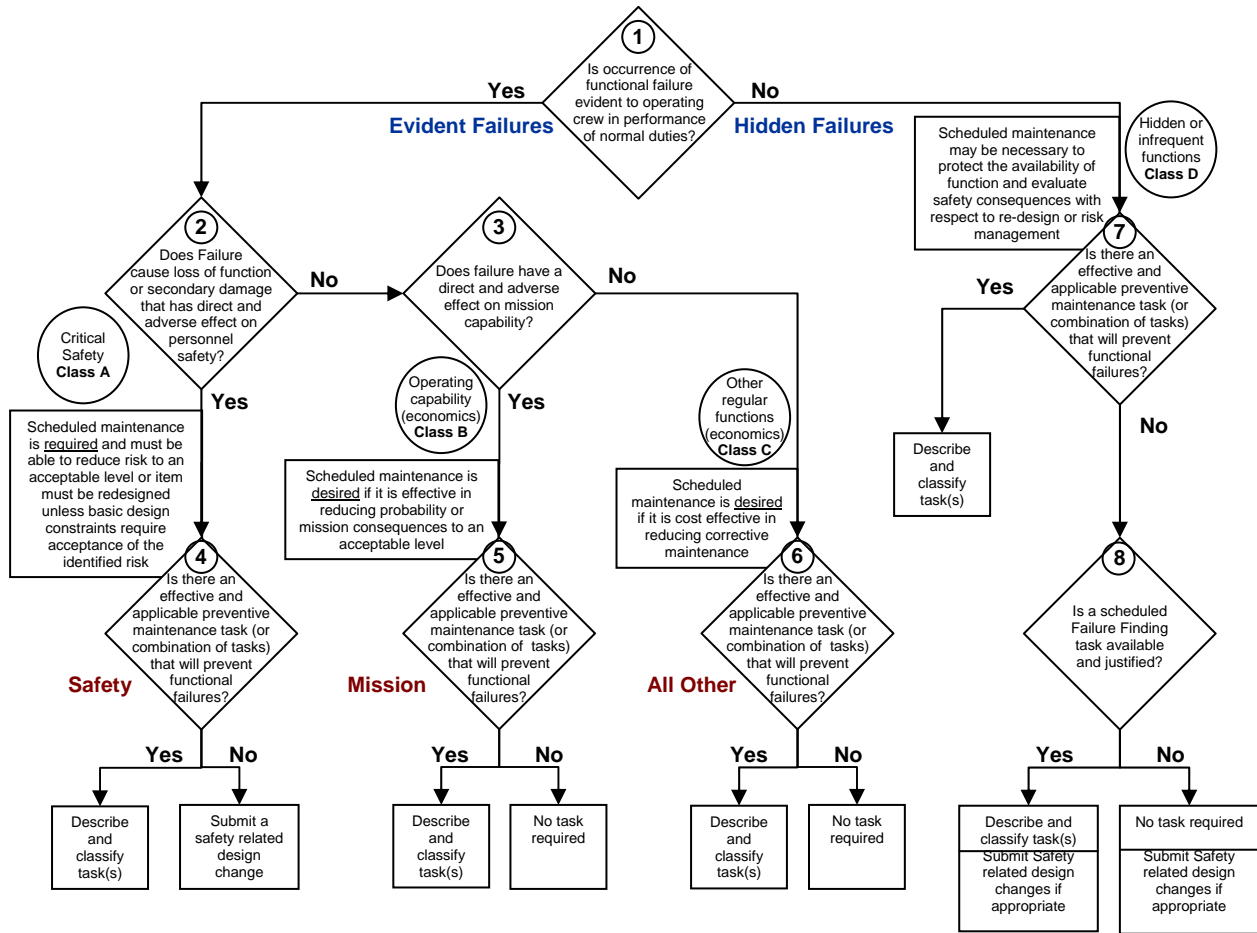


FIGURE 4. RCM decision logic tree.

5.1.5.1 RCM decision logic tree question 1. Is the loss of function (functional failure) evident to the operating crew during the performance of the crew’s routine duties? This separates the functional failures into two groups:

- a. Those functional failures which are evident to the crew during routine duties. The functions in this group are those that are operated either continuously or so often that the crew knows whether a loss of function (functional failure) has occurred.

If question 1 is answered “yes”, the analyst must provide rationale and justification as to how the functional failure is evident. This information must include:

- (1) What evidence of failure is observed?
- (2) Who observes the evidence?
- (3) What part of the observer’s routine duties places them in a position to observe the evidence?

b. Those functional failures which are hidden from the crew until the function is actually demanded of this item. Functions in this group are those used intermittently or infrequently so that the crew does not know whether a functional failure has occurred without some special check or test, or those that are not detectable until after another failure. For example, a failed-shut relief valve that cannot be discovered by the crew until over-pressurization damages another item in the system. If an applicable and effective preventive task is available for either failure, it will be used. However, if no task is available that will prevent the hidden failure, a specific task to find the failure may be necessary to tell the crew that restoration of the function is needed and to improve the probability that the function of the item will be available when needed.

If question 1 is answered “no”, the analyst must provide rationale and justification as to why the functional failure is hidden (not evident) from the operators during the performance of their routine duties.

5.1.5.2 RCM decision logic tree question 2. Does the failure cause a loss of function or secondary damage that has a direct and adverse effect on personnel safety? This questions requires the analyst to evaluate each failure mode and its effects (as documented on the FMEA) to determine if the failure mode has any direct or secondary damage caused by the failure mode or the loss of function caused by the failure mode. Closely investigate if any adverse effect on the safety of operators or other nearby individuals could occur. In the case of safety and protective devices, the analyst is allowed to consider the effects of a secondary failure that would require the device to operate. This question separates the evident failures into two groups:

a. Those that directly affect personnel safety. The functional failures in this group are the evident failure modes of any system which impact safety by their occurrence and the evident failures of safety equipment.

If the answer to question 2 is “yes” the analyst must provide rationale and justification describing the particulars of the threat to life, limb or health caused as a direct result of the failure.

b. Those that do not affect personnel safety. Functional failures in this group may have an impact on the capability of the ship to perform its mission or support functions.

If the answer to question 2 is “no”, rationale and justification are not required.

5.1.5.3 RCM decision logic tree question 3. Does the failure cause a loss of function or secondary damage that has a direct and adverse effect on required mission capabilities? This question requires the analyst to evaluate each failure mode and its effects (as documented on the FMEA) to determine if the failure mode itself, any direct or secondary damage caused by the failure mode or the loss of function caused by the failure mode, has a direct and adverse effect on the ability of the organization to carry out its assigned military function. This question separates the evident, non-safety-related failures into two groups:

a. Those which affect the ability of the ship to perform its military functions.

(1) If the answer to question 3 is “yes”, the analyst must provide rationale and justification describing the operationally critical functions that are degraded by the failure.

b. Those that affect non mission-related capabilities of the ship.

(1) If the answer to question 3 is “no”, rationale and justification are not required.

5.1.5.4 RCM decision logic tree questions 4, 5, 6, and 7. Is there an applicable and effective preventive task (or combination of tasks) that will prevent the functional failure? This question is asked about the dominant failure modes and separates them into two groups:

a. Those for which an applicable and effective preventive maintenance task (or tasks) can be specified.

b. Those for which there is no applicable and effective task.

Although this same question is asked in each of the four branches, the answer depends on the consequence of the failure.

5.1.5.4.1 Applicability. A task or group of tasks is applicable if, and only if, the task really does prevent, discover, or reduce the impact of the failure mode in question. Within question 4, 5, 6, and 7, there are two types of tasks that prevent or reduce failures:

a. Condition-directed (CD) tasks. These tasks are preferred over time-directed tasks because re-work, cleaning, or replacement tasks are not performed unless directed by the hardware condition. CD tasks are periodic tests or inspections to compare the existing conditions or performance of an item with established standards to determine the need for a follow-on renewal, restoration or repair to prevent the loss of function. For a CD task to be applicable, the occurrence of a specific failure mode must be preceded by a reduction in resistance to failure that is detectable sufficiently in advance of actual failure so that appropriate action can be taken to avoid the actual failure. This states that there must be:

(1) A set of conditions that can be clearly defined that indicate failure is about to occur – a potential failure point (P).

(2) A test or inspection that can be performed often enough to determine the occurrence of the potential failure prior to actual failure occurrence.

(3) Enough time must exist such that action can be taken to avoid the failure.

b. Time-directed (TD) tasks. These are tasks of periodic restoration or replacement of an item which is performed before the item reaches an age where the risk of failure is much greater than at earlier ages. For a TD task to be applicable, the item must exhibit an increased risk of failure after some age has been reached. There must be no condition that predicts failure. These criteria state that for the failure mode of concern:

(1) It must be possible to define an age at which the conditional probability of failure increases.

(2) The probability of failure prior to reaching this age is sufficiently low to limit the risk of premature failure to an acceptable level.

(3) The action proposed by the task must restore the item to a probability of failure more acceptable than that at the predicted age.

5.1.5.4.2 Effectiveness. A task that is applicable to a critical failure (Safety, Regulatory, or Mission) can be effective only if it reduces the risk of failure to an acceptable level. All other preventive tasks can be effective only if they are cost effective. The effectiveness of a task must be evaluated separately from applicability because the criteria are different.

5.1.5.5 Rationale and justification for questions 4, 5, 6, and 7. Questions 4, 5, 6, and 7 require the analyst to consider both the applicability and effectiveness of any preventive maintenance task chosen. Therefore, the rationale and justification required for yes or no answers to questions 4, 5, 6, or 7 must address both the applicability and effectiveness of tasks identified.

a. Applicability.

(1) The applicability rationale for CD tasks must describe:

(a) The potential failure. A measurable point prior to failure.

(b) How the chosen task will discover the potential failure condition.

(c) What actions will be taken if the potential failure point has been reached.

(d) How the follow-on actions will enable avoidance of the actual failure.

(2) The applicability rationale for TD tasks must describe:

(a) How the reliability of the item is adversely affected by age.

(b) How the risk of premature failure is acceptably low.

(c) How the chosen task restores the system to its design state of reliability.

b. Effectiveness.

(1) The effectiveness rationale for a critical failure must address how the task reduces the risk of failure to an acceptable level.

(2) The effectiveness rationale for a non-critical failure must address how the task is cost effective, i.e., pays for itself.

5.1.5.6 RCM decision logic tree question 8. Is a scheduled Failure Finding (FF) task available and justified?

This question is asked about hidden functional failures for which no applicable and effective preventive tasks exist. The failure in question here may be safety, regulatory, mission, or economics related. The analyst must determine first if there is an applicable FF task. If there is, the analyst must evaluate the reliability of the item specifically related to this failure mode, the effects of this failure mode remaining undetected until the function is next needed, and the benefits of performing the task. A task should not be specified unless it is both applicable and effective. If the failure mode in question is safety related, a safety related design change recommendation should be identified if no task is available or if the task does not provide sufficient confidence that the safety function will be available when needed. Because of its position in the logic tree and the questions that must be asked and answered before a failure finding task becomes available, the applicability and effectiveness rules for a failure finding task are:

- a. Applicability: The functional failure must be hidden from the crew during the performance of their routine duties.
- b. Effectiveness: Must increase the availability of the affected function to an acceptable level.

5.1.5.7 Maintenance task periodicity. Each maintenance task shall be assigned a periodicity. The periodicity delineates how frequently the maintenance requirement must be performed. The following tables show example periodicity codes. NAVSEAINST 4790.8 (Series) (Ships’ 3-M Manual) contains detailed information on Navy periodicity codes. Selecting the longest period between scheduled maintenance tasks, to ensure a predicted failure will not occur, requires knowledge of component failure and how it occurs as it relates to age and potential failure region. The MCA can provide specific guidance and instruction on the use of periodicity codes, especially the approved list of “R” situational codes.

a. Calendar periodicities

D	-	Daily		Q	-	Quarterly
2D	-	Every 2 days		4M	-	Every 4 months
3D	-	Every 3 days		S	-	Semi-annually
W	-	Weekly		8M	-	Every 8 months
2W	-	Every 2 weeks		9M	-	Every 9 months
M	-	Monthly		A	-	Annually
2M	-	Every 2 months		xM	-	Every x months x = # of months
	-					

b. Non-calendar periodicity

R	-	Situational requirement
U	-	Unscheduled or corrective maintenance
AP		Assessment Procedure

c. Inactive equipment maintenance

LU	-	Lay-up maintenance
PM	-	Periodic maintenance
SU	-	Start-up maintenance
OT	-	Operational test

5.1.5.8 Documenting the RCM decision logic tree analysis (DI-SESS-80984A/figure A-5). The RCM LTA data/form shall be completed as follows:

- a. Block 1 – ESWBS number. Duplicate the entry on the FFA or the Additional FSI Selection form, block 1. (Start a new form for each item.)
- b. Block 2 – Nomenclature. Duplicate the entry on the FFA or Additional FSI Selection form, block 2.
- c. Block 3 – Ship class. Duplicate the entry on the FFA or AFSI form, block 3.
- d. Block 4 – Prepared by. Enter the analyst’s name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer’s name and the date.
- f. Block 6 – Approved by. Reserved for MCA approval signature and date.
- g. Block 7 – Revision. See instructions for the MSSSI form in 5.1.1.4.g.
- h. Block 8 – Functional failure and failure mode(s). Enter functional failures and related failure modes receiving a “yes” in block 12 of the FMEA; number each as numbered in the FMEA.

i. Block 9 – Criticality analysis. Enter Y or N to signify a yes or no answer to each of the first three logic tree questions. Acceptable combinations are:

Question				Assign criticality class
1	2	3		
Y	Y	N/A		A
Y	N	Y		B
Y	N	N		C
N	N/A	N/A		D

j. Block 10 – Criticality class. Enter A, B, C, or D, based on the answers in block 9. These letters identify the four main criticality branches of the logic tree as follows:

- (1) Class A – personnel safety.
- (2) Class B – mission capability.
- (3) Class C – other regular functions.
- (4) Class D – hidden or infrequent functions.

k. Block 11 – Periodic maintenance (PM) task. Enter a Y or N to signify a yes or no answer to questions 4, 5, 6, or 7 in the logic tree. If the criticality class for this failure is A, the task must be able to reduce the risk to an acceptable level; cost is not a consideration. If no task is available, a safety related design change recommendation must be identified in block 13. Justification for a Y or N is required (see 5.1.5.5).

l. Block 12 – FF task. Enter Y or N signifying a yes or no answer to question 8 in the logic tree.

m. Block 13 – Redesign recommendation. Enter yes if one was identified for this failure, otherwise enter no.

n. Block 14 – Task description. Enter a brief description of the applicable and effective task.

o. Block 15 – Periodicity. The Periodicity delineates how frequently the maintenance requirement must be performed. Enter the periodicity for accomplishment of tasks in block 14. For periodicities other than calendar based periods, enter a description of the situation which triggers the task.

p. Block 16 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – see 5.1.1.4.j (1).
- (2) Segment 2 – see 5.1.1.4.j (2).
- (3) Segment 3 – enter the number 120 to indicate the Logic Tree Analysis form, followed by a slant (/).
- (4) Segment 4 – enter the ESWBS number from block 1.

5.1.6 Phase 6 – Servicing and lubrication analysis. The developer shall perform a servicing and lubrication analysis.

Servicing task: A task that adds or replenishes a consumable item depleted during normal operation (function) and is required in order for the item to perform its required function (e.g., a window washing system will not function without sufficient fluid in its reservoir.) Filter maintenance (replenishment through cleaning or replacement) is considered to be a servicing task.

Lubrication task: A task that adds or replenishes a lubricating film (oil or grease) that exists solely to reduce the wear that results from the friction of two surfaces moving in relation to each other.

However, as long as the chosen task satisfies the strict application of the definition for a servicing or lubrication task, it provides benefit which far exceeds any associated cost while maximizing the functional availability. Therefore, servicing and lubrication tasks are not processed through the complete logic tree but instead a more straight forward approach is used to document the need for the servicing or lubrication task. In evaluating these tasks, the following considerations should be made:

a. Is there evidence from existing data on failed hardware of insufficient or excessive servicing or lubrication? Current periodicities are frequently based only on manufacturers' recommendations and may be excessive. The goal is to determine the tasks that are applicable and effective and determine their correct periodicity.

b. What is the actual periodicity at which this task is performed, and what materials and procedures are used?

c. Can the current method be improved?

d. Can an approved alternative material be used? When practical, common periodicities and materials should be established so that several items can be serviced or lubricated at once, while minimizing the number of different materials required.

e. Are there existing operating procedures or standards that accomplish the requirements of the proposed tasks without the need for creating scheduled maintenance?

5.1.6.1 Completing the servicing and lubrication analysis (DI-SESS-80985A/figure A-6). The servicing and lubrication analysis data/form shall be completed as follows:

a. Block 1 – ESWBS number. Enter the ESWBS number of the system under analysis, as defined in Phase 1 on the MSSSI.

b. Block 2 – Nomenclature. Enter the nomenclature of the system under analysis from block 9 of the MSSSI.

c. Block 3 – Ship class. Duplicate the entry from block 3 of the MSSSI.

d. Block 4 – Prepared by. Enter the analyst's name and the date.

e. Block 5 – Reviewed by. Enter the first level reviewer's name and the date.

f. Block 6 – Approved by. Reserved for MCA approval signature and date.

g. Block 7 – Revision. See instructions for the MSSSI form in 5.1.1.4.g.

h. Block 8 – Item and task description. Enter the nomenclature of each item, and beneath that, the description of each servicing and lubrication task pertinent to that item. When the proposed task is a re-utilization of an existing task from the 3-M system, include MRC SYSCOM control numbers of the existing task.

i. Block 9 – Location. Enter the compartment number(s) where the task is performed.

j. Block 10 – Quantity. Enter the quantity of the items upon which the maintenance task is performed.

k. Block 11 – Previous Periodicity. Enter the most recently used periodicity for this task on this or similar items. If this is a new item, enter the manufacturer's recommendation, technical manual, or use engineering judgment.

l. Block 12 – Material specification. Enter the specification and symbols of any material used; for example, oil, grease, or fluid. MIL-HDBK-267A contains lubricant information.

m. Block 13 – Analysis decision. Enter action taken by analysis; NC-no change, OM-omit, CM-change material, CP-change procedure; and the revised periodicity, if appropriate. When making these decisions, reflect on the questions addressed in 5.1.5.

n. Block 14 – Explanation. Enter rationale and justification for the analysis decisions documented in block 13; discuss effectiveness of the task, explain why the change is appropriate (including revised periodicity), outline revised procedures, and specify new materials as appropriate.

o. Block 15 – Serial number. Enter a four-segment serial number as follows:

(1) Segment 1 – see 5.1.1.4.j (1).

(2) Segment 2 – see 5.1.1.4.j (2).

(3) Segment 3 – enter the number 121, indicating the servicing and lubrication analysis form, followed by a slant (/).

(4) Segment 4 – enter the ESWBS number from block 1.

5.1.7 Phase 7 – Inactive equipment maintenance (IEM) task identification. Upon completion of Phase 6 and by the direction of the MCA, the developer shall perform an IEM analysis. The RCM analysis process is focused on preventing equipment failures that occur when the equipment is in use in its normal operating environment. However, equipment is occasionally placed into inactive status during which damage/failure may still occur. It may be beneficial to develop maintenance to prevent this damage if possible and/or ensure the equipment is fully operational before it is returned to an operational environment. Upon completion of the IEM analysis, and by the direction of the MCA, the IEM requirements shall be subjected to procedure validation as specified in 5.1.11.

5.1.7.1 Inactive equipment maintenance analysis. Inactive equipment maintenance analysis shall be the basis for determining the maintenance requirements to be performed when equipment is inactivated for periods of prolonged idleness. Tasking may include:

- a. Lay-up maintenance (LU) – Prepare the equipment for inactive period.
- b. Periodic maintenance (PM) – Prevent equipment deterioration during the inactive period.
- c. Start-up maintenance (SU) – Prepare the equipment to become operational.
- d. Operational test (OT) – Ensure that the equipment is completely operational at the end of the inactive period.

The analysis shall identify: the maintenance actions required, the source of the required actions, such as existing PMS or technical manuals, and the required procedures available. The IEM analysis will assume that the equipment is in an operable condition when the procedures to inactivate the equipment are implemented and shall be performed using an inactive equipment maintenance (IEM) requirement form. The analysis is a continuation of the requirements investigation process. At the top of the IEM analysis form, enter the equipment item name or nomenclature, the date, and the page number.

5.1.7.2 Completing the IEM data/form (DI-SESS-80989A/figure A-7). The IEM data/form shall be completed as follows:

- a. Block 1 – ESWBS number. Enter the ESWBS number of the system under analysis, as defined in Phase 1 on the MSSI.
- b. Block 2 – Nomenclature. Enter the nomenclature of the system under analysis from block 9 of the MSSI.
- c. Block 3 – Ship class. Duplicate the entry from block 3 of the MSSI.
- d. Block 4 – Prepared by. Enter the analyst's name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer's name and the date.
- f. Block 6 – Approved by. Reserved for MCA approval signature and date.
- g. Block 7 – Revision. See instructions for the MSSI form in 5.1.1.4.g.
- h. Block 8 – Degradation. List what degradation will occur if equipment is inactive while ship is (a) operational, and (b) in an industrial environment, for example, regular overhaul (TYCOM or CNO availability) or modernization. Consider separately the equipment's internal workings, external surfaces, attachments, connecting lines, piping, or valves. Under the industrial environment, consider what the effects will be under conditions such as lack of power and heating or cooling problems. Consider the effects if the equipment is exposed to abnormal conditions, for example, having the bulkhead, overhead, and decking removed; or industrial work in progress in the immediate area such as welding, chipping, sandblasting, or painting.
- i. Block 9 – Requirements: Considering location and equipment design, state maintenance actions, with alternatives, to protect and prevent degradation of the equipment under the conditions listed
 - (1) Block 9a – Protection. List maintenance actions necessary to protect and maintain inactive equipment during a period of prolonged idleness. For example:
 - (a) Remove equipment and place in a protected area.
 - (b) Lubricate and cover exposed areas.
 - (c) Inactivate radar set.

(2) Block 9b – Activation. List maintenance actions necessary to return subsystem or equipment to service following a period of prolonged idleness. Specify what tests are required to ensure the operational readiness of the equipment.

j. Block 10 – Expense. Answer yes or no to the question: “Considering cost and resources is the requirement of block 9 worthwhile?” State whether or not the action would satisfy all requirements and give the reason. Justification is required for each requirement listed in block 9 and only the most cost effective requirements should survive the justification. Justification may recommend more than one alternative under different environmental conditions during a shut-down period.

k. Block 11 – Periodicity. Establish the IEM periodicity; lay up maintenance (LU), periodic maintenance (PM), start-up maintenance (SU), or operational test (OT), for each requirement fully justified in block 10. A maintenance requirement (MR) may be used under more than one IEM periodicity. For periodic maintenance, identify the periodicity of performance required by adding a code to the PM indicator; for example, “PM(W)”, “PM(M).” Justify each periodicity decision. If a requirement is to be performed in an industrial environment only, indicate by the notation (I); for example, “LU(I)”. This MR shall be entered on the RCM task definition form (Phase 10) with a note to describe the circumstance.

l. Block 12 – Source procedure. Review and list available maintenance procedures that could satisfy the requirements justified in blocks 10 and 11. Maximum use of existing maintenance procedures is desired. Apply existing procedures as written or modify as necessary. Maintenance procedures requiring modifications and maintenance actions which must be developed will be annotated in block 13. Indicate the source of existing procedures. Some of the sources will be technical manuals (TMs), ordnance publications (OPs), or existing MRCs.

m. Block 13 – Editing. This column provides a summary and check-off list of the development work required for IEM. Opposite each MR listed in block 11, indicate what must be done to complete the IEM development with one of the following:

(S)	The MR procedure exists on a MIP and is to be used as written. Enter MRC SYSCOM number.
(M)	The MR procedure exists on a MIP; but the procedure or periodicity must be modified for IEM. Enter MRC SYSCOM number.
(N)	A complete new procedure must be developed to satisfy the MR and shall be subjected to procedure validation.

n. Block 14 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – see 5.1.1.4.j (1).
- (2) Segment 2 – see 5.1.1.4.j (2).
- (3) Segment 3 – enter the number 129, indicating the inactive equipment maintenance form, followed by a slant (/).
- (4) Segment 4 – enter the ESWBS number from block 1.

5.1.8 Phase 8 – Corrective maintenance task identification.

Corrective maintenance development is only performed when uniquely identified and funded by the project sponsor via the acquisition documents. Upon completion of Phase 7, and at the approval of the MCA, the developer shall perform a Corrective Maintenance (CM) analysis. The purpose of corrective maintenance task analysis is to identify corrective maintenance and development of approved CM tasks. CM consists of those actions required to return systems or equipment from a failed status to an operational condition within predetermined tolerances or limits.

Corrective maintenance development is performed to provide a readily available procedure, as an extension to a service technical manual, when a procedure is not provided in the technical manual. These CM procedures shall be in the same format as PM procedures, but shall be identified as corrective maintenance. Within Navy PMS, CM tasks are listed as unscheduled maintenance.

In Phase 4, FMEA, the comprehensive list of all failures associated with the equipment under analysis is produced. Failures that are of suitable risk, (i.e., dominant failure modes), are transferred to the logic tree in Phase 5.

Consequently, failures transferred to the logic tree are also candidates for CM task identification. The Phase 4 failure modes transferred to Phase 5 shall be retrieved for CM consideration. Each failure mode shall be evaluated to determine the most appropriate CM task: repair task, replace task or both. Additionally, troubleshoot tasks may be identified during this analysis.

5.1.8.1 CM task analysis process. The following steps shall be taken to identify and classify corrective maintenance:

- a. Review FMEA failure modes and identify those transferred to the logic tree.
- b. Identify the CM task requirement(s) for failure modes identified in step a. This list shall be approved by the MCA and/or Program Sponsor prior to developing the CM procedures. Consideration for the selection of tasks for MRC development should be based upon frequency of failure (e.g., MTBF of the item) and consequence of failure. CM tasks consist of either a repair, replace, and troubleshoot procedures or combination of these procedures.
- c. Identify the maintenance level of repair. The task should be designated for organizational, intermediate, or depot level work.
- d. Review task to determine whether sufficient technical documentation exists to write the CM procedure, or whether further analysis is required, i.e., identify existing CM procedures. Procedures that are readily available in Navy Technical Manuals are not typically selected for MRC development.

5.1.8.2 Completing the corrective maintenance task list (DI-SESS-81829/figure A-8). The CM task list shall be completed as follows:

- a. Block 1 – ESWBS number. Enter the ESWBS number from block 8 of the subsystem under analysis, as defined in Phase 1 on the MSSI.
- b. Block 2 – Nomenclature. Enter the nomenclature of the subsystem under analysis from block 9 of the MSSI.
- c. Block 3 – Ship class. Duplicate the entry from block 3 of the MSSI.
- d. Block 4 – Prepared by. Enter the analyst's name and the date.
- e. Block 5 – Reviewed by. Enter the first level reviewer's name and the date.
- f. Block 6 – Approved by. Reserved for MCA approval signature and date.
- g. Block 7 – Revision. See instructions for the MSSI form in 5.1.1.4.g.
- h. Block 8 – Failure mode number. The failure mode number shall be taken directly from the LTA block 8 (see 5.1.5.8.h).
- i. Block 9 – Failure mode. Enter the verbiage of failure mode associated with column 8, copied from LTA form, Block 8 (see 5.1.5.8.h).

j. Block 10 – CM task description. The CM task description will typically follow one of three methods. One is to “restore” or “repair” the failed item. Another may be to “replace” the failed item with a new item. Another may be to “troubleshoot” the failed item (especially if it is complex in nature) to identify a failed sub-component for repair or replacing. The failure mode may have one or more of these types of CM procedures associated and the three described above are not all-inclusive of what may be required as corrective maintenance. Assign a task “trigger”, e.g., “perform when motor will not start” as appropriate.

k. Block 11 – Item mean time between failures (MTBF). If the item mean time between failures is known, enter it in the list. MTBF is useful to the analyst or MCA to identify which failure modes and consequent CM are more likely to occur during the service life of the equipment. MTBF is measured in hours and is typically available from original equipment manufacturer (OEM) documentation. The more frequent failures (i.e., dominant failures) are candidates for development of detailed CM procedures.

l. Block 12 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – see 5.1.1.4.j (1).
- (2) Segment 2 – see 5.1.1.4.j (2).
- (3) Segment 3 – enter the number 122, indicating the corrective maintenance form, followed by a slant (/).
- (4) Segment 4 – enter the ESWBS number from block 1.

5.1.9 Phase 9 – Maintenance requirements index (MRI). The MRI will be a list of maintenance tasks for the subsystem to include scheduled, inactive, and corrective maintenance and the recommended level at which the maintenance should be performed (i.e., organizational, intermediate, or depot).

a. Organizational level maintenance: Organizational-level maintenance is the lowest maintenance echelon and consists of all maintenance actions within the capability and resources provided to the organization who routinely oversees equipment operation (e.g., ship's force).

b. Intermediate level maintenance: Tasks requiring a higher skill, capability, or capacity than organizational level. Intermediate level maintenance is normally accomplished by centralized repair facility personnel such as the Navy Fleet Maintenance Activity (FMA), submarine refit and support facilities, Regional Maintenance Centers (RMCs), and Battle Group or other Intermediate Maintenance Activities (IMAs).

c. Depot level maintenance: Tasks focused on repair, fabrication, manufacture, assembly, overhaul, modification, refurbishment, rebuilding, test, analysis, design, upgrade, painting, assemblies, subassemblies, software, components or end items that require specialized facilities, tooling, support equipment, personnel with higher technical skill, or processes beyond the scope of the IMA.

5.1.9.1 Completion of the MRI data/form (DI-SESS-80986A/figure A-9). The MRI data/form shall be completed as follows:

- a. Block 1 – ESWBS number. Enter the ESWBS number of the subsystem under analysis, as defined in Phase 1 on the MSSI.
- b. Block 2 – Nomenclature. Enter the nomenclature of the subsystem under analysis from block 9 of the MSSI.
- c. Block 3 – Ship class. Duplicate the entry from block 3 of the MSSI.
- d. Block 4 – Prepared by. Enter analyst's name and submission date.
- e. Block 5 – Reviewed by. Enter name of first level reviewer.
- f. Block 6 – Approved by. Reserved for MCA approval signature and date.
- g. Block 7 – Revision. Enter Original, or A, B, or C, sequentially as appropriate and date.
- h. Block 8 – Task number. Task numbers are derived from the phase which generated the task as outlined below:

- (1) Logic tree analysis (Phase 5): For each task identified in Phase 5, enter a sequential task number in the format LTA-1, LTA-2, etc.
- (2) Servicing and Lubrication analysis (Phase 6): For each task identified in Phase 6, enter a sequential task number in the format SLA-1, SLA-2, etc.
- (3) Inactive equipment maintenance task identification (Phase 7): For each task identified in Phase 7, enter a sequential task number in the format IEM-1, IEM-2, etc.
- (4) Corrective maintenance task identification (Phase 8): For each task identified in Phase 8, enter a sequential task number in the format CM-1, CM-2, etc.
 - i. Block 9 – Nomenclature. Enter the name or description of the component on which the task is performed.
 - j. Block 10 – Task description. Enter the task description from the associated development phase (LTA, SLA, IEM, CM). This should be in the form of a sentence and be specific enough to convey the purpose of the task, e.g., “Lubricate bevel gear”.
 - k. Block 11 – RCM task type. For planned maintenance tasks, enter the RCM task type, i.e., “CD” for condition-directed, “TD” for time-directed, “FF” for failure finding, or “SL” for servicing & lubrication.
 - l. Block 12 – Reference: Enter the identification data for the publication that satisfies the task requirement or can be used as a baseline to assist in developing the task procedure. If no publication is available enter “None”.
 - m. Block 13 – Level of maintenance. Enter the level of maintenance; either “O: for organizational, “I: for intermediate, or “D” for depot level.
 - n. Block 14 – Periodicity. Enter the initial periodicity for the maintenance task. The initial periodicity for a maintenance task may be based upon similar existing tasks for the equipment, original equipment manufacturer (OEM) guidelines, Naval Ships’ Technical Manual (NSTM) guidelines, or best engineering judgment, et al.
 - o. Block 15 – Serial number. Enter a four segment serial number as follows:
 - (1) Segment 1 – see 5.1.1.4.j (1).
 - (2) Segment 2 – see 5.1.1.4.j (2).
 - (3) Segment 3 – enter the number 123, indicating the MRI form, followed by a slant (/).
 - (4) Segment 4 – enter the ESWBS number from block 1.

5.1.10 Phase 10 – Maintenance requirement task definition. Upon completion of Phase 9 and at the direction of the MCA, task definition forms shall be prepared for tasks identified in the MRI and specifically designated for further development by the MCA. The task definition process collects sufficient information about the detailed procedures of each task so that a decision can be made as to the appropriate maintenance level (organizational, intermediate, or depot) to perform the tasks and to write the maintenance procedure (see 6.2).

5.1.10.1 Preparation guidelines. Task definition forms shall be prepared for those tasks from the decision logic tree analysis, and servicing and lubrication analysis, identified on the MRI as O-level. Task definition forms shall be prepared for any IEM or CM task when specifically designated by the MCA for further development. Tasks identified on the MRI for I or D level accomplishment will not be designated for task definition, rather they will be forwarded by the MCA to the cognizant planning authority for incorporation into class maintenance plans. Selecting the echelon (O, I, or D) that will perform each maintenance task is an integral part of the task definition process. If the task frequency is often enough (e.g., weekly) and is required to ensure safety and/or mission capability, it is typically assigned to the organizational level. If the task frequency permits performance by I or D level resources, a choice must be made. This choice will be constrained by the ability of the organization to do the task without external skills, materials, tools, or equipment.

5.1.10.2 Completing the RCM task definition data/form (DI-SESS-80988A/figure A-10). The task definition data/form shall be completed as follows:

- a. Tasks covered by existing MRCs. For tasks covered by existing MRCs, a copy of the MRC may be attached to the task definition form in lieu of filling in redundant blocks.
- b. Block 1 – ESWBS number. Duplicate the entry from block 1 of the MRI form.
- c. Block 2 – Nomenclature. Enter the nomenclature of the item upon which the task is performed from block 2 of the MRI.
- d. Block 3 – Ship class. Duplicate entries from block 3 of the MRI.
- e. Block 4 – Prepared by. Enter the analyst name and date.
- f. Block 5 – Reviewed by. Enter the first level reviewer’s name and the date. Reserved for engineering review.
- g. Block 6 – Approved by. Reserved for the maintenance coordinating activity.
- h. Block 7 – Revision. Enter Original, A, B, or C, sequentially and the date.
- i. Block 8 – Equipment nomenclature. Enter the nomenclature of the item upon which the task is performed from the MRI.
- j. Block 9 – Quantity installed. Enter the installed quantity of the item on which this task must be performed.
- k. Block 10 – Reference MRC. Enter the reference data from block 12 of the MRI.
- l. Block 11 – Maintenance requirement description (task). Enter the task(s) description(s) from the MRI. If applicable, several tasks can be combined into a single maintenance task.
- m. Block 12 – Safety precautions. All required safety precautions shall be included in this block. The first entry in this area shall identify general safety requirement documentation by publication number and volume; for example, “Observe standard safety precautions in accordance with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100.19 (Series).” or “Forces afloat comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100.19 (Series);” Shore Safety activities comply with Safety Precautions for shore Activities.”
 - (1) Additional warnings. Additional or more specific warnings shall follow when applicable and shall be listed in the order in which they appear in the procedure area. These warnings will also immediately precede the applicable step.
 - (2) Additional warnings requiring the use of additional personnel. For those actions which require additional personnel because of safety regulations, the phrase, “Do not work alone” shall be added to the applicable safety precaution; for example, “Voltage dangerous to life is present when interlock switch is bypassed. Do not work alone.” Appropriate personnel and man-hours must be added when this statement is used.
 - (3) Capitalization required. The first letter of the first word in each safety precaution shall be capitalized, with all other words in lower case, unless capital letters are required for another reason.
 - (4) Submarine applications. When Submarine Safety (SUBSAFE) boundaries are to be violated, the statement “Ensure compliance with SUBSAFE Re-entry Control Procedures of NAVSEA 0924-062-0010 or COMFLTFORCOMINST 4790.3, Volume V, as applicable” shall appear in this area. When scope of certification items are impacted, the statement “Ensure compliance with DSS-SOC Re-entry Control Procedures of NAVSEA SS800-AG-MAN-010/P-9290 (with the appropriate DSS-SOC Notebook)” shall appear in this area.
 - (5) Cleaning solvents. Safety precautions shall be listed when cleaning solvents are involved. The following standard safety precaution is to be used at a minimum whenever cleaning solvents are involved: “Avoid prolonged contact with, or inhalation of, cleaning solvents. Avoid use near open flame and provide adequate ventilation.” Approved Navy standard messages are listed in the MRC development software.

n. Block 13 – Periodicity. Enter the periodicity of this task from block 14 of the Maintenance Requirements Index form. Enter a two-segment code; for example, “4416 Q-2”, “7211 Q-1”, or “2331 R-1”. The first segment is the ESWBS/MIP series code which will be provided by the applicable MCA. The second segment is the task periodicity. MRCs applicable to more than one MIP series will have each MIP series entered in this block. If more than four MIP series are applicable, reference shall be made to a note. The note shall be numbered and appear in the procedure block to provide the additional information.

o. Block 14 – Rates and man-hours. Identify and enter, by rating and rate, the number of persons required to perform the maintenance requirement and the man-hours for each person. Entries in this area shall be made as follows:

- (1) The Navy enlisted classification (NEC) shall be entered if special skills are required.
- (2) When both NEC and rates are important to the task, both shall be included; for example, GM2, with the NEC 0876 listed beneath the rate.
- (3) A commissioned officer or warrant officer may be required to be present or available for a specific task indicated in a maintenance procedure. Titles for officers shall be the first entry in the block when applicable; for example, Damage Control Assistant (DCA), Electronic Material Officer (EMO), Engineering Officer (Eng. Off.).
- (4) In cases where more than one rating is required, ratings shall be listed after the officers descending by rate within each rating category; for example, Eng. Off., Electrician’s Mate First Class (EM1), and Machinist’s Mate Second Class (MM2).
- (5) When more than one person is required for a particular rate, the appropriate number shall precede the rate; for example, two Operations Specialists First Class (2 OS1), two Sonar Technicians Surface First Class (2 STG1), and three Electronics Technicians Second Class (3 ET2). When two or more persons of the same rate are required and their time requirements are not equal, each person shall be listed separately. When additional personnel are required because of safety regulations, the rate and number of such personnel shall also be included.
- (6) In cases where either of two similar ratings can be assigned the work on an MRC, both ratings shall be listed and separated by a slash; for example, “Fire Control Technician First Class (FC1)/Electronics Technician First Class (ET1)”, “Gunner’s Mate Second Class (GM2)/Gunner’s Mate Missiles Second Class (GMM2).”
- (7) MRCs with a calendar periodicity or R periodicity shall include the necessary rates to perform the maintenance. Inactive Equipment Maintenance (IEM) procedural MRCs shall also include rates. MRCs with a U periodicity shall include rates when so directed by the MCA.
- (8) Manhours (M/H) (converted to hours and tenths of an hour) shall be entered immediately to the right of each rate in the RATES area. When the M/H figure is less than one hour, a zero shall appear before the tenths of an hour portion; for example, “0.1” and “0.4”. When a commissioned officer or warrant officer is required, no M/H shall be assigned for that person.
- (9) The time entered shall indicate the M/H required for each rate as if they were performing their tasks independently. When two or more of the same rating and rate are required and their time requirements are equal, the M/H will be the sum of their time requirements. When two or more persons of the same rating and rate are required and their requirements are not equal, each person must be listed separately.
- (10) Equipment warm-up time of 30 minutes or less shall be included in the assigned M/H. Warm-up time in excess of 30 minutes or periods not requiring maintenance technician intervention (i.e., charge batteries for 24 hours) shall not be included unless the maintainer is required for constant observance.
- (11) “Make ready” or “put away” time shall not be included in this area.
- (12) When another MRC or procedure is referred to in the procedure area and only a portion of that MRC or procedure is to be accomplished, time required to do that portion shall be included in the M/H of the person accomplishing the task of the subject MRC. However, if the referenced procedure is an entire scheduled related MRC, the M/H of that MRC shall not be included.

p. Block 15 – Total M/H. Enter the sum of the man- hours from the M/H block.

q. Block 16 – Elapsed time. The entry in this area shall indicate the elapsed time, in clock hours and tenths of an hour, from start to finish of the maintenance procedure. The time involved for preparation to accomplish the task and cleanup time upon completion shall not be included. The elapsed time entry does not always duplicate the longest entry in the M/H area. It may be longer when some personnel must wait for other personnel to complete specific actions in order to accomplish certain procedural steps.

r. Block 17 – Tools, parts, materials, test equipment (TPME). Enter and number the required test equipment, materials, parts, tools, and miscellaneous requirements, in that order. Each applicable category shall have a heading. Items within the category shall be numbered and identified by the applicable Standard PMS Materials Identification Guide (SPMIG) number when available. For items without a SPMIG number assigned refer to 5.1.10.2.r (13). Any item that cannot be substituted by a like item shall state “DO NOT SUBSTITUTE” after the item name. When identifying items in the TPME block, standardization requirements include:

(1) Quantities in excess of one and units of one unit of measure shall be enclosed in parentheses following the nomenclature and complete description of the item. For example: wrench, adjustable 8 inches (2); baking soda (2 pounds).

(2) Symbols of “, ’, °, and % shall be entered for inch, foot, degree, and percent. Fractions shall be typed with the numerator and denominator separated by a slash; for example, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{6}$.

(3) The term “equivalent” shall not be used with an item listed in this area. Equivalent items, if authorized, shall be specified as a note in the procedure area.

(4) A zero shall be placed before the decimal point when another figure does not precede the decimal. This shall occur even if there is a zero after the decimal point; for example, “wire, non-electrical, 0.041.”

(5) A national stock number (NSN) shall not be included in (TPME) block. National stock numbers, when authorized, shall be specified as a note in the procedure area.

(6) MRCs for nuclear submarine applications shall use the phrase, “approved safety cleaning solvent.” For other ship applications, specific cleaners shall be identified. For documentation which will be used for both nuclear submarine and other ships, a double statement will be used; for example, “nuclear submarines: approved safety cleaning solvent; other ships: approved safety cleaning solvent.”

(7) When Submarine Safety (SUBSAFE) boundaries are to be violated, ensure compliance with SUBSAFE Re-entry Control Procedures of NAVSEA 0924-062-0010 or COMFLTFORCOMINST 4790.3, Volume V, as applicable. When scope of certification items is impacted, ensure compliance with DSS-SOC Re-entry Control Procedures of NAVSEA SS800-AG-MAN-010/P-9290 (with the appropriate DSS-SOC Notebook).

(8) Only portable and non installed equipment required to perform the maintenance procedure shall be listed in the tools, parts, materials, and test equipment area. Installed equipment required to support the maintenance procedure shall not be listed. This equipment shall be specified in the appropriate procedural step.

(9) Each entry shall consist of one item only; for example, if an oiler with MIL-PRF-6086 oil is required, the oiler will be listed under the tool heading, and the oil will be listed under the material heading. If more than one oil is required, the procedural step shall specify which oil is required for that step.

(10) In the event that entries in this area must be continued to the second page, the heading information, tools, parts, materials, test equipment, shall be printed on the second page.

(11) In the event that entries are to be provided by another activity, the entry will be followed by the phrase, in parentheses, and an explanation provided in the note in the procedure area.

(12) The TPME block is grouped into five categories:

- (a) Category 1 – General Purpose Electrical/Electronic Test Equipment (GPETE). The Test, Measurement, Diagnostic Equipment (TMDE) program is controlled by Naval Sea Systems Command (NAVSEA). This program provides comprehensive life-cycle support, encompassing acquisition, outfitting, calibration support and retirement of GPETE as well as Calibration Standards. This includes test equipment that has the potential for use in PMS. GPETE provides comparison of an unverified equipment or subsystem performance level with the parameters of known and greater accuracy standards (thereby providing precision measurement). Use of GPETE is required to support the maintenance requirements of electronic, electrical, interior communications, weapons and propulsion prime systems and equipments.

The Sub-Category (SCAT) code is a four- to seven-digit numeric or numeric-alpha code used by NAVSEA to identify a range of measurement requirements by functional category (identified on an associated MRC). Within each currently active SCAT code, test equipment models capable of performing those measurement requirements are assigned to the appropriate SCAT. The TMDE Program is the only authorized agent for the assignment of SCAT codes to system measurement requirements. For prime systems not previously reviewed or test equipment not previously assigned a SCAT code, requests must be forwarded to the TMDE Program Office using an eCalibration and Measurement Requirements Summary (CMRS), DD Form 1426. If the request cannot be matched to approved NAVSEA GPETE and the associated SCAT code assignment, the results will be forwarded back to the requesting Program Office and In-Service Engineering Agent (ISEA) with a SCAT code assignment under Special Purpose Electrical/Electronic Test Equipment (SPETE). It must be understood that a SPETE SCAT assignment requires the requesting Program Office/ISEA to provide all life cycle support including calibration support development to maintain the viability of the instrument until such time as it is replaced or retired.

The NAVSEA TMDE index (TMDE-I) is a guide and reference for the identification of GPETE and SPETE, which has been assigned a Sub-Category (SCAT) code. The TMDE-I allows cross-reference searches to be accomplished by: SCAT code; model number; prime system; ship type and hull number. The TMDE-I is distributed semi-annually; copies are available upon request from the TMDE HELP email: NAVSEA_GPETE_HELP@navy.mil. The TMDE-I should be used in conjunction with the allowing document known as the Ship/Shore Portable Electrical/Electronic Test Equipment Requirements List (SPETERL). The TMDE-I does not under any circumstance supersede or modify the SPETERL, nor does it authorize the procurement or requisitioning of items not listed in the SPETERL.

The SPETERL is the authoritative allowance document that details onboard prime systems for a specific Naval ship or activity. The SPETERL thereby establishes the test equipment configuration to support preventive and corrective maintenance for those subsystems and associated equipments (MRC test equipment requirements must be synchronized with the SPETERL). The listed test equipment (with exception of SPETE), is considered GPETE and supports multiple systems installed onboard ships and shore stations. The listed GPETE (and SPETE) quantities within the SPETERL are used to maintain an onboard inventory that adequately supports measurement requirements. GPETE quantities determined as insufficient or excessive are addressed via the Allowance Change Request (ACR), Naval Supply Systems Command (NAVSUP) Form 1220-2 and submitted through the respective chain of command to the appropriate Fleet Type Commander. Requests for SPETERL reports can be made to the TMDE Program Office via the Help Desk email: NAVSEA_GPETE_HELP@navy.mil.

- (b) Category 2 – Consumables. Consumables constitute a majority of materials required to support maintenance. Category 2 includes a wide range of administrative and housekeeping items which may or may not be consumed in use. Some consumable items (grease, oils, and solvents) are consumed each time the maintenance action is performed whereas others (buckets, funnels and ladders) are not. Tools are not included in category 2 even though some tools may fit the general description of a consumable item. Examples of consumable items include ropes, rags, oil, cleaning solvents, brushes, corrosion protection agents, sealants, and protective coatings. By definition, any item appearing on an Allowance Parts List (APL) is considered a repair part (Category 3).
- (c) Category 3 – Parts. For purposes of MRC development, repair parts are defined as any item which is an integral part of the equipment. For example, gaskets, mechanical seals, packing material, O-rings and filters. In general, any item listed in a technical manual or drawing parts list is considered a repair part. An official definition of a repair part is any item appearing on an APL. The medium for identification of PMS repair part requirements to the Navy Supply System is the APL. As Commercial Off The Shelf (COTS) equipment is procured, APL's are not always developed. When no APL is available replacement parts used during maintenance shall be identified by CAGE code and Part number.

- (d) Category 4 – Tools. Category 4 includes common hand tools as well as other less commonly used tools, for example, precision measuring devices, dial indicators, micrometer, torque wrenches, and gages. Category 4 covers hand tools of all types except “special tools”. Special tools are by definition equipment-unique tools that are designed for a particular piece of equipment by the manufacturer. Such tools always have a manufacturer’s part number and Commercial and Government Entity (CAGE) code. Special tools will be listed on an APL and are, therefore, classified as repair parts. Equipage items are Category 5 even though some may be used as a tool; for example, jacking gear.
- (e) Category 5 – Miscellaneous. Category 5 covers all equipage items as well as any other special materials not otherwise covered under categories 1 through 4. As a general rule, all items which are identified and supported through Allowance Equipage Lists (AEL) will be considered category 5. Not all category 5 items are AEL applicable. Typical examples of category 5 materials are as follows:
1. Test equipment not listed in category 1.
 2. Radiation Detection, Indication and Computation (RADIAC) equipment or dosimeters.
 3. Sound powered phones, binoculars, telescopes, bore sights, and portable equipage items of all types; for example, fans, pumps, or blowers.
 4. Boiler feedwater testing equipment. Feedwater chemicals are category 2.
 5. Lube or fuel oil sampling kits, centrifuges, and testing apparatus.
 6. All items designated as controlled equipage.
 7. Safety harness, lanyards, and other safety equipment.
 8. Special clothing items including rubber gloves, and other items designated to protect users from chemical or toxic agents.
 9. Vacuum cleaners of all types.
 10. Chain falls, jacking gear devices, and other handling equipment except common hydraulic jacks which are considered category 4.
 11. Special test tapes, diagnostic tapes, or alignment tapes.
 12. Special connecting and adapting devices necessary to rig test equipment into prime equipment if such items are not supplied with the test equipment.
 13. Special software and support documents including supplemental MRCs, equipment technical manuals, handbooks, guides, and Naval Ships’ Technical Manuals (NSTMs).
- (13) Non-SPMIG tools, parts, materials, test equipment. Entries in the tools parts, materials, test equipment block not covered by the SPMIG, shall be determined and listed as follows:
- (a) Electronic and electrical test equipments shall be selected from NAVSEA TMDE-I. Test equipment will be identified by noun name, nomenclature, and SCAT code according to NAVSEA TMDE-I. When SCAT codes are not established, identify by noun name, manufacturer, model number, and AEL number, as applicable.
 - (b) Materials include lubricants, greases, solvents, cleaning agents and other consumables, such as tape, safety tags, or pencils. Lubricants, greases, solvents, and cleaning agents will be identified by Military, Federal, or Navy specification military symbol and the item name.
 - (c) Parts include all repair parts such as gaskets or O-rings. Repair parts will be identified by generic name, manufacturer’s part number, and the CAGE. The illustrated parts breakdown, manufacturer’s pamphlets, supply catalogs, APLs, and AELs are sources for these nomenclatures.
 - (d) Special tools such as gage pieces or thrust bars shall be identified by name, manufacturer’s part number, and CAGE.
 - (e) Common tools shall be identified using the nomenclature format as listed in the alphabetic index of NAVSUP Publication 4400 (Afloat Shopping Guide).

- (f) Miscellaneous requirements such as MRCs, technical manuals, or forms shall be identified by standard nomenclature or generic name, and company or government identification number.
- (g) When the MRC procedure refers to another entire MRC for a step-by-step procedure, that MRC shall be listed.
- (h) When published standard operating procedures are available, it is allowable to reference these procedures when full subsystem start-up or shutdown is required prior to or following the maintenance.
- (i) When fabrication of a unique tool is required, specifications for fabrications shall be included in the MRC.

s. Block 18 – Procedure. This area shall contain step-by-step instructions to accomplish the maintenance requirement. Illustrations and figures may be added here to enhance understanding of the text. Refer to MIL-P-24534A Amendment 1 and the following for technical writing format considerations for developing Navy PMS procedures:

- (1) The language used shall be free of vague and ambiguous terms and shall use the simplest words and phrases that will convey the intended meaning.
- (2) Sentence structure shall be short and concise to facilitate understanding and retention of thought. Steps shall be straightforward and simple. Steps with compound clauses shall be converted into sub-steps.
- (3) Consistency in choice of words and terminology and organization of material is mandatory.
- (4) Steps shall be written to consider the technical qualifications of the rating required to do the task.
- (5) Steps shall be written so that no interpretation of how to perform a procedural step is required.
- (6) Inspection and measurement steps shall clearly specify limits so that a condition can be easily determined to be acceptable or unacceptable.
- (7) Rewrite steps with extensive punctuation, or break singular steps into multiple steps for clarity.
- (8) Ensure that all procedures are safe. Whenever possible, maintenance actions shall be accomplished with equipment in a shutdown condition. Procedural steps directing removal of voltage or pressure shall be explicit as to which switches or valves are intended to be open or closed, and shall include tag-out action in the same step.
- (9) When using abbreviations or acronyms, always spelled out its' meaning, the first time it is to be used on a Task Definition Form.
- (10) Names of equipment parts, should be identified exactly as imprinted on the equipment (switches, handles, etc.), and the name should be capitalized in the procedural step.
- (11) Reference to technical manual procedures should be avoided, however when approved by MCA, technical manual references may be identified.

t. Block 19 – Ships crew. Enter a “Y” or “N” when signifying a yes or no answer to the question: “Can this task be done by the ship’s crew without external skills, materials, tools or equipment?”

u. Block 20 – Level.

- (1) Entry (a): Enter the lowest maintenance echelon at which this task can be done.
- (2) Entry (b): Enter the level at which this task should be done. Give consideration to organizational workload and class maintenance plan established by MCA.

v. Block 21 – Location. For ships, enter the compartment number of the space(s) where the item(s) are located. For all other applications, enter nomenclature to uniquely identify item(s) location.

w. Block 22 – Serial number. Enter a four-segment serial number as follows:

- (1) Segment 1 – Enter the developing organization abbreviation followed by a slant (/).
- (2) Segment 2 – For developers, enter the development authorization number followed by a slant (/); for other development activities assign a development number followed by a slant (/).
- (3) Segment 3 – Enter the number 124 indicating the task definition followed by a slant (/).
- (4) Segment 4 – Enter the ESWBS number from block 1.

5.1.10.3 Engineering reviews. The developing activity shall conduct appropriate engineering reviews of the technical information to ensure that it is safe, complete, logical, technically accurate, and comprehensible. Based on these reviews, the developing activity shall certify prior to validation that the technical information permits efficient performance of the intended equipment-support functions and that the technical information is ready for validation. All errors noted during the engineering review shall be corrected prior to validation. The developing activity shall maintain engineering review records and shall indicate certification by signing block 5 of the task definition form.

5.1.11 Phase 11 – Maintenance procedure validation. When directed by the MCA, each maintenance task procedure that evolves from the RCM process shall be subjected to a procedure validation (sometimes referred to as a “shipcheck”). All tasks including corrective procedures shall be validated as much as possible without doing a major breakdown of the equipment. Validated maintenance tasks are a certified product that is verified safe, technically sound, and capable of being performed by the rate identified, without any interpretation required. Procedure validation shall be performed by taking the written procedure to the actual equipment as installed onboard ship or shore facility and, in the presence of the maintenance technician(s), completely validate all steps in the procedure as well as the supporting information (see 6.2). The procedure validation shall verify the following elements:

- a. The procedure can be safely and effectively performed as written in the task definition, including the tagout requirements, safety warnings, cautions, and notes.
- b. The procedure makes sense from an engineering standpoint, is commensurate with resources available to the user, and that the equipment on which the maintenance is performed is accessible.
- c. Whether or not Hazardous Material (HAZMAT) is required for the procedure and, if so, that proper protective procedures and disposal directions are provided.
- d. The correct number of ratings and pay grades of maintenance personnel are identified.
- e. The correct tools, parts, consumables and miscellaneous items are specified.
- f. The correct elapsed time to perform the procedure is specified.
- g. Actions that do not support accomplishment of the MR are eliminated.

5.1.11.1 Validation requirements. Validation is a developing activity quality assurance responsibility that shall be accomplished for all maintenance tasks, changes, and revisions thereto. Validation shall provide a measure of the overall quality of the maintenance tasks. The validation shall be performed by individuals who are of approximately the same education, experience, and skill level as the actual target audience for the maintenance tasks. The MCA/In-Service Engineer Agent (ISEA) reserves the right to witness validation. The preparing activity shall notify the MCA/ISEA of the validation schedule prior to commencement. A maintenance task shall not be validated until the following conditions have been fulfilled:

- a. Developing activity’s engineering technical review has been completed.
- b. Information reflects configuration of the systems and equipment.
- c. Procedural instructions are readily understandable by the intended user and adequate to perform all intended functions.
- d. Adequacy of data is checked to ensure that it supports the approved maintenance strategy.
- e. Hardware of the proper configuration is available for the validation effort. An operational environment shall be used, if possible, or simulated, if practicable.

5.1.11.2 Validation performance. Operating and maintenance procedures including checkout, alignment, removal and replacement instructions, and associated checklists shall be validated against the system and equipment by actual demonstration. Malfunctions shall not be introduced into the system or equipment for the purpose of validation unless specifically required for certification of procedural tasks or system tests. Destructive malfunctions shall not be introduced into the system or equipment for any purpose.

5.1.11.3 Procedure validation data/form (PV) (DI-SESS-80987A/figure A-11). The purpose of the procedure validation is to collect data, at the location of the equipment, in order to improve or amend the maintenance task definition. This data will be used by developers to adjust the task definition and be approved by the MCA prior to authoring, publishing and delivery of maintenance procedures to the end user. Data required for procedure validation may be modified by the MCA as required, but represents the information that is typically important to validate. A PV should be prepared for each new maintenance procedure. When more than one page is required, the PV may include continuation pages. PV data shall be completed as follows:

- a. Block 1. Local control number. Enter the local control number as designated by the MCA.
- b. Block 2. Nomenclature. Enter the nomenclature of the subsystem, subsystem equipment group, or equipment, at the lowest hierarchical level that all maintenance on the task definition form is applicable (e.g., if maintenance tasks require interface with 2 pieces of equipment, 1 level higher indented level will be indicated as nomenclature).
- c. Block 3. Ship class. Enter the class of ship.
- d. Block 4. MRC serial. Enter the MRC serial number or proposed number for reference purposes.
- e. Block 5. Ship Hull/Facility. Enter the ship hull number or facility nomenclature.
- f. Block 6. Workcenter. Enter the workcenter responsible for the MRC, if available.
- g. Block 7. Periodicity. This block contains task periodicity.
- h. Block 8. Maintenance requirement description. Enter a brief task description of the maintenance requirement. Utilize task procedure indicated on Phase 10 Task Definition form that has undergone an engineering technical review and certified that technical information is correct, will not damage equipment, and is safe to perform.
- i. Block 9. Tagout required? Enter whether a tagout is required to safely perform the MRC.
- j. Block 10. HAZMAT required? Enter whether HAZMAT is required to perform the MRC.
- k. Block 11. Procedure modification? Indicate whether the procedure, as currently written, will require modification. This is a yes/no statement.
- l. Block 12. Safety concerns. Refer to block 12 of the RCM task definition form from Phase 10. Enter any additional safety concerns realized during the procedure validation.
- m. Block 13. Elapsed time. Enter the expected elapsed time to perform the MRC.
- n. Block 14. Actual elapsed time. Enter the elapsed time to perform the MRC as determined by the shipcheck. If it is the same as the estimate, enter "same".
- o. Block 15. Personnel validation. Indicate whether the ratings and pay grades required to perform the MRC are valid. This is a yes/no statement.
- p. Block 16. Comments/narrative. Enter recommended changes, in freeform text, to the procedures, personnel, tagout, HAZMAT, etc. This block shall be used to address deficiencies identified in the preceding yes/no questions.
- q. Block 17. Date & location. Enter the date the validation was performed and the shipboard location of the equipment, as applicable.
- r. Block 18. Evaluator. Enter contact information for the person performing the validation to include: name, title, activity, phone number, and email address, as applicable.

5.1.12 Phase 12 – Maintenance index page (MIP) and maintenance requirement card (MRC) development and preparation. The MCA will direct the contractor to develop MIPs and MRCs for specifically designated tasks identified in phase 9. The MCA will forward Intermediate and Depot Level tasks to the appropriate organization for development of CMP tasks. The format and content of MIPs and MRCs shall be in accordance with NAVSEA Data Item Descriptions (DIDs) DI-SESS-80992A (MIP) and DI-SESS-80991A (MRC), and 3.11 and 3.12 of MIL-P-24534A Amendment 1.

6. NOTES

6.1 Intended use. The maintenance procedures and associated artifacts produced in accordance with this standard are intended for use in the Navy 3M program. They apply to inspecting, cleaning, lubricating, replacing, adjusting, calibrating, functional testing, and system testing of equipment and/or systems located on ships, submarines, and shore stations. When identified as a unique deliverable, tasks developed may also include corrective maintenance procedures for aligning, repairing and troubleshooting failed equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this standard.
- b. Security classification of material to be used in MRC development (see 4.2).
- c. Identification and address of Maintenance Coordinating Activity (see 4.4).
- d. Identification of subsystem, or equipment for which the maintenance requirements are to be developed (see 5.1.1).
- e. Schedules and identification of applicable tasks described in this standard; these include applicable development phases, preparation of the verification draft, documentation validation, and shipment of deliverable items (see 5.1.10 and 5.1.11). Corrective maintenance analysis and MRC development requires a separate line item to invoke DID-SESS-81829. When not uniquely specified in the acquisition document, corrective maintenance analysis should not be performed.

6.3 Associated Data Item Descriptions (DIDs). This standard has been assigned an Acquisition Management Systems Control (AMSC) number authorizing it as the source document for the following DIDs. When it is necessary to obtain the data, the applicable DIDs must be listed on the Contract Data Requirements List (DD Form 1423).

<u>DID Number</u>	<u>DID Title</u>
DI-SESS-80979A	- Reliability-Centered Maintenance (RCM) Master System and Subsystem Index (MSSI)
DI-SESS-80980A	- Reliability-Centered Maintenance (RCM) Failure Modes and Effects Analysis (FMEA) Report
DI-SESS-80981A	- Reliability-Centered Maintenance (RCM) Functional Failure Analysis (FFA) Report
DI-SESS-80982A	- Reliability-Centered Maintenance (RCM) Functionally Significant Item (FSI) Index
DI-SESS-80983A	- Reliability-Centered Maintenance (RCM) Additional Functionally Significant Item (AFSI) Selection Report
DI-SESS-80984A	- Reliability-Centered Maintenance (RCM) Logic Tree Analysis (LTA) with Supporting Rationale and Justification Report
DI-SESS-80985A	- Reliability-Centered Maintenance (RCM) Servicing and Lubrication Analysis (SLA) Report
DI-SESS-80986A	- Reliability-Centered Maintenance (RCM) Maintenance Requirement Index (MRI)
DI-SESS-80987A	- Reliability-Centered Maintenance (RCM) Procedure Validation
DI-SESS-80988A	- Reliability-Centered Maintenance (RCM) Task Definition Report
DI-SESS-80989A	- Reliability-Centered Maintenance (RCM) Inactive Equipment Maintenance (IEM) Requirement Analysis Report

<u>DID Number</u>	<u>DID Title</u>
DI-SESS-80991A	- Planned Maintenance System (PMS) Maintenance Requirement Card (MRC)
DI-SESS-80992A	- Planned Maintenance System (PMS) Maintenance Index Page (MIP)
DI-SESS-80994A	- Reliability-Centered Maintenance (RCM) Functional Block Diagram (FBD)
DI-SESS-81829	- Reliability-Centered Maintenance (RCM) Corrective Maintenance (CM) Development Report

The above DIDs were current as of the date of this standard. The ASSIST database should be researched at <https://assist.daps.dla.mil/quicksearch/> to ensure that only current and approved DIDs are cited on the DD Form 1423.

6.4 Supersession data. This standard supersedes Phases 1-11 of MIL-P-24534A Amendment 1. Phase 12 requirements for the development of MRCs and MIPs are specified in MIL-P-24534A Amendment 1. This standard does not negate, nor require review and update, of any RCM analysis previously performed in accordance with its predecessor, MIL-P-24534A(NAVY).

6.5 Subject term (key word) listing.

Active function
Condition-directed (CD) task
Corrective maintenance
Decision logic tree analysis (LTA)
Failure effects
Failure mode
Failure modes and effects analysis (FMEA)
Functional failure
Functionally significant item (FSI)
Hidden function
Master system and subsystem index (MSSI)
Passive function
Periodicity
Potential failure
Preventive maintenance
Redundancy
Time-directed (TD) task

RCM ANALYSIS DATA COLLECTION FORMS

A.1 SCOPE

A.1.1 Scope. This Appendix consists of figures as sample forms to indicate the data to be provided as called out in the DIDs for different phases of RCM covered by this standard. The data itself is to be provided electronically. This Appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

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APPENDIX A

1. ESWBS GROUP NUMBER	2. GROUP NOMENCLATURE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE	5. REVIEWED BY DATE	6. APPROVED BY DATE	7. REVISION DATE	
8. ESWBS SUBGROUP/ SUBSYSTEM NUMBER	9. SUBGROUP/SYSTEM/SUBSYSTEM NOMENCLATURE			

MASTER SYSTEMS AND SUBSYSTEMS INDEX

FIGURE A-1. Master systems and subsystems index (MSSI).

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APPENDIX A

1. ESWBS NUMBER	2. NOMENCLATURE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE	5. REVIEWED BY DATE	6. APPROVED BY DATE	7. REVISION DATE	
8. SOURCES OF INFORMATION				
9. DESCRIPTION (Add additional sheet, if necessary)				
10. FUNCTIONS AND OUT INTERFACES				
11. SYSTEM IN INTERFACES				
12. FUNCTIONAL FAILURES				
				13. SERIAL NUMBER

FUNCTIONAL FAILURE ANALYSIS

FIGURE A-2. Functional failure analysis (FFA).

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APPENDIX A

1. ESWBS NUMBER	2. NOMENCLATURE FSI CANDIDATE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE	5. REVIEWED BY DATE	6. APPROVED BY DATE	7. REVISION DATE	
8. DESCRIPTION			9. LOCATION	
			10. QTY	
11. FUNCTIONS			11A. IMPACT? (Y/N)	
ARE ANY OF THESE FUNCTIONS NECESSARY FOR SAFETY, MOBILITY, OR MISSION?				
12. FUNCTIONAL FAILURES			12A. IMPACT? (Y/N)	
DO ANY OF THESE FAILURES HAVE A DIRECT ADVERSE IMPACT ON SAFETY?				
13. RELIABILITY			13A. IMPACT? (Y/N)	
IS THE ESTIMATED CORRECTIVE MAINTENANCE RATE GREATER THAN 1 PER YEAR?				
14. COST			14A. IMPACT? (Y/N)	
IS THIS ITEM'S PURCHASE COST GREATER THAN \$5000?				
15. MASTER FSI INDEX TRANSFER? (Y/N)		16. SERIAL NUMBER		

ADDITIONAL FUNCTIONALLY SIGNIFICANT ITEMS SELECTION

FIGURE A-3. Additional functionally significant items (AFSI).

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APPENDIX A

1. ESWBS NUMBER	2. SUBSYSTEM NOMENCLATURE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE	5. REVIEWED BY DATE	6. APPROVED BY DATE		7. REVISION DATE
8. ESWBS NUMBER	9. NOMENCLATURE		10. LOCATION	
		11. SERIAL NUMBER		

FUNCTIONALLY SIGNIFICANT ITEMS INDEX

FIGURE A-3A. Functionally significant item index (FSI Index).

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1. ES/MS NUMBER	2. NOMENCLATURE			3. SHIP CLASS	SH OF
4. PREPARED BY DATE		5. REVIEWED BY DATE	6. APPROVED BY DATE		7. REVISION DATE
8. FUNCTION(S)	9. FUNCTIONAL FAILURES	10. DOMINANT FAILURE MODES	11. FAILURE EFFECTS a. LOCAL b. SUBSYSTEM c. END EFFECT		12. TRANSFER Y/N
			13. SERIAL NUMBER		

FAILURE MODES AND EFFECTS ANALYSIS

FIGURE A-4. Failure modes & effects analysis (FMEA).

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1. ES/MS NUMBER	2. NOMENCLATURE					3. SHIP CLASS	SH OF		
4. PREPARED BY DATE			5. REVIEWED BY DATE		6. APPROVED BY DATE		7. REVISION DATE		
8. FUNCTIONAL FAILURE/ FAILURE MODE	9. CRITICALITY ANALYSIS (1) (2) (3)			10. CRITICALITY CLASS (A) (B) (C) (D)	11. FMTASK? (Y/N) (4, 5, 6, or 7)	12. FAILURE FINDING TASK? (8)	13. REDESIGN? (Y/N)	14. TASK DESCRIPTIONS	15. PERIO- DICTY

LOGIC TREE ANALYSIS

FIGURE A-5. Logic tree analysis (LTA).

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APPENDIX A

1. ES/BS NUMBER	2. NOMENCLATURE				3. SHIP CLASS	SH OF
4. PREPARED BY DATE		5. REVIEWED BY DATE		6. APPROVED BY DATE		7. REVISION DATE
8. ITEM AND TASK DESCRIPTION	9. LOCATION	10. QUANTITY	11. PERIODICITY	12. MATERIAL SPECIFICATION	13. ANALYSIS DECISION	14. EXPLANATION

SERVICING AND LUBRICATION ANALYSIS

FIGURE A-6. Servicing & lubrication analysis (SLA).

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1. ES/ABS NUMBER	2. NOMENCLATURE				3. SHIP CLASS		SH OF	
4. PREPARED BY DATE		5. REVIEWED BY DATE		6. APPROVED BY DATE		7. REVISION DATE		
8. DEGRADATION: a. operational b. industrial environment	9. REQUIREMENTS		10. EXPENSE		11. PERIODICITY (L, U, FM, SU, OT)		12. SOURCE PROCEDURE (TM, OP, MRC, ETC.)	13. EDITING (S) (M) (N)
	9a. Protection	9a. Activation	Y/N	Justify	Code	Justify		
					14. SERIAL NUMBER			

INACTIVE EQUIPMENT MAINTENANCE (IEM)

FIGURE A-7. Inactive equipment maintenance (IEM).

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APPENDIX A

1. ESWBS GROUP NUMBER	2. GROUP NOMENCLATURE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE		5. REVIEWED BY DATE	6. APPROVED BY DATE	7. REVISION DATE
8. FAILURE MODE NUMBER	9. FAILURE MODE	10. CM TASK DESCRIPTION		11. ITEM MTBF
				12. SERIAL NUMBER
CORRECTIVE MAINTENANCE TASK LIST				

CORRECTIVE MAINTENANCE TASK LIST

FIGURE A-8. Corrective maintenance (CM) task list.

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APPENDIX A

1. ESWBS NUMBER	2. NOMENCLATURE				3. SHIP CLASS		SH OF	
4. PREPARED BY DATE:		5. REVIEWED BY DATE:		6. APPROVED BY DATE:		7. REVISION DATE:		
8. TASK NUMBER	9. NOMENCLATURE	10. TASK DESCRIPTION			11. RCM TASK TYPE	12. REFERENCE / PUBLICATION	13. LEVEL OF MAINTENANCE	14. PERIODICITY
					15. SERIAL NUMBER			

MAINTENANCE REQUIREMENTS INDEX

FIGURE A-9. Maintenance requirements index (MRI).

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APPENDIX A

1. SYS/SUBSYS ESWBS NUMBER	2. SYSTEM/SUBSYSTEM NOMENCLATURE		3. SHIP CLASS	SH OF
4. PREPARED BY DATE	5. REVIEWED BY DATE	6. APPROVED BY DATE		7. REVISION DATE
8. EQUIPMENT NOMENCLATURE		9. QTY. INSTALLED	10. REFERENCE MRC	
11. MAINTENANCE REQUIREMENT DESCRIPTION (TASK)			13. PERIODICITY	
			14. RATES	M/H
			15. TOTAL M/H	
			16. ELAPSED TIME	
12. SAFETY PRECAUTIONS				
17. TOOLS, PARTS, MATERIALS, TEST EQUIPMENT				
18. PROCEDURE				
19. SHIP'S CREW? (Y/N)		20. LEVEL: (a) (b)		
21. LOCATION			22. SERIAL NUMBER	

TASK DEFINITION

FIGURE A-10. RCM task definition.

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APPENDIX A

1. LOCAL CONTROL NUMBER	2. NOMENCLATURE		3. SHIP CLASS	SH OF
4. MRC SERIAL	5. SHIP/HULL / FACILITY	6. WORKCENTER	7. PERIODICITY	
8. MAINTENANCE REQUIREMENT DESCRIPTION			9. TAGOUT REQUIRED? Y / N	
			10. HAZMAT REQUIRED? Y / N	
			11. PROCEDURE MOD? Y / N	
12. SAFETY CONCERNS			13. ELAPSED TIME	
			14. ACTUAL ELAPSED TIME	
			15. PERSONNEL VALID? Y / N	
16. COMMENTS / NARRATIVE				
17. DATE & LOCATION			18. EVALUATOR	

PROCEDURE VALIDATION

FIGURE A-11. Procedure validation (PV).

AGE EXPLORATION

B.1 SCOPE

B.1.1 Scope. This Appendix provides a short description of Age Exploration (AE), which is part of back-fit RCM, as it relates to time-directed (TD), condition-directed (CD), and failure-finding (FF) tasks. The Appendix does not provide a detailed treatment of AE, which is outside the scope of this standard. This Appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

B.2 Introduction. AE is an important aspect of the RCM program because determining the optimum interval for performing a preventive maintenance task can be difficult. The RCM analysis is a very systematic process to determine what preventive maintenance tasks should be done. But the process does not tell us when these tasks should be performed.

B.3 Age-reliability relationship. Age exploration requires understanding of how a given material changes over time, and how that change results in a failure mode. If we know the age-reliability relationship for a specific failure mode, it enables us to seek a TD task needed to prevent the failure mechanism related to known aging. Knowing the age-reliability relationship also provides the necessary statistical information to determine the TD task interval.

B.4 TD tasks. However, in reality, the precise age-reliability relationship is usually not known. Therefore, one has to use one's operating experience to estimate the initial task interval for performing a TD task. One is likely to be conservative at this stage, and pick too short an interval. AE is a process to correct this expensive conservatism.

B.5 CD and FF tasks. The applicability of a CD task depends on the ability to measure reduced failure resistance. Its effectiveness depends on the inspection interval. The same is true for FF tasks. Thus, CD and FF tasks also require determination of intervals for inspection and data acquisition. In absence of statistical information to determine such intervals, one is again compelled to estimate, starting out with a conservative periodicity. Here also, one can use AE to correct this expensive conservatism. For a CD task, however, one not only needs to specify a task interval, but also a parameter value indicating a potential failure condition.

B.6 Refining the estimate. After initially estimating a task interval, one can use AE to refine this estimate in a systematic manner to improve the accuracy of the interval. AE is an empirical technique that involves increasing the initial estimate of the task interval by a fixed percentage (say 10 percent), provided a complete and thorough inspection does not indicate any signs of aging or wear and tear. This process is repeated until an inspection indicates signs of aging or wear and tear. Once this happens, the AE process is stopped, the task interval is reduced by the same fixed percentage (say 10 percent), to define the final task interval.

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Navy – SH
(Project SESS-2010-005)

Review activities:

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Navy – AS, CG, CH, EC, MC, ND, NP, OS, SA
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DLA – CC, DH, SO
MISC – DC1, DC5, DI, MDA, MP, NRO, NS
OSD – DMS, HS, MA, SE, SP

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