DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVE SE
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY REFER TO
NAVSEAINST 4790.27B
Ser SEA 05Z-107/488
21 Jan 2022

NAVSEA INSTRUCTION 4790.27B

From: Commander, Naval Sea Systems Command

Subj: CONDITION-BASED MAINTENANCE PLUS AND RELIABILITY-CENTERED MAINTENANCE POLICY FOR SHIPS, SHIP SYSTEMS, AND EQUIPMENT

Ref: See enclosure (1)

Encl: (1) References
(2) SEA 05 CBM+ IPT
(3) NAVSEA CBM+ Organization
(4) RCM, CBM, and CBM+ Background
(5) DoD and OPNAV RCM, CBM, and CBM+ Policies
(6) RCM Training and Certification Program
(7) Notional CBM+ Architecture
(8) CBM+ Performance Requirements
(9) CBM+ Metrics
(10) CBM+ Maturity Levels
(11) CBM+ Definitions

1. Purpose. This instruction implements Department of Defense (DoD) and Department of the Navy (DON) reliability-centered maintenance (RCM), condition-based maintenance (CBM), and condition-based maintenance plus (CBM+) policy per references (a), (b), and (c). This instruction delineates responsibilities for integrating RCM, CBM, and CBM+ into the life cycle maintenance processes for U.S. Navy ships. Further, it is Naval Sea Systems Command's (NAVSEA) policy that CBM+ will be established as the basis for sustainment transformation across the enterprise; will assist NAVSEA to move from reactive to proactive and predictive maintenance; and will be implemented based on a warfighter-focused strategy that employs the most cost-effective maintenance health management methods for the fleet. CBM+ is defined as the integration of RCM and CBM requirements with enabling processes, technologies, and knowledge-based capabilities that enhance the readiness and maintenance effectiveness of DoD systems and components across their life cycle. Figure 1 illustrates the relationships between RCM, CBM, and CBM+. References (a) through (n) apply to the policy of this instruction and its enclosures.

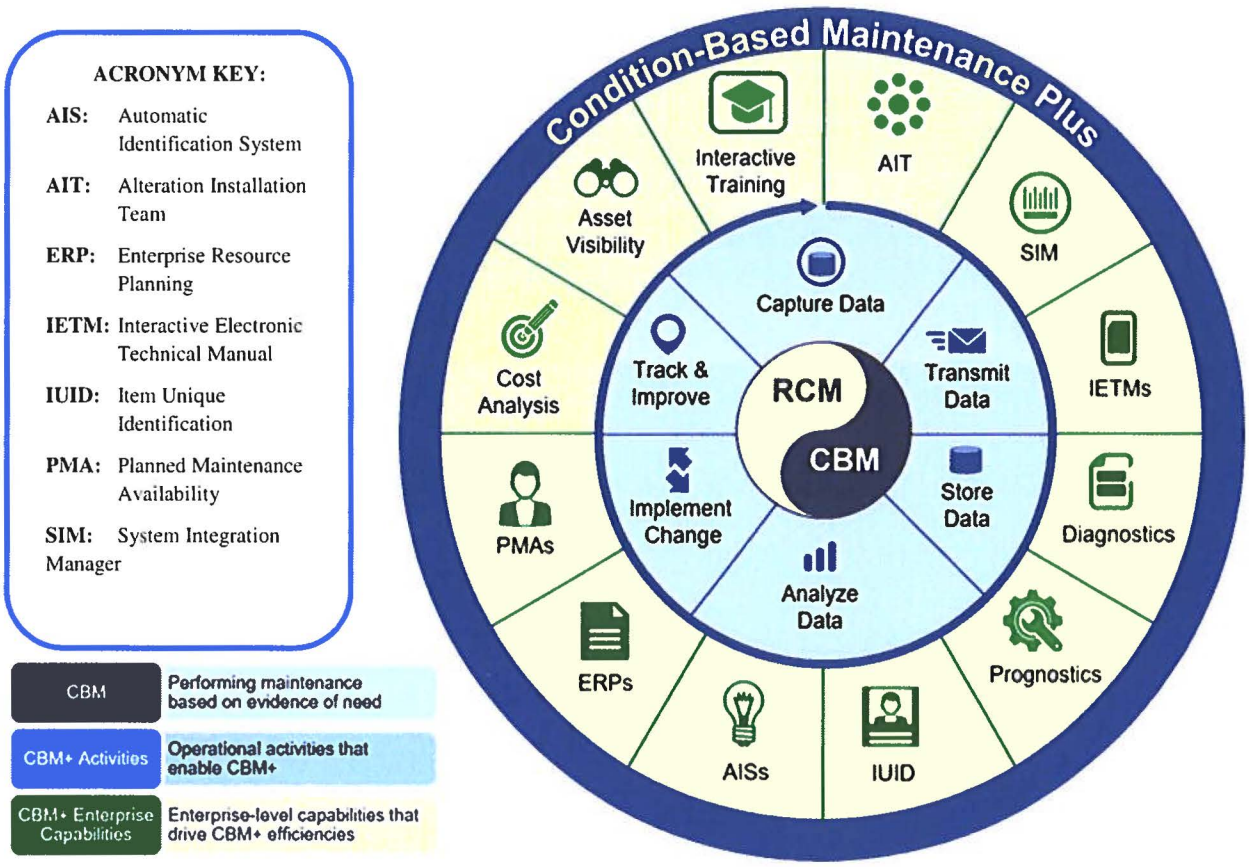


FIGURE 1. RCM, CBM, and CBM+ Relationships

When directed, this instruction provides a process for vetting new CBM+ technologies using the integrated product team (IPT) outlined in enclosures (2) and (3). This instruction is a complete revision and should be reviewed in its entirety. This instruction establishes NAVSEA policy and responsibilities for integrating RCM, CBM, and CBM+ into the life cycle maintenance processes for U.S. Navy ships according to reference (a) as is depicted on figure 1.

2. Cancellation. NAVSEAINST 4790.27A of 30 May 2013.

3. Scope and Applicability. This instruction is subordinate to references (a) and (b) and applies to all acquisition category (ACAT) and business capability acquisition cycle (BCAC) programs; new weapons system procurements (combat systems); hull, mechanical, and electrical (HM&E) procurements; and all modernization programs. It also applies to current weapon systems (which includes ships, service craft, small boats, mission modules and all related equipment, materials, services, personnel, and means of delivery and deployment) and materiel sustainment programs where it is technically feasible, cost effective (against total lifecycle costs, not single color-of-money impacts), and beneficial. It applies throughout the life of all ships, ship systems, and equipment. For the purposes of this instruction, the term "ship" refers to submarines, surface

ships, aircraft carriers, and craft covered by reference (c). Nothing in this instruction detracts from the technical authority of other systems commands (SYSCOM) or activities responsible for safety programs, such as safety of flight or the submarine safety program. The following are exclusions from the scope of this instruction:

a. The Director, Nuclear Propulsion (SEA 08), is responsible for all technical matters pertaining to nuclear propulsion of U.S. Navy ships and craft, including all aspects of integration of the nuclear plant into the ship system. Nothing in this instruction detracts in any way from those responsibilities. Accordingly, SEA 08 must be consulted in all matters pertaining to or affecting nuclear propulsion plants, including all nuclear and non-nuclear propulsion plant systems and components.

b. The Director, Strategic Systems programs (DIRSSP) is responsible for providing materiel support (acquisition and fleet support) to ballistic missile and strategic weapon systems, including missiles, platforms, associated equipment, installation, and direction of necessary supporting facilities. Nothing in this instruction detracts in any way from those responsibilities. Accordingly, DIRSSP must be consulted in all matters pertaining to or affecting strategic systems.

c. Ships, systems, subsystems, and equipment procured solely for Military Sealift Command (MSC) or the United States Special Operations Command (USSOCOM) through the Navy Special Warfare Command are governed by the RCM, CBM, and CBM$^+$ requirements of reference (a). Nothing in this instruction detracts in any way from MSC or USSOCOM development or implementation of maintenance plans for their ships, systems, subsystems, and equipment.

d. Rapid acquisition programs such as Joint Emergent Operational Needs, Maritime Accelerated Capabilities Office, and Joint Urgent Operational Need are governed by the requirements of reference (d). Nothing in this instruction restricts a rapid acquisition process. CBM$^+$ processes and principles applied at the appropriate point in the program life cycle will reduce program sustainment costs.

e. In the process of implementing CBM$^+$ and developing or revising maintenance requirements, it is imperative that all NAVSEA activities and personnel must follow all applicable environmental, safety, and health laws and regulations, as required, per NAVSEA's RCM analysis process documented in and supported by reference (e).

4. Policy

a. This instruction requires that each ship class have a NAVSEA-approved class maintenance plan (CMP), also known as a maintenance and ship work plan, that describes organizational, intermediate, and depot level planned maintenance requirements and that NAVSEA's RCM methodology will be used for the planning, development, review,

modification, verification, and approval of all ship maintenance requirements per reference (c). The NAVSEA-approved RCM methodology for ships, systems, subsystems, and equipment is contained in reference (e). The background on RCM, CBM and CBM+ is found in enclosure (4). DoD and the Operational Navy (OPNAV) RCM, CBM, and CBM$^+$ policies are described in enclosure (5).

b. Programs must conduct RCM analysis as part of the program's overarching product support analysis and systems engineering processes and ensure that the RCM analysis is integrated with the program's overarching product support business case analysis (BCA). Specifically, the BCA(s) will encompass the RCM analysis and the projected reliability, availability, maintainability, operations and support (O&S) cost, and return on investment (ROI) impacts of CBM$^+$ decisions made by the program. BCA(s) on CBM$^+$ decisions will be incorporated into the programs' required overarching product support BCA and life cycle sustainment plan (LCSP).

c. RCM training is an essential component of NAVSEA maintenance policy. RCM training and certification are required by reference (f) for all maintenance managers, engineers, Technical Warrant Holders (TWH), technicians, subject matter experts (SME), and maintenance developers, both Government and commercial contractors, who develop, review, plan, modify, verify, or approve maintenance requirements and maintenance tasks for ships, systems, subsystems, and equipment. Backfit RCM certification is required for those who review, modify, plan, or approve changes to existing, approved maintenance tasks. Classic RCM certification is required for those who develop, review, verify, or approve new maintenance requirements. This applies to organizational, intermediate, and depot level maintenance requirements. A full description of NAVSEA's RCM training and certification program is provided in enclosure (6).

d. RCM and CBM$^+$ will be integrated into the development and management processes critical to ship material readiness throughout its service life. Enclosure (7) illustrates a notional CBM$^+$ architecture.

e. CBM$^+$ refers to the active management of system health based on the collection of timely data related to system performance. It leverages technology (hardware, software, and process management tools) and core RCM attributes to manage failures and failure modes through identification, classification, analysis, and removal (or mitigation) throughout the system's life cycle. The implementation of CBM$^+$ technologies and maintenance approaches for a particular system or platform must be consistent with a BCA showing that the value of CBM$^+$ implementation is expected to exceed the cost. More specifically:

(1) CBM$^+$ utilizes RCM as an enabler and ensures maintenance is performed when needed rather than on a strict schedule. It employs multiple sensors embedded on individual major shipboard systems to record operating parameters and fault codes at the source of the

problem, which allows analysts and engineers to predict the real-time health status of equipment and schedule maintenance before catastrophic failures occur.

(2) The CBM+ process manages the health condition of assets to perform maintenance at the most opportune times, and only when needed, by optimizing the trade-off between maintenance and performance costs. This increases availability and reliability while eliminating unnecessary maintenance. Once a platform has been "CBM+ enabled", fleet managers can make better decisions concerning the level and source of repair.

(3) CBM+ ensures the ability to accurately forecast trends towards a system's not-mission-capable status, based upon asset usage, to prevent catastrophic and mission incapacitating equipment failure.

f. It is NAVSEA policy to ensure that:

(1) CBM+ is included in the development of the mandatory sustainment key performance parameter (KPP) and supporting key system attributes (KSA) required for all ACAT and BCAC programs. Programs with materiel solutions must include CBM+ in the development of the Sustainment KPP or sponsor-defined sustainment metrics per reference (a).

(2) CBM+ is included in the selection of maintenance concepts, technologies, and processes for all new weapon systems, equipment, and materiel programs based on readiness and modernization requirements, life cycle cost goals, and RCM analyses per reference (a).

(3) CBM+ is implemented, per reference (a) and following the process flow in appendix F of reference (e), into current systems, equipment, and materiel sustainment programs. A BCA must be performed that considers equipment availability and reliability and is linked to mission performance and the generation or the prevention of loss of reliable mission days. The mission days must be monetized to perform a cost-to-value comparison.

(4) CBM+ is pursued through a rigorous system engineering analysis with inputs and consideration from supportability elements, which will define the needed sensor systems and analytic capabilities based upon the failure models to be managed. To address these needs, there will need to be examination, evaluation, and implementation of reliability engineering methods and tools, as well as enabling of technologies, tools, and process improvements from both public and private sources per reference (a).

(5) CBM+ technologies, processes, enablers, and workforces are incorporated as part of organic maintenance capabilities, as well as its incorporation into contracts and commercially supported systems or programs per reference (a).

(6) CBM+ implementation is resourced, to include research, development, RCM analysis, system engineering, test, evaluation, transition of new technologies and processes, software

costs, test equipment, training requirements, configuration control, and information assurance compliance required to achieve the desired operational availability throughout the life cycle per reference (a), as well as availability for operational tasking (AOT) requirements.

(7) CBM+ performance requirements are developed and implemented per enclosure (8).

5. Responsibilities

a. NAVSEA CBM+ Leadership. The CBM+ executive steering committee (ESC) chaired by Naval Systems Engineering Directorate (SEA 05) must consist of senior representatives from Cyber Engineering and Digital Transformation (SEA 03), Industrial Operations (SEA 04), Surface Warfare (SEA 21), Program Executive Office (PEO) Carriers, PEO Integrated Warfare Systems (IWS), PEO Ships, PEO Strategic Submarines (SSBN), PEO Attack Submarines (SSN), PEO Unmanned and Small Combatants (USC), and PEO Undersea Warfare Systems (UWS) as described in enclosure (3). The ESC reports directly to Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) for all maintenance requirements, RCM, and CBM+ matters related to class maintenance plans. The ESC oversees both the CBM+ task force (TF) and the CBM+ IPT. The ESC has the following responsibilities:

(1) Establish and direct an end-to-end CBM+ program across all enterprises, as well as support DoD and OPNAV CBM+ policies, practices, and strategies. An end-to-end CBM+ program must have engineering analysis, strategy development, and failure mode model definitions in place before any data acquisition strategy can be defined. Data must be analyzed aboard the ship to provide recommendations to the crew and, ultimately, must be uploaded to shore-based organizations. This approach provides shipboard visibility of system risks and an understanding of the operational consequences from equipment accelerated wear. Because the most effective response to evolving issues is at the deck-plate level, the initial analysis and decision support must be at the organization level. This will also provide for disconnected operations. Shore-side support has a separate role in evaluating effectiveness of the algorithms and updating them as required. The results of the analysis are provided to all relevant organizations (i.e., in-service engineering agent (ISEA), Port Engineer, etc.). Additionally, shipboard personnel must have access to the results of trend analysis based upon the shore-side data archives.

(2) The Office of the Secretary of Defense (OSD) has also established a requirement for CBM+ leadership from each service or SYSCOM to meet periodically with the representative from OSD's maintenance policy and programs office to work toward cross-DoD CBM+ implementation and capabilities. SEA 05 will provide CBM+ principal representation for maintenance execution within the NAVSEA enterprise systems (ES) program of record (POR) within NAVSEA technical authority. SEA 04 will provide CBM+ principal representation for logistics execution, maintenance development, maintenance planning, and maintenance policies.

(3) Standardize CBM+ processes across the NAVSEA enterprise. As a central point of direction for CBM+ matters, the ESC will gather information from the CBM+ TF and the CBM+ IPT regarding the number and scope of all CBM+ projects currently underway and in planning stages. The ESC will review the objectives of each project, as well as its costs and benefits to the fleet. Using this information, the ESC will direct activities that will result in the sharing of CBM+ capabilities across NAVSEA while working to eliminate unnecessary duplication of effort or investment of resources. This is expected to result in cost avoidance and optimization of CBM+ resources across platforms.

(4) Coordinate investment in commercial and Government CBM+ resources. The ESC will review enterprise CBM+ best practices and proposals to evaluate and guide the direction of NAVSEA investment in CBM+ technology and infrastructure. This is expected to streamline investments, thus resulting in cost avoidance and improved logistics support.

(5) CBM+ should be measured for its benefit(s) to mission planning due to its predictability of system readiness. Therefore, the collection of CBM+ metrics data from NAVSEA organizations must be standardized. CBM+ metrics will be of two types: maturity level metrics related to achieving and tracking end-to-end CBM+ across NAVSEA platforms and life cycle sustainment outcome metrics. The maturity level metrics must include data collection, data transmission, data consolidation, data storage requirements, data analysis, analysis products, feedback scheduling, maintenance planning, maintenance and action execution, and system analysis. Life cycle sustainment outcome metrics will consist of how well NAVSEA CBM+ meets the KPP and KSA requirements of availability KPP, reliability KSA, O&S costs KSA, and mean downtime (MDT). CBM+ metric collection requirements are described in enclosure (9). CBM+ maturity levels are defined in enclosure (10) and the CBM+ definitions are listed in enclosure (11).

(6) Meet quarterly or as required.

b. The CBM+ TF. The CBM+ TF will be chaired by Marine Engineering (SEA 05Z) and must consist of appropriate representatives from the following organizations: SEA 03; SEA 04; SEA 05; SEA 21; Naval Sea Logistics Center (NSLC); Commander, Navy Regional Maintenance Centers (CNRMC); PEO Carriers; PEO Expeditionary Warfare; PEO IWS; PEO Ships; PEO SSBN; PEO SSN; PEO USC; PEO UWS; Naval Surface Warfare Centers (NSWC); Naval Undersea Warfare Centers (NUWC); Submarine Maintenance Engineering, Planning, and Procurement (SUBMEPP); Surface Maintenance Engineering Planning Program (SURFMEPP); carrier planning activity (CPA); Fleet Forces Command; Pacific Fleet (PACFLT); and Naval Information Warfare Systems Command (NAVWAR). The CBM+ TF will:

(1) Coordinate CBM+ policies, practices, implementation, and integration strategies across NAVSEA, PEOs, directorates, maintenance planning activities, regional maintenance centers, naval shipyards, warfare centers, maintenance coordinating activities, ships program

managers, program managers, participating acquisition resource managers (PARM), product support managers, life cycle managers (LCM), other acquisition managers, and technical authorities for ships, systems, subsystems, and equipment.

(2) Hold quarterly meetings of the TF members to share information and report progress and status of action items.

(3) Develop a common concept of operations (CONOPS) on how CBM+ data is used and by whom.

(4) Identify whether CBM+ data should be classified, for how long, and develop a process for data declassification.

c. NAVSEA CBM+ IPT. The CBM+ IPT will be composed of representatives from the applicable functional disciplines working together to build successful programs, identify and resolve issues, and make sound and timely recommendations to facilitate NAVSEA CBM+ ESC decision making. When directed by the NAVSEA CBM+ ESC, the operation of the IPT will be to follow enclosures (2) and (3). IPTs are used during the development and review of complex CBM+ systems, projects, and programs. The emphasis of the CBM+ IPT is on the involvement of all stakeholders (users, customers, management, developers, and contractors) in a collaborative forum.

The CBM+ IPT will be chaired by SEA 05Z and will consist of designated representatives from SEA 03, SEA 04, SEA 05 (includes Afloat Cybersecurity Engineering Directorate (05Q) and Technology Office (05T)), SEA 21, PEOs and program managers, TWHs (as applicable), ISEAs, waterfront representatives or regional maintenance centers (as required), industry, U.S. Fleet Forces (by invitation), PACFLT (by invitation), and NAVWAR (by invitation).

d. Cyber Engineering and Digital Transformation (SEA 03). SEA 03 will:

(1) Provide support for the development and implementation of CBM+ cybersecurity strategies that enhance resiliency on Navy afloat, undersea, and associated shore-based systems and exercise certification authority for CBM+ cybersecurity processes and equipment improvements on afloat and undersea systems. Assist in CBM+ cybersecurity technology development efforts for enhancements on afloat and undersea systems and collaborate with PEOs and warfare centers to leverage efforts across NAVSEA platforms and warfare systems.

(2) Provide a representative on the SEA 05 CBM+ IPT to provide guidance on the implementation of new CBM+ cybersecurity processes and policies on afloat and undersea systems.

e. Industrial Operations (SEA 04). SEA 04 is COMNAVSEASYSCOM's central point of contact for maintenance policy and the process owner for RCM and CBM. SEA 04 is also the program manager for the ships' maintenance and material management program and NAVSEA's RCM training and certification program. SEA 04 will:

(1) Oversee RCM and CBM policy implementation across NAVSEA, PEOs, directorates, maintenance planning activities, regional maintenance centers, naval shipyards, warfare centers, maintenance coordinating activities, ships program managers, program managers, PARMs, product support managers, LCMs, maintenance developing activities, other acquisition managers, technical authorities, and maintenance requirements developers for ships, systems, subsystems, and equipment.

(2) Serve as a member of the CBM$^+$ ESC.

(3) Ensure incorporation of RCM, CBM, and CBM$^+$ principles in the establishment and updating of CMPs through periodic fleet maintenance effectiveness reviews (FLEETMER), RCM Workshops, and other RCM-based analyses.

(4) Certify or re-certify all Backfit RCM and Classic RCM instructors and facilitators per references (e) and (f).

(5) Oversee all maintenance plan processes for developing, standardizing, and improving maintenance requirements.

(6) Coordinate with the CBM$^+$ TF on the sharing of CBM$^+$ data for use in maintenance improvements (e.g., integrated condition assessment (ICAS) or enterprise remote monitoring (eRM) data use during the evaluation of planned maintenance requirements).

(7) Provide a representative on the NAVSEA CBM$^+$ IPT.

(8) Provide personnel who develop, review, plan, verify, modify, or approve maintenance requirements RCM training and certification per references (e) and (f).

(9) Support the development of organizational, intermediate, and depot level maintenance requirements. This includes technical feedback report (TFBR) resolution and working with NAVSEA PEOs and directorates to include CBM$^+$ identified requirements.

(10) Ensure RCM and CBM requirements for maintenance development and management will be included in the 081 Section (Maintenance Planning) of S9000-AD-SPN-010, Naval Combatant Design Specification.

(11) Represent COMNAVSEASYSCOM in forums resolving DoD and Navy-wide RCM and CBM policy issues.

(12) Conduct maintenance requirements compliance reviews in support of independent logistics assessments (ILA), and as necessary, to ensure compliance with DoD, OPNAV, and NAVSEA maintenance policies.

(13) Provide a representative to the CBM+ TF.

f. Naval Systems Engineering Directorate (SEA 05). SEA05 will provide the technical authority stewardship for CBM+ practices and ensure engineers executing CBM+ concepts are integrated into the applicable TWH's support network. Additionally, SEA 05 will ensure the inclusion of CBM+ technical requirements into the program's system engineering process and technical reviews. SEA05 will support the NAVSEA CBM+ IPTs as members in addition to the other responsibilities detailed below.

(1) SEA 05Z is COMNAVSEASYSCOM's central point of contact for the execution of maintenance policies within the Navy CBM+ ES POR and under the applicable warranted technical areas for HM&E systems, subsystems, and equipment. SEA 05Z will:

(a) Establish CBM+ processes to solve the challenge of providing continuous and dedicated data consolidation and analysis of CBM+ data in assigned shore activities.

(b) Define standard equipment data collection requirements to support the end-to-end CBM+ process.

(c) Establish and maintain a standardized set of equipment failure mode models that can be reused across similar systems, subsystems, and equipment across submarine, aircraft carrier, and surface ship enterprises.

(d) Define the information system architecture options, including data storage, applications integration, and user interfaces that will support business, technical, and operational decision management, as determined by CBM+ requirements.

(e) Identify workflow automation elements that must be implemented to enable the CBM+ process.

(f) Establish a CBM+ point of contact for each product area to provide analysis of shipboard CBM+ data in a timely manner to operational commands.

(g) Ensure that CBM+ requirements for maintenance development and management will be included in the 081 Section (Maintenance Planning) of S9000-AD-SPN-010.

(h) When directed by the ESC, establish a CBM+ IPT using enclosures (2) and (3).

(i) Serve as chair of the CBM+ ESC.

(2) Readiness and Logistics (SEA 05R) is COMNAVSEASYSCOM's central point of contact for the execution of acquisition logistics and for advancing common variance reduction policies and processes to deliver affordable, reliable, and mission-supporting systems. SEA 05R will:

(a) Provide a representative to the NAVSEA CBM+ IPT.

(b) Provide a representative to the NAVSEA CBM+ TF.

(c) Assist in the development and implementation of innovative and sustainable CBM+ acquisition and maintenance solutions.

(d) Provide supportability inputs into CBM+ requirements.

(3) SEA 05T engineers, research analysts, program managers, and support staff provide CBM+ research and development (R&D) management and engineering support to NAVSEA. SEA 05T serves as the program authority for assigned CBM+ R&D programs and SMEs for the CBM+ R&D competency. SEA 05T will:

(a) Provide assistance to NAVSEA and sponsors in the decision process for planning, budgeting, and execution of studies, tool development, design, and prototyping of CBM+ technologies, subsystems, and whole systems.

(b) Provide a representative on the NAVSEA CBM+ IPT.

g. Surface Warfare (SEA 21). SEA 21 will:

(1) Provide CBM+ life cycle support for all non-nuclear surface ships.

(2) Be the principal interface with the surface warfare enterprise on all matters related to CBM+.

(3) Equip today's surface ships with the latest CBM+ technologies and systems to maximize readiness by utilizing planned modernization and upgrade programs throughout the service life of a ship.

(4) Ensure systems, subsystems, and equipment programming and budgeting plans will include funding for RCM, CBM, and CBM+ during acquisition and sustainment, software costs, test equipment and calibration requirements, configuration control, cybersecurity compliance, ISE PMS technical development and approval, TFBR resolution, and organizational RCM reviews and processing throughout the systems, subsystems, and equipment life cycle.

(5) Provide a representative to the NAVSEA CBM+ IPT.

(6) Provide a representative to the NAVSEA CBM+ TF.

h. PEOs and Directorates (other than IWS). PEOs and program managers (other than IWS) will:

(1) Support DoD, Secretary of the Navy (SECNAV), OPNAV, and NAVSEA policies and requirements for RCM, CBM, and CBM+ acquisition, implementation, and sustainment requirements during the life cycle of NAVSEA's submarines, surface ships, aircraft carriers, shore activities, systems, subsystems, and equipment, including acquisition and sustainment processes and requirements.

(2) Provide a full range of research, development, tests, and evaluations of CBM+ technologies that support the USW mission area.

(3) Coordinate the development of CBM+ technologies to maximize USW mission readiness.

(4) Ensure RCM, CBM, and CBM+ requirements for maintenance development and management are included in the 081 Section (Maintenance Planning) of S9000-AD-SPN-010.

(5) Ensure that approved CBM+ performance requirements are implemented.

(6) Provide representation, as required, to the NAVSEA CBM+ IPT (PEO Carriers, PEO Ships, PEO SSBN, PEO SSN, PEO USC, and PEO UWS).

(7) Provide representation, as required, to the NAVSEA CBM+ TF (PEO Carriers, PEO Ships, PEO SSBN, PEO SSN, PEO USC, and PEO UWS).

(8) Provide program management for RCM, CBM, and CBM+ development and implementation during acquisition, execution, and sustainment phases.

(9) Provide SMEs to identify CBM+ ship, system, subsystem, and equipment solutions throughout acquisition and sustainment.

(10) Ensure data analysis starts at the equipment level during acquisition and sustainment, with visibility of current and predicted risk provided to the crew.

(11) After shipboard analysis and deck-plate actions have been completed, ensure the on-time delivery of shore-based analyses of shipboard CBM+ data to ships, fleet, and operational commands during sustainment.

(12) Ensure TWH involvement during the acquisition and sustainment processes, including invitation to all ILA milestone reviews, to ensure that CBM$^+$ technologies are incorporated where feasible and effective.

(13) During the modernization process, ensure TWH review is conducted for concurrence, as part of the Navy modernization plan ship change documents (SCD), to promote the inclusion of CBM$^+$ technologies where feasible and cost effective.

(14) Provide a CBM$^+$ point of contact for every ship, system, subsystem, and equipment acquisition program.

(15) Ensure maintenance programs, CMPs, and maintenance requirements are adequately developed using NAVSEA's RCM process during acquisition for all LCSPs, procurement specifications, program funding, and systems engineering plans for all platforms, equipment, subsystems, and systems.

(16) Ensure systems, subsystems, and equipment programming and budgeting plans will include funding for RCM, CBM, and CBM$^+$ during acquisition and sustainment, software costs, test equipment and calibration requirements, configuration control, cybersecurity compliance, ISE PMS technical development and approval, TFBR resolution, and organizational RCM reviews and processing throughout the systems, subsystems, and equipment life cycle.

(17) Ensure funding is provided to establish and maintain a standardized set of equipment failure mode models that can be reused across similar systems, subsystems, and equipment across submarine, aircraft carrier, and surface ship enterprises.

(18) For CBM$^+$ inclusion technologies, ensure the SCD sponsor has mature logistics products (spare parts, documentation, training, etc.) per the Navy's modernization process.

(19) Report status of CBM$^+$ implementation including status of metrics or maturity levels mandated by this instruction to the CBM$^+$ senior leadership as required. CBM$^+$ metrics will be of two types: maturity level metrics related to achieving and tracking end-to-end CBM$^+$ across NAVSEA ships and life cycle sustainment outcome metrics.

(a) The maturity level metrics will include data collection, data transmission, data consolidation, data storage, data analysis (diagnostics and prognostics), analysis products, and shore-to-ship feedback communication capability, maintenance planning, maintenance and action execution, and system analysis. CBM$^+$ maturity levels will be reported against the functional areas. CBM$^+$ maturity level descriptions, functional area definitions, and supporting information are found in enclosures (10) and (11).

(b) Life cycle sustainment outcome metrics will include the KPP and KSAs requirements of sustainment KPP, reliability KSAs, O&S costs KSAs, and MDT. Life cycle sustainment metrics are described in enclosure (9).

(20) Consult with the CBM+ TF to validate CBM+ requirements development for all fleet platforms, equipment, subsystems, and systems.

i. PEO IWS. PEO IWS is Commander, NAVSEA's point of contact for combat systems CBM+ implementation and will:

(1) Establish shore-based CBM+ processes to solve the challenge of providing continuous and dedicated data consolidation and analysis.

(2) Define standard equipment data collection requirements to support the end-to-end CBM+ process.

(3) Establish and maintain a standardized set of equipment failure mode models that can be reused across similar systems, subsystems, and equipment across submarine, aircraft carrier, and surface ship enterprises.

(4) Define the information system architecture options, including data storage, applications integration, and user interfaces, which will support business, technical, and operational decision management, as determined by CBM+ requirements.

(5) Identify workflow automation elements that must be implemented to enable the CBM+ process.

(6) Establish a maintenance plan and CBM+ point of contact for each product area to provide analysis of shipboard CBM+ data in a timely manner to operational commands.

(7) Ensure that CBM+ requirements for maintenance development and management will be included in the 081 Section (Maintenance Planning) of S9000-AD-SPN-010.

(8) Ensure systems, subsystems, and equipment programming and budgeting plans will include funding for RCM, CBM, and CBM+ during acquisition and sustainment, software costs, test equipment and calibration requirements, configuration control, cybersecurity compliance, ISE PMS technical development and approval, TFBR resolution, and organizational RCM reviews and processing throughout the systems, subsystems, and equipment life cycle.

(9) Ensure funding is provided to establish and maintain a standardized set of equipment failure mode models that can be reused across similar systems, subsystems, and equipment across submarine, aircraft carrier, and surface ship enterprises.

j. Warfare Centers. Warfare centers will, to the extent tasked and resourced by PEOs and others:

(1) Establish CBM+ processes that provide continuous and dedicated data consolidation and analysis of CBM+ data in assigned shore activities.

(2) Define standard equipment data collection requirements to support the end-to-end CBM+ process.

(3) Establish and maintain a standardized set of equipment failure mode models that can be reused across similar systems, subsystems, and equipment across submarine, aircraft carrier, and surface ship enterprises.

(4) Define the information system architecture options, including data storage, applications integration, and user interfaces, that will support the business, technical, and operational decision management, as determined by CBM+ requirements.

(5) Identify workflow automation elements that must be implemented to enable the CBM+ solution to require minimal crew man-hours at the shipboard level.

(6) Establish a maintenance plan and CBM+ point of contact for each product area to provide analysis of shipboard CBM+ data in a timely manner to operational commands.

(7) Support RCM development, review, approval, and improvement of maintenance requirements, including PMS and related TFBR resolution and CBM+ implementation.

(8) Provide assistance to NAVSEA and sponsors in the decision process for planning, budgeting, and execution of studies, tool development, design, and prototyping of CBM+ technologies, subsystems, and whole systems.

(9) Provide a representative to the NAVSEA CBM+ TF.

(10) Maintain NAVSEA RCM certification for maintenance developers per appendix J of reference (f).

(11) Develop, maintain, and train a workforce that is capable of designing, developing, updating, maintaining, and operating the CBM+ solution.

k. Commander, Fleet Forces Command (COMUSFLTFORCOM). COMUSFLTFORCOM is invited to participate in the CBM+ TF to provide fleet requirements input.

l. NAVWAR. NAVWAR is invited as part of the CBM+ TF to advise NAVSEA with respect to data transmission, equipment, and systems under their responsibility.

6. Records Management

a. Records created as a result of this instruction, regardless of format or media, must be maintained and dispositioned per the records disposition schedules located on the DON/Assistant for Administration, Directives and Records Management Division (DON/AA DRMD) portal page at https://portal.secnav.navy.mil/orgs/DUSNM/DONAA/DRM/Records-and-Information-Management/Approved%20Record%20Schedules/Forms/AllItems.aspx.

b. For questions concerning the management of records related to this instruction or the records disposition schedules, please contact your local records manager.

7. Review and Effective Date. Per OPNAVINST 5215.17A, SEA 05Z will review this instruction annually around the anniversary of its issuance date to ensure applicability, currency, and consistency with Federal, DoD, SECNAV, and Navy policy and statutory authority using OPNAV 5215/40 Review of Instruction. This instruction will be in effect for 10 years, unless revised or cancelled in the interim, and will be reissued by the 10-year anniversary date if it is still required, unless it meets one of the exceptions in OPNAVINST 5215.17A, paragraph 9. Otherwise, if the instruction is no longer required, it will be processed for cancellation as soon as the need for cancellation is known following the guidance in OPNAV Manual 5215.1 of May 2016.

W. J. GALINIS

Releasability and distribution:
This instruction is cleared for public release and is available electronically only via the NAVSEA Public Web site located at http://www.navsea.navy.mil/Resources/Instructions/

REFERENCES

Ref:
(a) DoD Instruction 4151.22, Condition Based Maintenance Plus for Materiel Maintenance, of 14 August 2020
(b) OPNAVINST 4790.16B, Condition-Based Maintenance and Condition-Based Maintenance Plus Policy, of 01 October 2015
(c) OPNAVINST 4700.7M, Maintenance Policy for Navy Ships, of 08 May 2019
(d) SECNAVINST 5000.42, Department of the Navy Accelerated Acquisition for the Rapid Development, Demonstration and Fielding of Capability, of 22 December 2016
(e) MIL-STD-3034A, Reliability-Centered Maintenance (RCM) Process, of 29 April 2014
(f) NAVSEAINST 4790.8D, Ships' Maintenance and Material Management (3-M) Manual, of 17 June 2021
(g) DoDM 4151.22, Reliability Centered Maintenance (RCM), of 30 June 2011
(h) Condition Based Maintenance Plus DoD Guidebook, of May 2008
(i) OPNAVINST 4790.4F, Ship's Maintenance and Material Management System Policy, of 27 October 2014
(j) SECNAV M-5239.1, Department of the Navy Information Assurance Manual, of 01 November 2005
(k) DoD Instruction 8500.01, Cybersecurity, of 14 March 2014
(l) NAVSEAINST 9400.2A, NAVSEA Platform Information Technology-Control Systems Cybersecurity Governance and Guidance, of 20 September 2016
(m) NAVSEA SL720-AA-MAN-030, Navy Modernization Process Management and Operations Manual (NMP-MOM), of 19 January 2018
(n) Surface Warfare Enterprise, Top Level Requirements for Condition Based Maintenance, V1.0, of 06 December 2007

SEA 05 CBM+ IPT

An IPT is a team composed of representatives from appropriate functional disciplines working together to build successful programs, identify and resolve issues, and make sound and timely recommendations via the appropriate engineering review board (ERB) to facilitate leadership decision making. IPTs are used to review complex systems, developmental programs, and projects in order to aid in decision making. The IPT emphasizes a collaborative involvement between all stakeholders (users, customers, management, developers, and contractors).

Decision memos offer advice on critical decisions that will be made and recommend a course of action. As such, the ability of the IPT to covey complex information in a simple way is key. Also important is the IPT's forethought about the consequences of those decisions.

The steps of the CBM+ IPT process are as follows:

1. Define the CBM+ product and technology purpose and scope (Milestone 1) (applicable TWH or Program Office). The decision memorandum (DM) request is submitted by the applicable TWH or program office representative. The DM will include a draft document that will define the purpose of the DM. In defining the purpose, a concise description should:

a. Provide background on the issue.

b. Describe the problem.

c. Clearly articulate the objectives.

d. Characterize the potential impacts to the affected equipment.

e. Suggest potential approaches that may lead to a solution.

f. Summarize the goal(s).

g. Include a statement of work (SOW) that addresses all the areas discussed in the purpose statement.

h. Assign a DM number and title.

i. List organizations, sources, or contractors involved.

j. Develop and utilize the IPT CBM+ organization chart, appropriate to the issue at hand, to generate IPT invite(s), itinerary, meeting location and time, and agenda for the DM Milestone 2 review.

2. IPT review of purpose and SOW (Milestone 2) (IPT). During Milestone 2, the following occurs:

a. Submit a draft of the DM purpose statement and SOW to the IPT for review, collaboration, discussions, and concurrence.

b. Modify the DM draft(s) based upon the inputs from the IPT.

c. Prepare the ERB pre-brief that summarizes the DM issues, proposed solutions, and the recommendations of the IPT.

d. Review and revise the list of organizations, sources, or contractors "nominated" to perform work.

e. Utilize the ERB organization chart, appropriate to the issue at hand, to generate ERB invite(s), itinerary, meeting location and time, and agenda for the DM ERB review and approval (Milestone 3).

3. ERB review and approval of IPT-recommended purpose and SOW (Milestone 3) (ERB). During Milestone 3, the following occurs:

a. Present the IPT-recommended purpose statement and SOW to the ERB for discussion, consideration, and technical approval.

b. Present the IPT-recommended list of organizations (including Naval Surface Warfare Center Philadelphia (NSWCPD)), sources, or contractors "nominated" to perform the work for approval.

c. Conduct a roll-call vote among the ERB membership on the DM.

d. Record and address any ERB comments and concerns with each DM and publish the final technically approved purpose and SOW.

e. Forward the ERB technically approved DM purpose and SOW to the appropriate program office for funding of the engineering analysis.

4. Acquire rough order of magnitude (ROM) for the approved SOW from approved organizations, sources, or contractors (Milestone 4) (IPT Coordinator). During Milestone 4, the IPT coordinator requests ROM(s) from ERB approved organizations, sources, or contractors.

5. Submission of funding request and ROM to the appropriate program office (Milestone 5) (Program Office). During Milestone 5, the following occurs:

a. Submit SEA 05 ERB-approved funding request or ROM to the appropriate program office, requesting funding for a specified ROM, SOW, and contractor or organization to conduct the engineering analysis within the scope of the previously approved purpose or SOW.

b. Review all documentation and conduct fact finding, as necessary.

c. Determine funding. If the determination is made not to fund the DM, the program office notifies the ERB of its decision and the DM is returned to the ERB (Milestone 3) for closure consideration.

d. If the determination is made to fund the DM, program office funds specified ROM, SOW, and contractor or organization to conduct the engineering analysis within the scope of the previously approved purpose or SOW and the DM advances to Milestone 6.

6. Conduct engineering analysis (Milestone 6) (Contractor/Organization/Warfare Center). During Milestone 6, the following occurs:

a. Conduct engineering analysis following the ERB-approved purpose or SOW.

b. Prepare a listing of contractor and organization CBM$^+$ design change recommendations for IPT review, including all previous analyses and associated documentation.

c. Provide a final report that includes recommendations for CBM$^+$ components or system changes.

d. Utilize the IPT CBM$^+$ organization chart, appropriate to the issue at hand, to generate IPT invite(s), itinerary, meeting location and time, and agenda (in preparation for Milestone 7).

7. IPT analysis review (Milestone 7) (IPT). During Milestone 7, the following occurs:

a. Conduct a review of the detailed DM, SOW, engineering analysis and recommendations for CBM$^+$ components or system changes.

b. Provide comments and modify findings and recommendations, as required.

c. Generate a pre-ERB summary of analysis, final report, and recommendations.

d. Forward the DM to the ERB with final IPT technical recommendations.

e. Utilize the ERB organization chart, appropriate to the issue at hand, to generate ERB invite(s), itinerary, meeting location and time, and agenda for Milestone 8.

8. ERB adjudicates DM for technical approval (Milestone 8) (ERB). During Milestone 8, the following occurs:

a. Submit IPT findings and recommendations to the ERB for technical approval.

b. Revise the DM (if necessary).

c. Conduct a roll-call vote to provide technical approval of each individual DM recommendation.

d. If the ERB determines that the CBM$^+$ component or system does not adequately meet the requirements laid out in the purpose and SOW of the DM, return the DM to Milestone 7 for review and revision. The ERB can also decide that the DM should be closed. If it is closed, outline the reasons for closure in a closing statement.

9. DM forwarded to SEA 05Z for concurrence (Milestone 9) (SEA 05Z/Senior Executive Service). During Milestone 9, the following occurs:

a. Receive the DM with approval recommendation from ERB for concurrence.

b. If SEA 05Z does not concur, return the DM to the ERB (Milestone 8) for review, revision, or closure.

10. DM forwarded to SEA 05 for concurrence (Milestone 10) (SEA 05). During Milestone 10, the following occurs:

a. Receive the DM with approval recommendation from SEA 05Z for concurrence.

b. If SEA 05 does not concur, return the DM to the ERB (Milestone 8) for review, revision, or closure.

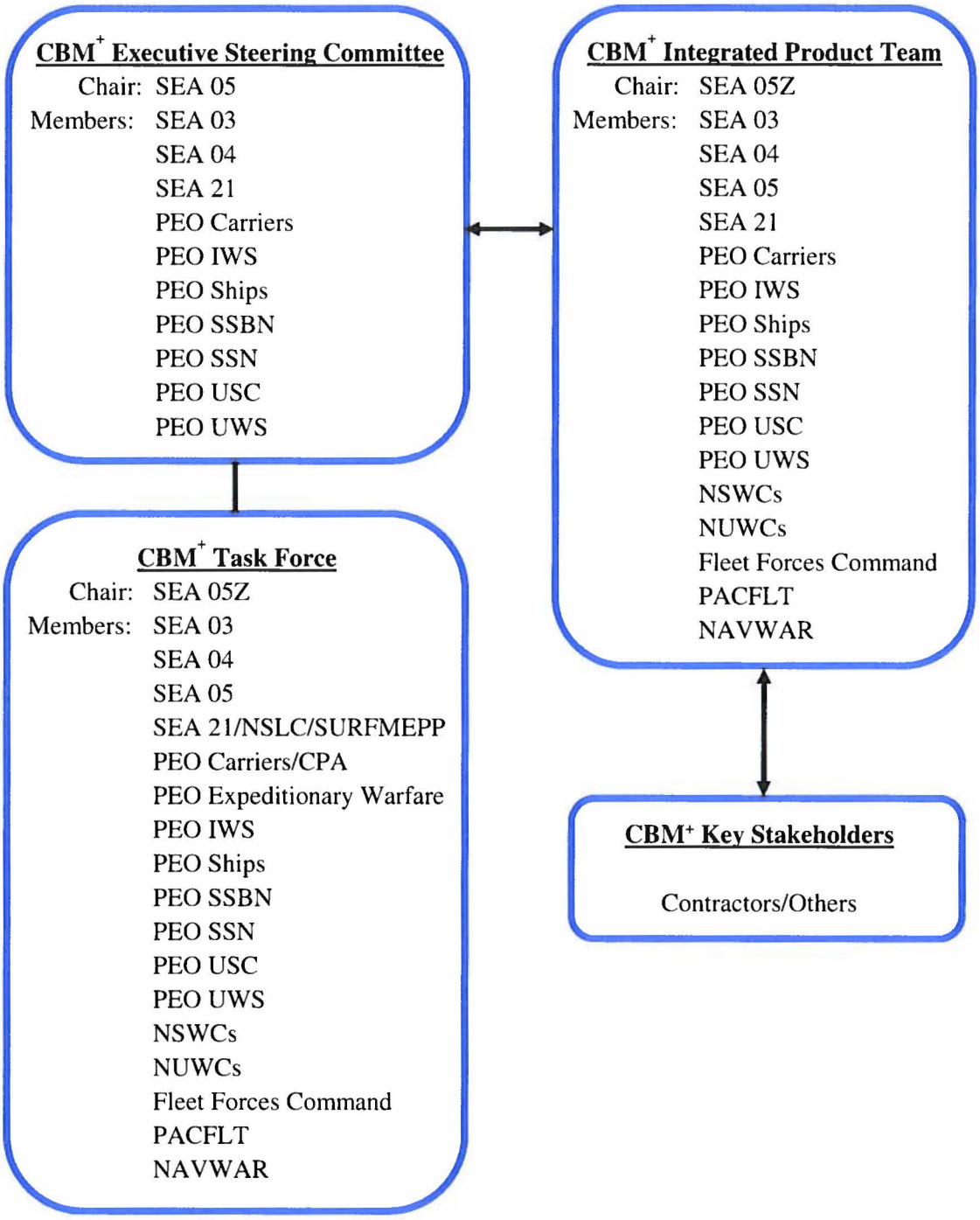
11. DM forwarded to SEA 00 for approval (Milestone 11) (SEA 00). Milestone 11 involves:

a. Receive the DM with approval recommendation from SEA 05 for approval.

b. If SEA 00 does not concur, return the DM to ERB (Milestone 8) for review, revision, or closure.

c. If SEA 00 approves the DM, forward it to the appropriate program office for an SCD or engineering change request initiation.

NAVSEA CBM+ ORGANIZATION



RCM, CBM, and CBM+ BACKGROUND

1. In the 1960s, the airline industry started a maintenance revolution called RCM. The DoD believed this process to be promising and, in 1978, commissioned a commercial airline to describe the RCM philosophy and methodology in the form of a manual. This volume, titled "Reliability-Centered Maintenance", is the capstone document for all RCM processes we use today. After the DoD published this RCM manual, the individual service branches followed suit with their applications of RCM. SEA 04 originated the first Navy RCM military specification, MIL-P-24534A, Planned Maintenance System: Development of Maintenance Requirement Cards, Maintenance Index Pages, and Associated Documentation, in 1985.

2. The push to implement CBM took a step forward for all ships with the initial installation of an ICAS in 1995. ICAS provides the capability to monitor machinery condition and, through analysis, the ability to diagnose or identify potential failures.

3. In 1996, NAVSEA initiated a systematic Backfit RCM-based review of all existing ship maintenance known as the surface ship maintenance effectiveness review (SURFMER). The SURFMER process evolved into today's FLEETMER, which is a Backfit RCM-based disciplinary examination of all levels of maintenance utilizing combined NAVSEA, fleet, and engineering integrated teams. The cross-enterprise reviews involve maintenance coordinating activity and maintenance planning activity participants from the submarine, surface ship, and aircraft carrier enterprises, engineering activities, equipment specialists, and TWHs responsible for systems, subsystems, and equipment described in CMPs.

4. In 2004, a series of facilitated Classic RCM analyses were conducted in support of an ongoing submarine type commander maintenance effectiveness review (MER) initiative. This evolved into the Classic RCM Workshop process, which is now available for all ship enterprises. RCM Workshops complete facilitated Classic RCM analyses in a collaborative group environment to re-engineer the CMP; participants include NAVSEA, the fleet, TWHs, maintenance planning activities, engineering activities, maintenance coordinating activities, equipment specialists, and maintenance executing activity personnel.

5. The proactive maintenance planning-engineering analysis (MP-EA) process was developed in 2005 and was designed to identify and prioritize systems, subsystems, and equipment candidates for Classic RCM Workshop analysis using objective data and feedback to assess maintenance burden. In 2008, the Common Maintenance Planning Working Group adapted the MP-EA process to prioritize systems, subsystems, and equipment across all ship enterprises for all types of RCM reviews including FLEETMERs, RCM Workshops, and other RCM-based analyses.

6. In 2007, the DoD identified RCM as the basis for CBM$^+$ with the publication of reference (a) and later developed references (g) and (h). The DON updated its RCM and CBM policy with references (b), (c), and (i), which also reinforced the relationship between RCM, CBM, and CBM$^+$.

7. In 2009, NAVSEA issued its RCM and CBM instruction (NAVSEAINST 4790.27) aligning NAVSEA policy with DoD and OPNAV specific RCM-based maintenance development requirements and applicability to the defense acquisition system.

8. To update the RCM process first established with MIL-P-24534A, NAVSEA published reference (e), which was issued in 2011. Reference (e) was updated and reissued in 2014. The NAVSEA-approved process for conducting both Classic RCM and Backfit RCM analysis is contained in reference (e).

9. Reference (c) requires that each ship class have a tailored and approved RCM-based CBM program that includes organizational, intermediate, and depot level maintenance requirements. It also requires that each ship class have a NAVSEA-approved CMP that describes organizational, intermediate, and depot level planned maintenance requirements and that RCM will be used in the determination of these maintenance requirements.

10. CBM$^+$ is the next logical step in the evolution of maintenance, based on evidence of need. This includes a conscious effort to shift maintenance from a calendar-based approach to a more proactive and predictive approach driven by analysis-based decisions. CBM$^+$ uses maintenance enabling technologies to provide accurate predictions of potential failures based on data that improves maintenance decisions and, ultimately, system and equipment availability.

DOD AND OPNAV RCM, CBM, AND CBM+ POLICIES

1. DoD CBM+ Policy. Reference (a) directs CBM+ to be used as the primary reliability driver in the total life cycle systems management supportability strategy of the DoD. CBM+ strives to optimize key performance measures of availability, materiel reliability, and O&S costs and to minimize MDT. CBM+ is defined as the application and integration of appropriate processes, technologies, and knowledge-based capabilities to improve the reliability and maintenance effectiveness of DoD systems and components. CBM+ uses a system engineering approach to collect data, enable analyses, and support the decision-making process for system acquisition, sustainment, modernization, and operations.

a. CBM+ is a comprehensive strategy to select, integrate, and focus a number of process improvement capabilities, thereby enabling maintenance managers and their customers to attain the desired levels of system and equipment readiness in the most cost-effective manner across the total life cycle of the system.

b. The DoD has produced a CBM+ guidebook, reference (h), that provides detailed goals and objectives for the implementation of CBM+.

c. Maintenance comprises a major portion of total ownership costs for Navy weapons systems. Maintenance programs must balance safe materiel condition, readiness, environmental compliance, and cost throughout the ship's life cycle to include acquisition, sustainment, modernization, and operations. Unnecessary maintenance contributes to inflated total ownership costs and reduced availability of deployable assets. RCM, as defined in reference (a), provides the maintenance engineering principles used to determine objective evidence of need and reference (e) provides the methodology for determining and continuously improving applicable and effective maintenance requirements and associated maintenance procedures. The goal is to achieve inherent system and equipment reliability. When maintenance has been properly identified using RCM, and where CBM+ is implemented, it is performed based upon the objective evidence of need.

d. Reference (a) requires CBM+ policy to be incorporated into existing maintenance programs and into the integrated product support program elements for systems, subsystems, and equipment under acquisition. Navy policy directs that CBM+ must be documented in the system engineering plan and the LCSP program and assessed during acquisition process reviews and evaluations per reference (b).

2. Chief of Naval Operations (CNO) CBM+ Policy. Reference (b) states:

a. CBM+ must provide a basis for maintenance decisions that focus limited resources on the maintenance most needed to ensure safety and mission readiness. CBM+ methodology must be used to determine maintenance decisions and reduce scheduled maintenance and manpower

requirements. It must be used to improve operations while reducing sustainment costs and ensuring that appropriate maintenance is performed.

b. Organic monitoring and control systems must be utilized where applicable to aid in failure analysis and optimize maintenance planning.

c. The transition to CBM$^+$ involves changes in policy, processes, procedures, information systems, and logistics support. To this end, maintenance programs must incorporate CBM$^+$ strategy to the maximum possible extent, where proven cost-effective through a BCA.

d. CBM$^+$ strategy must be used to:

(1) Determine maintenance decisions and optimize calendar-based scheduled maintenance, unscheduled maintenance, and manpower requirements, while reducing operating and sustainment costs and ensuring appropriate maintenance is performed.

(2) Minimize equipment failures and improve operational availability by providing real-time prognostic and diagnostic monitoring capabilities, automated repair scheduling, updating preventive maintenance schedules, and automated parts acquisition processes for afloat and ashore warfighting and infrastructure systems across the Navy.

(3) Reduce total ownership cost by eliminating unnecessary maintenance and accurately pre-positioning required assets for an effective logistics footprint in support of war-fighting requirements.

e. For legacy systems, rapid system demonstration and testing is desired to evaluate CBM$^+$ technologies. Initial logistics support need only be sufficient to ensure valid testing and proof-of-concept. Prior to comprehensive and repetitive installation of CBM$^+$ supported systems or equipment, complete logistics support is required.

f. CBM$^+$ implementation must include training for maintenance managers, technicians afloat, technical support personnel ashore, and maintenance requirements developers. Embedded and on-board training capabilities must be identified in training maintenance management and logistics support information systems. The impact of information systems data collection, processing, and warehousing requirements on afloat and ashore resources must be included in system design, development, and life cycle planning.

g. All CBM$^+$ technologies must be compliant with Navy information assurance and cybersecurity policies per references (j), (k), and (l).

h. CNO will fund naval programs, processes, and enabling technologies proven applicable and effective in supporting the maintenance, manning, and cost-reduction objectives of this instruction following the entitled process in reference (m).

i. CBM+ metrics must be tracked as specified in reference (a).

3. CNO Maintenance Policy for Navy Ships. Reference (c) requires that each ship class have a tailored and approved RCM-based CBM program that includes organizational, intermediate, and depot level maintenance requirements. It also requires that each ship class have a NAVSEA-approved CMP that describes organizational, intermediate, and depot level planned maintenance requirements and that RCM will be used in the determination of these maintenance requirements.

RCM TRAINING AND CERTIFICATION PROGRAM

1. Purpose. To institutionalize RCM methodology for NAVSEA maintenance managers, engineers, program managers, and contractors tasked with developing, reviewing, modifying, verifying, planning, and approving maintenance requirements and documentation for all levels of maintenance.

2. RCM Certification Categories. There are four RCM certifications that meet the distinctly different maintenance program responsibilities that exist. Individual certifications include:

a. Backfit RCM Certification. Backfit RCM certification addresses the responsibilities of and is required for those individuals tasked to review, modify, plan, or approve changes to existing approved maintenance requirements. Backfit RCM recertification is required every 3 years.

b. Classic RCM Certification. Classic RCM certification addresses the responsibilities of and is required for those individuals tasked to develop, review, verify, or approve new maintenance requirements for new systems, subsystems, or equipment during acquisition and as a result of modernization. Classic RCM recertification is required every 3 years.

c. Backfit RCM Instructor Certification. Backfit RCM instructor certification is designed for candidates nominated by their command to support requirements identified by Maintenance Engineering (SEA 04RM) to teach Backfit RCM certification courses at their organization and to serve as local RCM SMEs. These individuals must also be available to instruct at other locations outside their activity or command as needed by SEA 04. The nominees must pass the 2-week NAVSEA Backfit RCM instructor course and demonstrate competence in the delivery of all instructional material to the satisfaction of the NAVSEA certifying agent (SEA 04RM) to achieve initial certification. Recertification as a Backfit RCM instructor is required annually.

d. Classic RCM Instructor Certification. Classic RCM instructor certification is designed for candidates nominated by their activity or command to support requirements identified by SEA 04RM to teach Classic RCM certification courses at their organization and to serve as local RCM SMEs. These individuals must also be available to instruct at other locations outside their activity or command as needed by SEA 04. The nominees must pass the 2-week NAVSEA Classic RCM instructor course and demonstrate competence in the delivery of all instructional material to the satisfaction of the NAVSEA certifying agent (SEA 04RM) to achieve initial certification. Recertification as a Classic RCM instructor is required annually.

3. Organizational Responsibilities. Responsibility for RCM certification are as follows:

a. SEA 04RM. As the RCM process owner and program manager for NAVSEA's RCM training and certification program, SEA 04RM is responsible for all aspects of the RCM program. Specific responsibilities include:

(1) Maintaining certification records within the ePMS Gateway at https://epmsgateway.pmsmis.navy.mil/Gateway/home.aspx.

(2) Establishing the RCM training and certification courses of instruction.

(3) Administering Backfit and Classic RCM certification courses as required, including recertification.

(4) Developing the annual NAVSEA RCM training and certification schedule in conjunction with the fiscal year.

(5) Identifying the need for Backfit or Classic RCM certification instructors at specific organizations or in specific geographic areas. Requesting instructor candidates be recommended by identified organizations and conducting instructor training for selected individuals.

(6) Certifying course instructors in writing after ascertaining that appropriate RCM subject matter and instructional expertise has been achieved.

(7) Ensuring that all personnel who develop, review, verify, modify, or approve maintenance requirements are provided RCM training and certification per references (e) and (f).

(8) Administering testing of RCM certification candidates and maintaining test question and answer databases for all RCM certifications.

b. ISE, NSLC, and Maintenance Planning Activities. These activities are responsible for:

(1) Maintaining sufficient Backfit RCM certified personnel to review, modify, plan, or approve changes to current approved maintenance tasks.

(2) Maintaining sufficient Classic RCM certified personnel to develop, review, verify, or approve new maintenance task requirements.

(3) Responding to NAVSEA requests for RCM instructor certification candidates to conduct Backfit and Classic RCM certification courses as scheduled by NAVSEA.

(4) Ensuring all personnel, including contractors, who develop, review, verify, modify, plan, or approve maintenance requirements are properly certified in NAVSEA Backfit RCM and Classic RCM, as appropriate.

4. RCM Certification Process. RCM certification training comprises three elements:

a. Formal instruction to develop a fundamental understanding of RCM methodology.

b. Application of principles to enrich the fundamental understanding of RCM tenets and to demonstrate practical application.

c. Testing to assess student knowledge and ensure an adequate level of qualification prior to certification.

5. RCM Practitioner Courses

a. NAVSEA Backfit RCM for Practitioners Course

(1) Required Attendees. Government and contractor personnel who review, modify, plan, or approve changes to existing approved maintenance requirements for NAVSEA must be NAVSEA Backfit RCM certified.

(2) Dates and Locations. As issued by the annual NAVSEA RCM training and certification schedule message released in conjunction with the fiscal year and published on the ePMS Gateway at https://epmsgateway.pmsmis.navy.mil/Gateway/home.aspx. Initial Backfit RCM certification can also be attained at any time by completing the online training and certification course located on ePMS Gateway.

(3) Purpose. Each course focuses on fundamentals necessary to apply the NAVSEA Backfit RCM process to existing approved maintenance tasks. Backfit RCM certification is dependent upon successful completion of a written examination. Recertification is required every 3 years.

(4) Recertification may be accomplished in one of two ways:

(a) Successful completion of a NAVSEA Backfit RCM for practitioner's exam following formal training at a standalone training session or in conjunction with a NAVSEA FLEETMER event.

(b) Successful completion of a recertification exam on the ePMS Gateway (does not require retaking the course).

b. NAVSEA Classic RCM for Maintenance Requirements Developers Course.

(1) Required Attendees. Government and contractor personnel who develop, review, verify, or approve new maintenance requirements for NAVSEA must be NAVSEA Classic RCM certified.

(2) Dates and Locations. As issued by the annual NAVSEA RCM training and certification schedule message released in conjunction with the fiscal year and published on the ePMS Gateway at https://epmsgateway.pmsmis.navy.mil/Gateway/home.aspx. There is no provision for initial Classic RCM certification via online training.

(3) Purpose. Each Classic RCM for maintenance requirement developer's course focuses on application of Classic RCM as defined in reference (e). Fundamentals taught during this course are necessary to apply RCM principles to the development of maintenance requirements for new systems, subsystems, and equipment. Classic RCM certification is dependent upon successful completion of a written practical examination. Recertification is required every 3 years.

(4) Recertification is accomplished by successful completion of a Classic RCM for maintenance requirement developer's certification exam following formal training or successfully completing the recertification exam online at the ePMS Gateway.

6. RCM Instructor Courses

a. NAVSEA Backfit RCM Instructor Certification Program. The NAVSEA Backfit RCM instructor certification course is typically given over a 10-day period, but this schedule may be modified as required to best meet the training needs as deemed appropriate by SEA 04RM.

(1) Required Attendees. NAVSEA may identify the need for certified Backfit RCM instructors at particular organizations or within a geographic area. As necessary, NAVSEA will request recommendations for instructor candidates from the identified command(s). Candidates must have a thorough understanding of the fundamentals of Backfit RCM and have instructor or public speaking experience.

(2) Dates and Locations. As designated by SEA 04RM.

(3) Prerequisites. Successful completion of Backfit and Classic certification requirements and recommendation of parent command or activity with SEA 04RM concurrence.

(4) Purpose. The NAVSEA Backfit RCM instructor certification course serves two functions:

(a) To increase the candidate instructor's foundation and understanding of RCM theory and methodology.

(b) To train the candidates in the techniques needed to effectively teach NAVSEA's Backfit RCM principles and methodology.

(5) Backfit Certification Training. Certified Backfit RCM instructors are authorized to provide Backfit RCM certification training during RCM training sessions authorized by NAVSEA under the RCM certification training program. Successful certification as a Backfit RCM instructor is dependent upon passing a written exam in RCM theory and practical exercises, and successful completion of at least two SEA 04RM-monitored practice teaching sessions.

(6) Recertification. Recertification is required annually and accomplished by successful completion of a SEA 04RM monitored practice teaching session.

b. NAVSEA Classic RCM Instructor Certification Program. The NAVSEA Classic RCM instructor certification course is typically given over a 10-day period, but this schedule may be modified as required to best meet training needs as deemed appropriate by SEA 04RM.

(1) Required Attendees. NAVSEA may identify the need for certified Classic RCM instructors at particular organizations or within a geographic area. As necessary, NAVSEA will request recommendations for instructor candidates from the identified command or activity. Candidates should have a thorough understanding of the fundamentals of RCM and have instructor or public speaking experience. Classic RCM instructor candidates must already be certified as Backfit RCM instructors.

(2) Dates and Locations. As designated by SEA 04RM.

(3) Prerequisites. Successful completion of Backfit RCM and Classic RCM certification requirements, successful certification as a Backfit RCM instructor, and recommendation of parent command with SEA 04RM concurrence.

(4) Purpose. The NAVSEA Classic RCM instructor certification course serves two functions:

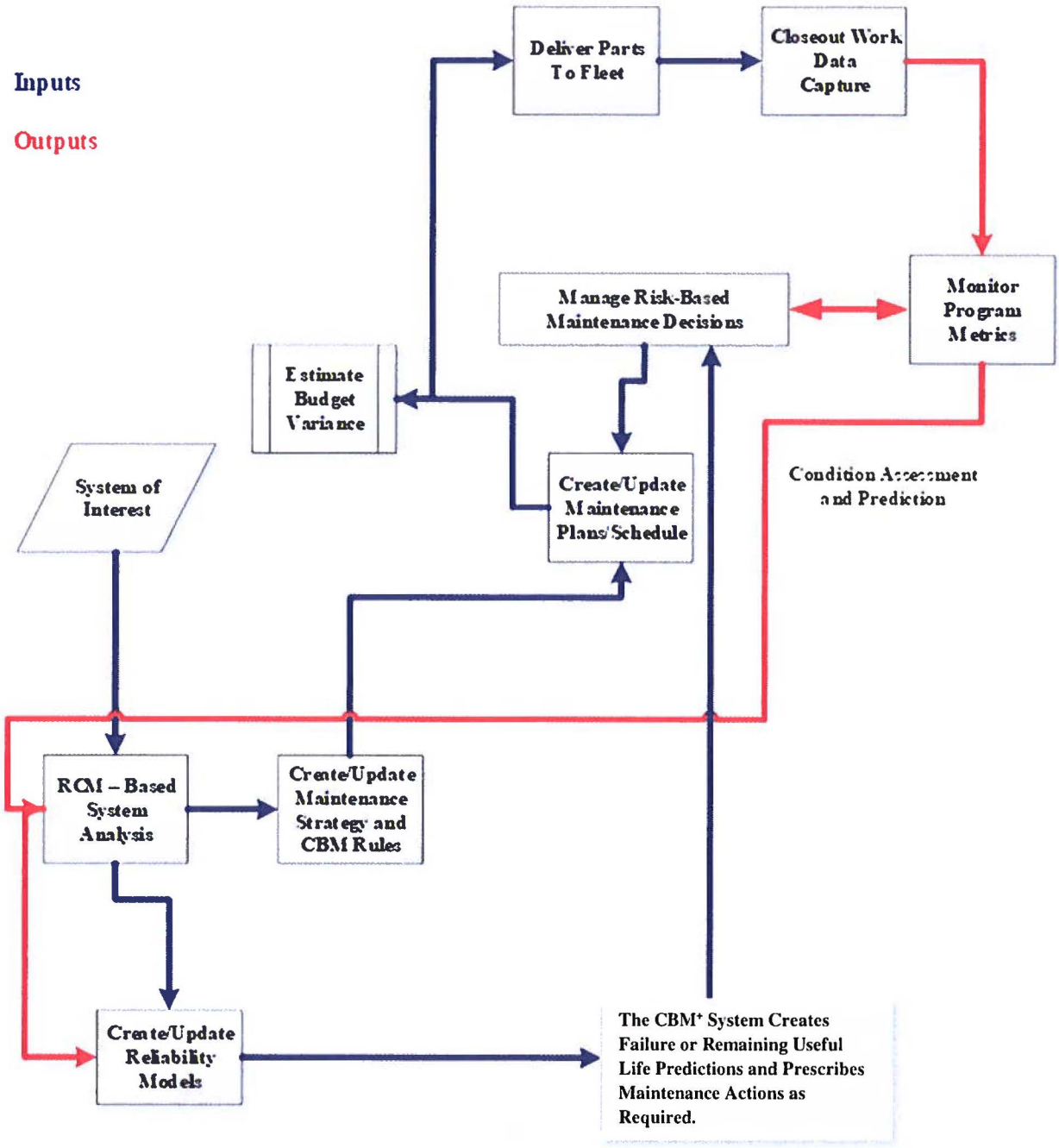
(a) To increase the candidate instructor's foundation and understanding of RCM theory and methodology.

(b) To train the instructor in the techniques needed to effectively teach NAVSEA's Classic RCM principles and methodology.

(5) Classic Certification Training. Certified Classic RCM instructors are authorized to provide Classic RCM certification training during RCM training sessions authorized by NAVSEA under the RCM certification training program. Successful certification as a Classic RCM instructor is dependent upon passing a written exam in RCM theory and practical exercises, and successful completion of at least two SEA 04RM-monitored practice teaching sessions.

(6) Recertification. Recertification is required annually and is accomplished by successful completion of a SEA 04RM-monitored teaching session.

NOTIONAL CBM+ ARCHITECTURE



CBM+ PERFORMANCE REQUIREMENTS

1. Consistent with reference (n), NAVSEA requires CBM+ systems to be able to provide the following capabilities:

a. Shipboard CBM+. Ships' CBM+ systems must be able to process the performance data associated with identified equipment, assess equipment health, and provide a prognosis of equipment failure probability to the Ship's Force. This data will support an initial diagnosis of the problem, an estimation of time to failure if no action is taken, and will prescribe solutions to mitigate or rectify the anomaly.

(1) Systems which should apply CBM+ are grouped into four distinct categories:

(a) HM&E systems

(b) Combat systems

(c) Command, control, communications, computers and intelligence Systems

(d) Other systems, such as:

1. Aircraft support systems

2. Damage control support systems

3. Medical support systems

4. Supply support systems

5. Administration support systems

6. Embarked support systems

7. Mission modules

8. Ordnance modules

9. Landing craft (air cushion landing craft [utility]), etc.

(2) A CBM+ human machine interface (HMI) must be developed for use by Ship's Force to display system and equipment health information for all system categories leveraging best practices as documented in MIL-STD-1472 where feasible. This interface must have the capability to process and display, as part of a prognostic or diagnostic evaluation, the system and equipment health to the crew. It will also provide the operators the capability to view and analyze raw data. Existing HMIs should be leveraged, when available.

(3) When possible, shipboard systems should utilize edge computing. Edge computing processes data near the edge of the network where data is generated, allowing for on-the-spot computing and real-time analytics, improving response time and conserving bandwidth. CBM+ systems should leverage, where applicable, the use of artificial intelligence, machine learning, and cloud-based solutions as technology and tools advance.

(4) All CBM+ shipboard systems utilizing a distance support architecture should utilize solutions that minimize the need to transport large volumes of data over limited bandwidth for centralized processing, notification, analysis, and archival purposes. Smart data management techniques are required to ensure that the right data is delivered to the right users at the right time rather than trying to deliver all the data to all the users all the time. Batch processing should be utilized to offload data when sufficient bandwidth is available. All shipboard systems must implement data management policies that identify what is critical to send when bandwidth is limited.

(5) Shipboard systems must deliver data in a standard format that enables integration between shipboard equipment and shore-side applications, databases, and information systems.

(6) Vital equipment health parameters that compare the existing conditions or performance of an item with established standards to determine the need for follow-on action must be monitored.

(7) After component failure or required replacement, a detailed as-found condition or data root cause failure analysis is foundational to the development and validation of predictive or prognostic CBM efforts.

(8) The program manager, TWH, ISEA, regional maintenance centers, and maintenance coordinating activities must use an RCM-based systems analysis per reference (e) to determine the correct system parameters to monitor with regard to preserving functionality.

(9) Information contained in the equipment control systems must be available regardless of the equipment's status. This allows analysis of steady state or transient conditions.

(10) CBM+ systems must provide risk predictions of equipment operational condition to support maintenance advance planning cycles, thereby minimizing equipment failures during operations.

(11) CBM+ systems must conform to all applicable Navy and DoD information technology and cybersecurity policies and requirements.

(12) Distance support architecture must support data transmission of both unclassified and classified data, as required by the platform.

b. Off-ship CBM+. Off-ship CBM+ support will be provided by NAVSEA-approved SMEs via a shore-based distance support facility (DSF). Shipboard CBM+ systems, subsystems, and equipment will provide the ability to:

(1) In addition to the organic CBM+ functions, they will also have the ability to upload reliability data to the DSF when bandwidth is available to allow for a detailed review of the organic shipboard data, analysis, prognostics, and diagnostics. After this review is completed, the DSF will conduct additional analysis of the data to provide Ship's Force with advanced prognostic and troubleshooting information on monitored equipment.

(2) Prognostic, diagnostic, and maintenance data should be accessible aboard the ship or off-ship via a web browser-based user interface.

(3) All transactions that occur when the system is off-line or in reduced bandwidth must be buffered such that they can be replicated shore-side when connectivity permits.

(4) Transmit prognostic and diagnostic data to the DSF on a configurable and periodic basis. This will provide off-ship backup of data, archives for long-term trend analysis, and ship-independent data access by shore-based maintenance activities.

(5) Provide continuous failure probability predictions based upon equipment conditions including run to failure projections, where applicable. Prognostics also include time frame and content of prescribed maintenance action(s) to mitigate or eliminate the failure.

(6) Avoid recurring cost licensing.

(7) CBM+ systems must conform to all applicable Navy and DoD information technology and cybersecurity policies and requirements.

(8) Distance support architecture must support data transmission of both unclassified and classified data, as required by the platform.

2. CBM+ support services. Some services may not be directly linked to daily CBM+ activities, yet the presence of these services in a support role is necessary for successful CBM+ end-to-end management.

a. CBM+ systems are required to maintain compatibility with existing and evolving interfaces, hardware, software, and protocols employed by the DoD.

b. All systems, interfaces, and associated HMIs must use open system design methods and comply with industry and defense standards. Compliance with this requirement will ensure development efforts are available for government reuse, as needed, and will provide designs that can be adapted as technologies evolve. Some examples of standards and methods include (note that this list is not all-inclusive):

(1) Institute of Electronics and Electrical Engineers standards

(2) W3C (open web platform standard)

(3) Machinery Information Management Open Systems Alliance

(4) Wireless highway addressable remote transducer protocol

(5) Open architecture (OA) development tools and methods

c. Avoid recurring cost licensing.

d. Distance support architecture must support data transmission of both unclassified and classified data, as required by the platform.

e. CBM+ systems must conform to all applicable Navy and DoD information technology and cybersecurity policies and requirements.

CBM+ METRICS

1. Metrics Requirements. Per reference (a), CBM+ outcomes must be measured through the following life cycle sustainment outcome metrics:

a. Sustainment KPP. The sustainment KPP consists of two availability metric components: materiel availability and operational availability.

(1) Materiel Availability. Materiel availability is the measure of the percentage of the total inventory of a system operationally capable, based on materiel condition, of performing an assigned mission. This can be expressed mathematically as the number of operationally available end items divided by the total population. The total system population includes all operational systems necessary to support the operational context of the capability development document or capability production document, including operational systems for training (vice mock-ups, partial systems, simulators), systems for attrition reserve and prepositioning, and systems temporarily in a non-operational materiel condition, such as planned depot maintenance.

Materiel availability covers the timeframe from placement into operational service through the planned end of service life. Materiel availability considers the total calendar time that a system is in the inventory, including "out-of-reporting" status. For single or small-quantity systems, materiel availability can represent available time (i.e., up time, when the system is in operational status) as a percentage of total calendar time.

(2) Operational Availability. Operational availability is the measure of the percentage of time that a system or group of systems within a unit are operationally capable of performing an assigned mission and can be expressed as (uptime/[uptime + downtime]). Operational availability is usually specified for a given scenario or type of unit (e.g., combat group wartime scenario, peacetime training unit). It is normally based on a steady-state situation, usually expressed in terms of annual usage. Determining the optimum value for operational availability requires a comprehensive analysis of the system and its planned CONOPS and operational mode summary or mission profile, including the planned operating environment, operating tempo, reliability and maintenance concepts, and supply chain solutions.

(3) Availability for operational tasking (AOT) is defined as the probability that the system will be ready to perform its specified function, in its specified and intended operational environment, when called upon. It is a quantitative link between readiness objectives and supportability. AOT defines uptime as the time between failures of a system only when it was required for operational tasking and it impacted that platform's mission performance either partly or completely.

b. Reliability KSAs. Reliability is a measure of the probability that the system will perform without failure over a specific interval in the future. Reliability is generally expressed in terms of mean time between failures and can be measured by dividing the actual operating hours by the number of failures experienced during a specific interval.

For predictive analysis (prognostics), reliability is defined as the failure probability within certain time periods or the hazard function. This can also be converted to "remaining useful life".

c. O&S Cost KSAs. O&S cost metrics provide balance to the sustainment solution by ensuring that the O&S costs associated with availability and reliability are considered in making decisions. The O&S cost KSAs must be computed using base year dollars. Costs must be included regardless of funding source or management control. The O&S value should cover the planned life cycle timeframe consistent with the timeframe and system population identified in the materiel availability metric. Sources of reference data, cost models, parametric cost estimating relationships, and other estimating techniques or tools must be identified in supporting analyses. Programs must plan for maintaining the traceability of costs incurred to estimates and must plan for testing and evaluation.

2. MDT. MDT is the average total downtime required to restore an asset to its full operational capabilities. This can be expressed mathematically as the total downtime for all failures divided by the total number of failures. MDT includes the time between the reporting of an asset being down to the asset being restored to full operational capability. MDT includes administrative time of reporting, logistics, materials procurement, and tag-out of equipment for repair or preventive maintenance.

CBM+ MATURITY LEVELS

CBM+ Maturity Level (CBML)		Description	Supporting Information
0	System identified for CBM+ consideration.	System identified as important enough to consider for CBM+ implementation.	NSWC Corona reliability reports, MP-EA process, MRDB reports, and fleet feedback.
1	CBM+ need identified. RCM or FMEA analysis (relevant failure modes) done.	Critical system identified. RCM or FMEA performed on system to identify dominant failure modes for tracking and analysis.	Published FMEA that identifies the failure modes of concern. References to who, where, and when.
2	Technology concept or CBM application formulated.	Invention begins. Once failure modes are identified, research begins to identify if technology currently exists or must be developed to support CBM.	Publications or other references (fleet or industry) that outline the technology being considered and that provide analysis to support the concept.
3	BCA completed that indicates that implementation of a CBM+ technology will lower life cycle maintenance cost.	BCA is performed that indicates that the cost of the CBM technology will pay for itself in lower life cycle maintenance cost or mission readiness.	Has this technology been used in other applications? Does current ROI information exist? What level of ROI would be considered at threshold?
4	CBM+ technology validation in a laboratory (OEM or military) relevant environment.	Proof of concept development. OA software is able to interface with hardware and data. Collection instruments link properly with systems and with mainframe.	Gap analysis identifies sensor holes, software, and hardware needs. Test results identify path to CBML 5.
5	System or subsystem model or prototype demonstration in a relevant shore-based environment.	Representative model or prototype system, which is well beyond that of CBML 4, is tested in a relevant environment, such as a shore-based simulator or interactive system. CBM information is meaningful and useable for analysts. All software and hardware interaction are error-free.	How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are the plans, options, or actions to resolve problems before moving to the next level?
6	System prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from CBML 5 by requiring demonstration of an actual system prototype in an operational environment (e.g., on an aircraft, vehicle, submarine, carrier, or in a surface application).	How is the prototype environment different from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are the plans, options, or actions to resolve problems before moving to the next level?
7	Actual system completed and qualified through test and demonstration in fleet. May be on limited number of test platforms.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this CBML represents the end of true system development.	Technology is proven to work. Actual technology completed and qualified through test and demonstration.
8	Actual system installed on platforms and performing operationally.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Example: using the system under operational mission conditions.	Actual application of technology is in its final form. Technology proven through successful operations.

CBM+ DEFINITIONS

1. Analysis Products. Reports, advisories, prescriptive recommendations, automated workflow triggers to ship operators, and sustainment community to trigger operational decisions, maintenance actions, or advance maintenance planning.

2. Condition-Based Maintenance (CBM). A maintenance strategy based on equipment operational experience derived from analysis. RCM is the foundation upon which a CBM program is built. CBM includes maintenance processes and capabilities derived from real-time or approximate real-time assessments obtained from embedded sensors or external tests and measurements using either portable equipment or actual inspection. The objective of CBM is to perform maintenance based on the evidence of need while ensuring safety, reliability, availability, and reduced total ownership cost.

3. Condition-Based Maintenance Plus (CBM+). The application and integration of appropriate processes, technologies, and knowledge-based capabilities to achieve the target availability, reliability, and operation and support costs of DoD systems and components across their life cycle. At its core, CBM+ is maintenance performed based on the evidence of need, integrating RCM analysis with those enabling processes, technologies, and capabilities that enhance the readiness and maintenance effectiveness of DoD systems and components. CBM+ takes CBM to the next level by including not only the technical requirements for CBM, but also new technologies and analytics as well as the infrastructure and programmatic elements that enable it to function as a true end-to-end process.

4. Data Analysis Diagnostics. Data collected is analyzed to support predictive maintenance and updating of scheduled maintenance. Automated data analysis is performed diagnostically (analysis of anomalies). Data analysis is used to support the MER process and maintenance improvement efforts.

5. Data Analysis Prognostics. Data collected is analyzed to support predictive maintenance and updating of scheduled maintenance. Data analysis can be used to predict remaining useful life.

6. Data Collection. System and equipment operational data is collected at the source, especially via sensors. Data can be used for prognostics. Where sensors are not applicable, equipment operational data is collected and uplinked to the CBM+ server.

7. Data Consolidation. Data collected across ships is consolidated so that it can be accessed from a central location. Like-equipment data can then be compared (e.g., start-up vibration readings for all gas turbine modules across the fleet).

8. Data Transmission. Automated movement of performance data back and forth from the ship to the shore-based DSF.

9. Maintenance and Action Execution. As maintenance is completed, CBM+ data is collected: as-found condition, as-left condition, parts used, man-hours, and task completion time. This data is used to feed shore-based CBM+ data analysis efforts.

10. Maintenance Planning. CBM+ is used to support advance planning and availability production planning.

11. Reliability-Centered Maintenance (RCM). The foundation upon which a CBM and CBM+ program is built. RCM is a method for determining maintenance requirements based on the analysis of the likely functional failures of components, equipment, subsystems, or systems having a significant impact on safety, operations, and life cycle cost. RCM supports the failure-management strategy for any component, equipment, subsystem, or system based on its inherent reliability and operating context.

12. Shore-to-Ship Feedback Communication. Shore-based communication of analysis products to the ship.

13. System Analysis. CBM+ for ships is planned and updated at the system level to include RCM, MERs, sensor gap analysis, maintenance policy and plans updates, and simulations. System analysis is the continuous improvement element in CBM+.