"WHY?"

10.07 Edition

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MFOM 2.0 Executive Summary

For the first time, a ship's material condition is immediately available to support maintenance planning and timely operational readiness reporting. Through a virtual Program Office, the Navy ship maintenance community has developed a software program that consistently and objectively calculates a ship's material readiness and links it directly to cost. This near real time system is called Maintenance Figure of Merit (MFOM). MFOM 2.0 is a web-based software tool that operates on unclassified and classified networks both ashore and afloat. Using existing maintenance documentation (CASREPS, 2 Kilos, CMP, etc), MFOM 2.0 calculates material condition readiness values for equipment, systems, ships or ship classes against various tasks, missions and warfare areas.

MFOM 2.0 uses mathematical algorithms along with ship models to calculate material readiness values and screening values for individual maintenance actions. These calculated values are combined with cost information to generate the cost of readiness. MFOM 2.0 then displays this information in various, crisp, easily understood formats that support the chain of command from OPNAV to the sailor on the ship. Additionally, MFOM prioritizes maintenance actions, provides projected future readiness, develops Operational Availability (Ao) and identifies degraded systems and equipment. MFOM 2.0 feeds equipment material readiness information to the Defense Readiness Reporting System-Navy (DRRS-N).

MFOM 2.0 reduces infrastructure costs by utilizing existing hardware (e.g., Distance Support) and communications software to minimize both its afloat and ashore footprints. The software was designed, tested and certified to Department of Defense software specifications (i.e., DITPR-DON JAN 07, ATO JUL 07). Ongoing enhancements in the software include a "Turbo Tax" like front end and portable barcode reading technology that will greatly reduce input errors and data input time. MFOM is also reducing data duplication by linking to other existing shipboard maintenance systems as well as sharing existing data bases. Additionally, users are greeted with a "Microsoft Office" type simplicity that includes a single login and password for all shipboard maintenance programs. MFOM ship models were developed collaboratively using technical and operational Subject Matter Experts (SME). The technical SMEs (SYSCOM, warfare centers, PYs, etc) built the ship models from the system level down to the sub-component level. The operational SMEs (COs, XOs, DHs, Senior Enlisted, etc.) verified the work done by the technical SMEs and assigned the specific systems and components to their related tasks, missions and warfare areas. Ship models account for redundancy and system interdependency. Model accuracy is maintained primarily through the alteration process. Before installation, the ship alteration process requires models to be updated. Models are also available for ship's force review and update.

One of the maintenance community's more perplexing and chronic problems has been dealing with poor data quality. MFOM addresses the data quality issue through coordinated use of automation, technology, software and training. By limiting the data sailors must manually enter, we reduce variation and simplify training requirements. MFOM uses a multi-faceted approach to training: school house training, computer based training, integrated computer help functionality, a 24 hour help desk and detailed user manuals. The combination of all these elements is expected to improve data quality. Associating the traditional maintenance data with readiness calculations has the added benefit of increased management attention, accuracy and detail. MFOM 2.0 is the single, authoritative, centrally managed application that provides the necessary data upgrades and improvements to support readiness and maintenance reporting.

MFOM 2.0 Overview, a Primer

What is MFOM / MRAS?

Maintenance Figure of Merit (MFOM)/Mission Readiness Assessment System (MRAS) is a software program designed to help the Navy improve maintenance on equipment in near real time while reducing the overall cost. It supplies the ship's material condition in order to support maintenance planning and objective readiness reporting. The ship's material condition is determined through a comparison of the ship's current system status to a certain standard of the design criteria for the system or the systems normal operating parameters. MFOM uses equipment discrepancy reporting data streams already in existence (CASRESPs, 2Ks, tag-outs) to calculate the material condition values for equipments, systems, or even entire ships against various tasks and missions. It automatically provides succinct, cohesively displayed material condition information objectively derived from mathematical algorithms to provide readiness and screening values readily viewable for the ship and other leadership, such as Type Commanders (TYCOMs), Fleet Maintenance Officers (FMOs), and Port Engineers in order to determine what gets fixed, when it gets fixed, and how much money it costs to fix it.

MFOM 2.0 is the most recent software version of MFOM and is accessible via any internet connection. It is resides on the classified and unclassified networks both ashore and afloat. The ashore version is called MFOM and the afloat version is called Mission Readiness Assessment System (MRAS). MFOM and MRAS (commonly referred to as MFOM afloat) are identical; however, the only difference is the software platforms they were built in: MFOM was built in Oracle and MRAS was built in SQL.

What is MFOM's vision?

To create an integrated fleet equipment readiness approach through an accessible architecture, state of the art capability-based readiness reporting system using Mission Essential Tasks (METs) for all Navy warfare command echelons and combat support organizations. MFOM provides clear equipment material condition readiness indices, the recommended prioritized maintenance actions required to improve those indicators, and the cost impact of those maintenance actions using automated means where possible.

What can MFOM do?

This software provides three significant tools for the fleet: a screening tool for maintenance actions, a material readiness reporting tool for ship systems, and a material readiness-to-resources tool. As a screening tool for maintenance actions, MFOM provides each maintenance action a numerical value based on the Equipment Operating Capability (EOC) and the index number (the system impact). This allows those responsible to prioritize maintenance actions by looking at equipments' contributions relative to the material readiness of the ship. As a material readiness reporting tool for ship systems, MFOM calculates and reports readiness for shipboard equipment and systems based on the documented material condition represented as a percentage against specific thresholds or expectations. Ships now know exactly where they stand from a readiness perspective for the various missions they may be asked to perform. Their operational tasking authorities will simultaneously know the same status. For example, a Strike Group Commander can access all of his/her ships of interest, while the individual ships have an "own ship" view. As a material readiness resources tool, MFOM portrays the resources (costs) required to reach a certain level of material readiness based on the documented material condition. This helps ships and other maintainers in the planning and spending of their allotted budgets in a much more efficient and effective manner than currently performed. Therefore, MFOM essentially supplies the Navy with three tools in one, with its strongest capability being that it now provides a direct correlation between readiness and dollars.

MFOM 2.0 uses the model unique to each vessel as an extract of the overall class model. It is a database relating the components of a ship to the various supported missions of the unit. When work candidates representing deficient equipment and carrying an EOC are mapped to that model hierarchy in near real time, the model will represent the current configuration of the entire unit's equipment. This model configuration is accomplished by reading the normal discrepancy reporting data stream collected from various sources relating to specific maintenance worthy equipment in that ship. In the classified portion of MFOM, the weights and impacts of these deficient equipments (their importance) is represented as they relate to the unit's ability to perform current or anticipated future tasking. In other words, this calculated material condition is now the readiness picture of the unit. A simple summing algorithm (readiness MFOM) rolls up or tallies the component scores and associates grades to mission areas. A similar, but unclassified, summing algorithm in the unclassified environment translates what needs to be fixed (screening MFOM) by recommending priorities for the work candidates to an informed maintenance team. So, MFOM requires three essential elements, the ship's configuration data (model), all the active work candidates, and either algorithm depending on whether it is computing readiness or screening information.

For example, in MFOM the user can search a specific ship's readiness for a selected scenario/mission. In selecting a unit, the user is actually directing MFOM to use that specific ship's configuration database. MFOM then links the work candidates created by the Ship's Force that impact that selected scenario/mission for that ship. MFOM can then calculate that ship's material condition readiness using the readiness algorithm. The resultant value that MFOM computes enables operators and decision makers to view the actual value (0-1, where 0 is bad and 1 is good) for the Warfare Areas in the ship. When queried for a recommendation (a simple button push), MFOM will even go a step further and indicate what work candidates should be repaired (highlighted in green). It will indicate an estimate of the man days it will take to fix and how much the repair could cost to support the selected scenario or mission as well. Thus, MFOM gives operators and decision makers the ability to assess, prioritize, plan, and execute maintenance actions to achieve the RIGHT READINESS, at the RIGHT TIME, and at the LOWEST COST.

Once MFOM has recommended work candidates to go fix (which are highlighted in green and the individual work candidates are checked off by the user), it re-calculates the ship's readiness values. This hypothetical condition validates that the chosen repairs provide the correct improvement in the selected mission area. This projected value function gives operators and decision makers a high level of certainty that their readiness expectations for that unit will be met quickly and efficiently when the actual repairs are made.

What are MFOM's goals?

MFOM 2.0 achieves five strategic goals for the Navy maintenance community. First, MFOM provides an accurate and timely material condition readiness status for all installed shipboard equipment or systems; therefore, it presents an overall material condition readiness. MFOM can even take it a step further and forecast the change in equipment readiness and cost over time of deferred planned maintenance. This is done at the component level as specified by the Class Maintenance Plan (CMP/ICMP) task level. MFOM 2.0 provides for five generic types (Slope, Knee, Step, Rapid, and Gradual) of degradation profiles. The Degradation Profile for a given component is specified by the Warranted Technical Authority who determines the Operational Duration, Degradation Duration, Type of Curve, and EOC value.

Second, MFOM supplies the equipment material readiness metric (NMET) to the Defense Readiness Reporting System-Navy (DRRS-N) in a much more objective way than the traditional SORTS report. DRRS-N requires each resource category in Personnel, Equipment, Supply, Training, Ordnance (P-E-S-T-O) to provide an integer $0 \leq x \leq 100$ and color reflecting the equipment material condition supporting Major Combat Operation (MCO) assigned to each unit. MFOM directly feeds these two indicators to DRRS-N to support the E pillar of P-E-S-T-O. MFOM 2.0 employs three colors in association with each of the equipment material condition NMET indicators. These colors are green, yellow, and red. The "green" indicator means the unit can accomplish the task to prescribed standards and conditions with its equipment in the current condition. The "green" indicator always denotes the highest state of material condition readiness. The integers 80-100 are indicated in green in DRRS-N. The "yellow" indicator means the unit can accomplish the task to the prescribed standards and conditions but a portion of the unit's equipment is impaired and thus, there is risk. The "yellow" indicator is still a "yes"—it sends Force Managers the signal the unit's equipment is expected to accomplish the task to standard, under most conditions, but not all required equipment is fully operational. The yellow indicator always denotes an equipment material condition below green and above red. The integers 60-79 are reflected in yellow to DRRS-N. The "red" indicator means the unit is unable to accomplish the task to prescribed standards and conditions due to inoperable equipment. The value associated with this threshold (0-59) should be clearly supportable by observed and evaluated values. The red indicator always denotes the lowest equipment material condition.

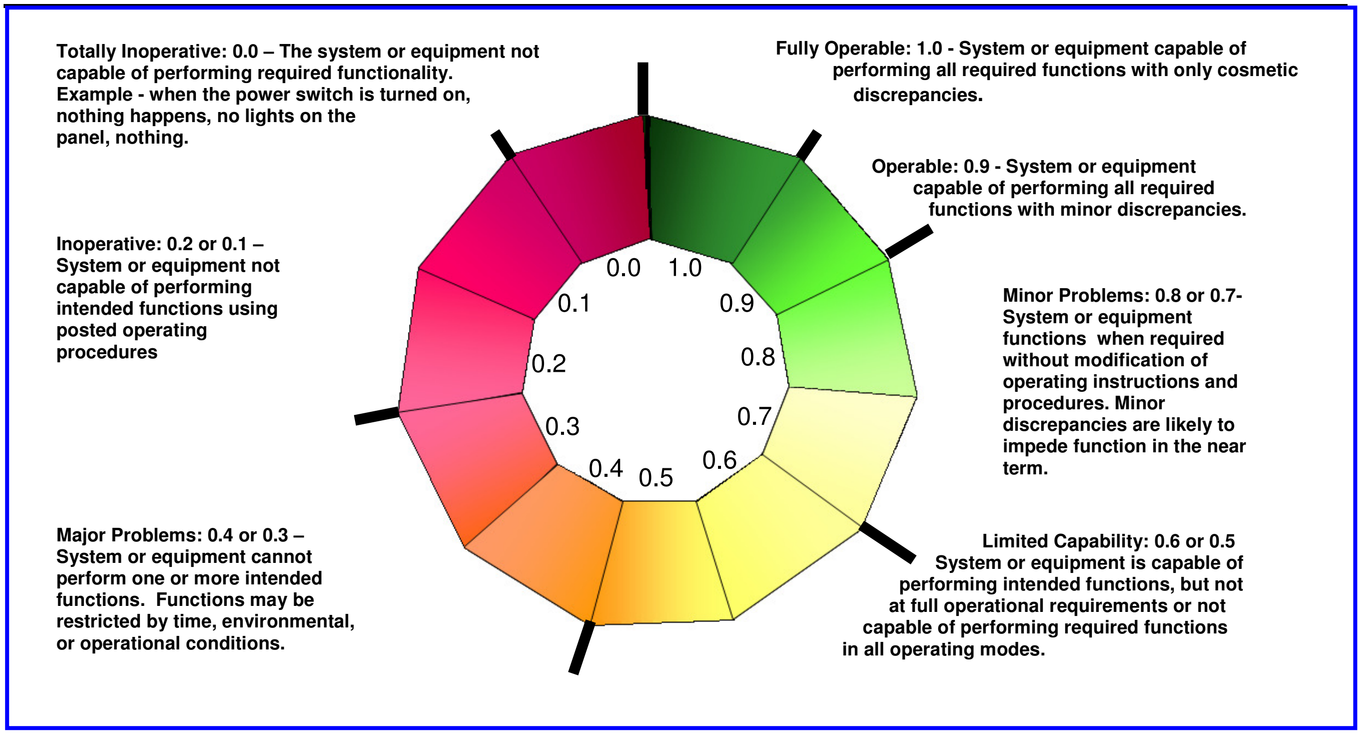
Third, MFOM calculates a screening value for individual work candidates to provide the maintenance management process with prioritized maintenance actions. The screening value is number between 0-100 where 0 means the item needs to be fixed as soon as possible and 100 means the item does not need to be fixed at that time. This allows for the assignment of work candidates for repair that will provide the best material condition for a given mission.

Fourth, MFOM ties the cost of equipment maintenance to overall equipment material readiness. This relationship accurately reflects the costs associated with all maintenance actions to the material readiness requirements.

Finally, MFOM provides a ship level comparison tool for evaluating similar ships for assignment to a capability-based task. This comparison produces the basis to assess and mitigate risk and the cost associated with the selected ship(s). In conclusion, the maintenance community now possesses a program that will accomplish five tactical goals needed in today's environment.

What are MFOM's strengths and unique attributes?

MFOM 2.0 resources are channeled and concentrated to provide a tool that aggregates quantitative and qualitative information from multiple sources to provide an assessment of equipment material condition readiness in near real time. EOC is a dimensionless number (0.0-1.0) used in the MFOM model to represent the actual material condition of a particular item (sub-component, component, sub-system, or system). This is the Fleet's Measure of Effectiveness. Through the use of Scripted Standardized Assessment Procedures, measured objective evidence was obtained and compared to a standard such as a design criteria or normal operating parameters. The result of this comparison is an assigned EOC value. The figure below sets out the range of values and their standard set of definitions.



Equipment Operational Capability (EOC)

Based on marine engineering, MFOM 2.0 is a tool that objectively models equipment structural relationships between a ship's functional areas, systems, subsystems, components, and sub-components. Model levels are hierarchically organized in parent-child relationships accounting for redundancy and impact of the child on the parent. This structured approach produces consistent and repetitive structure across ship classes and equipment.

The MFOM network recognizes three types of parent-child relationships or families which mimic operational relationships and provide logic for system/machinery control resulting in the sophisticated model. A family is composed of a parent and at least two or more children. A vertical family is a model structure that consists of one parent and at least two or more children all within the same Functional Area/Level One (system). An example of a vertical family would be a fire main system with multiple pumps and zones. A horizontal family is a model structure that consists of two or more parents with one or more children in two or more Functional Areas/Level One (system) that can be aligned or cross connected to functionally support another parent. An example of this family would be trim and drain pumps on a submarine or use of AN/SPS-49 radar when AN/SPN-43 radar is inoperative. An operationally linked family is a model structure that consists of two or more parents in the same or different Functional Areas/Level One (system) where the material condition of families is associated. An example of an operationally linked family is the boiler and boiler inspection device or TACAN and flight operations.

The ship models are updated as ships change configuration, as cost of maintenance changes, and as information systems technology improves; therefore, it always supplies the most current system information that is available at that particular time. The Navy Alterations and Modifications process even includes a model update process for ensuring the accuracy of the affected factors contained in MFOM 2.0. Additionally, MFOM provides the associated corrective costs to Navy maintenance planners in support of operators and decision makers to carry out actual missions and assigned unit tasks. This feature supports maintenance planning and execution. Costs are supplied for all maintenance activities in order to facilitate accurate and timely operational decisions with full knowledge of their financial impact.

MFOM 2.0 allows both classified and unclassified access to enable maximum user functionality. Viewers can distinguish the security classification of the database in which they are working by observing the color of their monitor screen border, the GUI presentation. The classified database has a red border and the unclassified database has a blue border. Another difference is that the classified database provides the actual readiness numbers of the ships and, of course, they are not available in the unclassified representations. The unclassified side of MFOM 2.0 allows data to be entered and plan maintenance. The listing of previously screened work and the associated availability, recommended availability for the work candidate, estimated cost, and the screening MFOM value (calculated on the classified side and displayed on the unclassified side) facilitates prioritization of work candidates. Data is transmitted to the classified side for computation of the equipment material condition readiness value and links that readiness to cost. Afloat units and shore commands have access to both classified and unclassified information as previously mentioned.

MFOM 2.0 uses state of the art technology information systems to: automate collection and storage of related quantitative data, distribute data, and display resultant information in formats useful to intended audiences such that the information supports decision making, coordination, control, analysis, and visualization. Furthermore, MFOM 2.0 leverages many of the maintenance processes and networks that already exist.

MFOM 2.0 creates a process to store, display, and manipulate related quantitative and qualitative data and make this data available for trending and predicting or for other methods of analysis.

Why do we need MFOM?

The transition from the massive forces of industrial age warfare to information age warfare with its emphasis on the power through distributed network of alliances and shared situational understanding has transformed the nature of war fighting arena as it is known today. This dramatic transformation has also changed how our military organizes, equips, trains, and employs the military forces and Department of Defense (DoD) organizations. For the Navy maintenance community, this requires better information than previously considered attainable in order to achieve the right levels of readiness, at the right time, and at the right cost.

Over the last 20 years, as new information technology has been introduced to the U.S. Navy, organizations at different levels made step function improvements in information management based on command or local initiatives. As the requirement to standardize processes became more critical for global maintenance readiness and cost reduction, the lack of standard systems became a major barrier.

Responding to the times, DoD, and the Navy as part of it, is transitioning from static readiness snapshots in a stand-alone readiness reporting system to a net-centric, information sharing, readiness management system. MFOM 2.0 provides the means for the maintenance community to support this transition. To support capabilities-based planning, MFOM 2.0’s readiness metrics are based on Mission Essential Tasks (METs) and answers the fundamental question: Is your organization’s equipment ready today to execute its assigned mission with acceptable risk and bring the expected capabilities to the joint fight? To get to this point, equipment readiness management and investment decisions must be seamlessly integrated while objectively and timely supported.

Who has access to MFOM?

The assignment of roles within MFOM and MRAS controls who has access to what information in these programs. Each role is associated with specific, allowed functionalities and data viewing permissions. Remember, the traditional guidelines and directives which govern both **need to know** and **security classification** still applies to the information dealt within MFOM and MRAS.

Ashore access refers to the MFOM website and afloat access refers to the MRAS website. Access also involves the unclassified, unclassified NNPI, For Official Use Only (FOUO), classified NNPI, and classified domains. Generally, no higher than confidential access is required (except for SSBNs) and is consistent with local command directives and national guidance.

For Afloat units, administration of MRAS accounts must generally be accomplished within the lifelines by local command administrators. The local commands are responsible for deciding what the individual can do and see in a particular location. For MFOM, administration of accounts can be accomplished by local command administrators or by the Anchor Desk Level 1 Help Desk Analysts. Account requests can be taken by the Anchor Desk Level 1 Help Desk Analyst or submitted directly via the appropriate website for the program in which one is requesting an account. In establishing the account request, the Level 1 Analyst records information about the user including first and last name, command, city, email address, phone number, reason for requesting account access (level of access requested), a government sponsor, sponsor's grade and position, the sponsor's phone number and email address. Note: for full MFOM access ashore, users are expected to have SIPRNET access. Account requests are normally adjudicated within 72 hours. When users require accounts in both shore and shipboard instances (since they only differ by software platform), accounts may be established for those select users using the same user ID and password.

Who supports the MFOM / MRAS users?

Just as MFOM uses data streams currently in existence and existing hardware, MFOM also receives support from a help desk already in existence. The Navy Anchor Help Desk provides help desk support that is available 24/7 for all the users of MFOM and MRAS in addition to the other Navy maintenance programs. Help can be initiated by phone at 1-877-4-1-TOUCH or by email at help@anchordesk.navy.mil. The Navy Anchor Help Desk provides Level 1 support and can assist in coordinating higher level support. Examples of Level 1 support can be resetting a password, establishing account requests, and answering basic MFOM/MRAS questions such as what is the website, how can my account be upgraded, etc. If Level 1 cannot support the user, then the issue is escalated to Level 2. USFF personnel or its delegates provide Level 2 support allowing for the maximum amount of coverage for the maintenance community. Level 2 issues are when a user asks to how to perform a certain function currently available and when user support consists of code or data analysis to determine why the application provides a certain metric or answer.

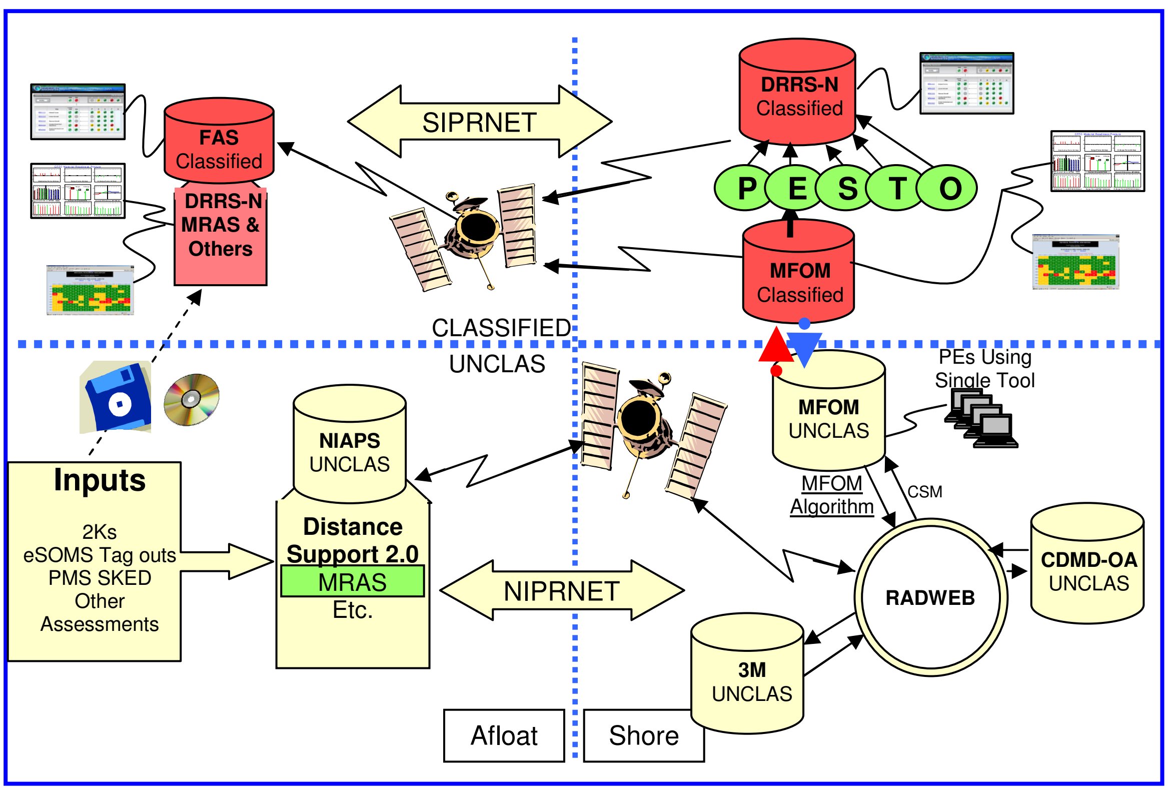
How does MFOM share data?

In addition to the ship's configuration data in the Configuration Data Managers Database-Open Architecture (CDMD-OA), MFOM gathers already existing documentation such as Automated Work Requests (i.e. OPNAV 4790 Form 2 Kilos), tag-outs from eSOMS, machinery monitoring systems (i.e. ICAS), Class Maintenance Plans (CMPs), and other technical documentation (i.e. DFS, UROs, IMMPs, Master Specification Catalog, MRCs). MRAS (MFOM afloat) captures and uses these inputs on the Distance Support Server. Remember, this unclassified version does not contain system or mission impacts but can produce organized material condition information. The data in MRAS is exchanged through a landline and/or satellite communication via NIPRNET to RADWEB. Since MFOM is an authorized user on RADWEB, it allows MFOM to send and receive unclassified information.

Unclassified MFOM uses the MFOM screening algorithm and takes information from the model in order to calculate the ship's material condition.

When unclassified MFOM data is fed into the classified domain, the MFOM readiness algorithm operates on the material condition information in the expanded model addressing the discrepant equipments' impact on mission readiness. There, it produces classified mission readiness numbers and synchronizes the database information it used with the reporting ship via the SIPRNET. The readiness information ultimately feeds the equipment pillar of DRRS-N directly addressing readiness to support Major Combat Operations (MCO), better known as deployment to Navy units. Even though most of the information MFOM uses is unclassified, whenever readiness values are computed or impacts are involved, the information becomes classified and is segregated accordingly throughout. Using SIPRNET, regular landlines and/or satellite links manage classified communications between MFOM and MRAS on the FAS/CAS or ARRS servers aboard ship. A convenient feature is that the unclassified version of MRAS produces data that can be directly, but manually, fed to the classified instance of MRAS where the readiness impacts are calculated. Then, the ship's CO can view and understand the consequent readiness effects in isolation from the communication network. This convenience allows the ship's 3MC to review 2Ks before they are uploaded and submitted into the maintenance reporting system and before being included in MFOM readiness calculations that ultimately influence DRRS-N. Both classified MFOM and classified MRAS submit information to DRRS-N where Department of Defense (DoD) leadership can view and use the calculated information in their planning efforts.

As long as there is communication through landlines and/or satellite, both MFOM and MRAS databases are identical. If there is a break in the communication link, the databases will differ but will automatically synchronize upon re-connection.



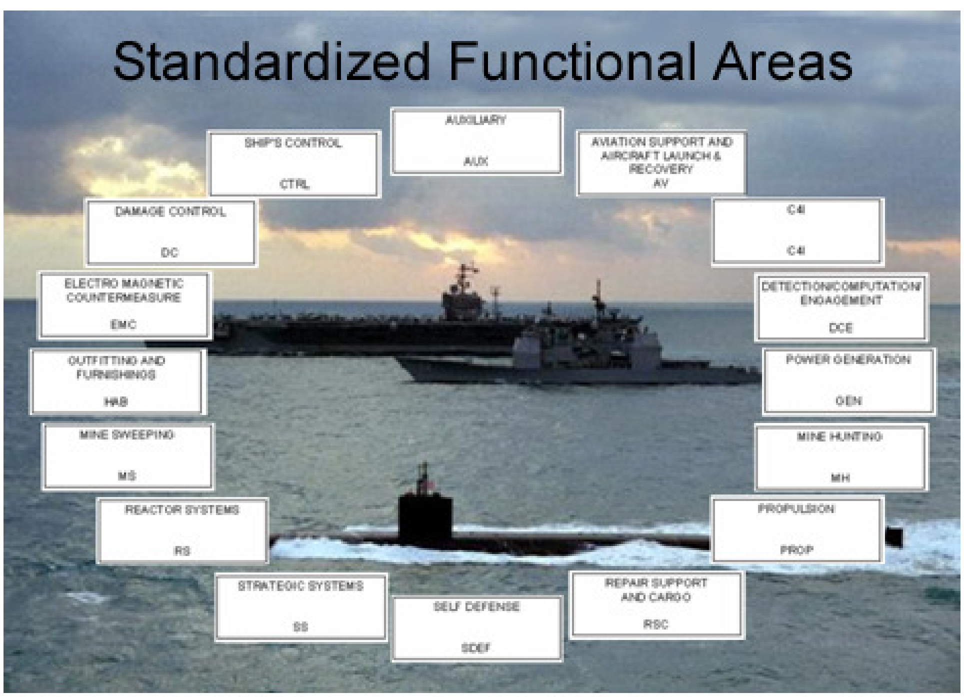
How are MFOM models developed?

MFOM 2.0 was developed and implemented using the "build-a-little, test-a-little" approach known as rapid spiral development which is an interactive process among users, testers, and developers. Lessons learned from the MFOM 1.0 development process were also taken into consideration. One ship class in the surface Navy is modeled initially and then followed by the remaining surface ship classes using the commonality expected between ship classes at the systems, subsystems, component, and subcomponent levels. The lessons of this development were then applied to the parallel development of the carriers and submarines.

FFC N43 operates and maintains the MFOM 2.0 model. MFOM 2.0 allows data revisions as ships are added, retired, and/or undergo a change in configuration, maintenance costs, and/or Navy readiness reporting requirements. It is also anticipated that the MFOM 2.0 software will be modified as information systems and hardware technology improves.

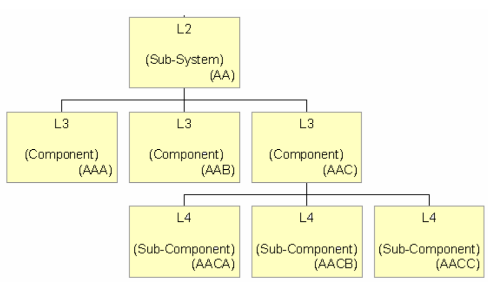
MFOM 2.0 is an equipment material condition reporting model that provides both the actual material condition of a given piece of equipment and the effects of that equipment material condition on supporting other ship functions (e.g., warfare area, mission area, functional area, system, etc). The term, material condition readiness, describes MFOM 2.0's ability to capture both of these readiness measures. MFOM 2.0 was developed in a series of phases.

Phase I – There are two parts to Phase I. Initially, In-Service Engineering Agent (ISEA) or Planning Activity maps respective components and creates a functional hierarchal structure. Components are then bundled within sub-systems and then systems within the 16 Standardized Functional Areas. (Each ship class is built using the Functional Area Templates originally developed for the MCM Class Prototype Model and then modified as more class models are built.)



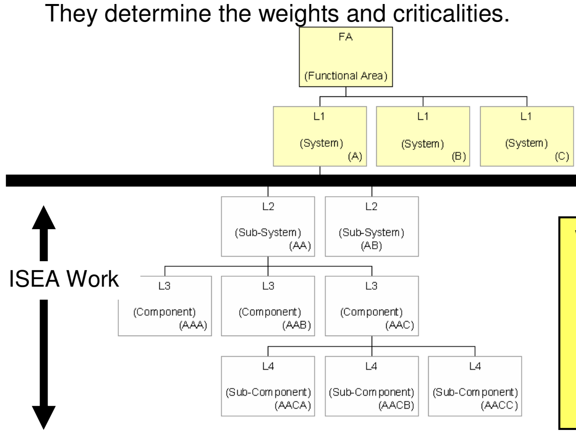
The second part of Phase I took entries from the Class Functional File (CFF) from the Configuration Data Managers Database – Open Architecture (CDMD-OA) and parsed it out to the respective Functional Areas. As part of the parsing work, boundary conditions, redundancy, and other special conditions are determined at all levels from component through system up to Functional Area.

- Train and work with ISEs to develop equipment models.
- ISEs first build structure and then determine boundary conditions, redundancy, and other special conditions.
- The ISEs then determine the weights and criticalities.



Worked with NSWC Senior PAD and ISEAs at:
Philadelphia
Corona
Port Hueneme
Panama City
Crane
Indian Head
Dahlgren
Lakehurst
CPA (Carriers)
SUBMEPP (Subs)
SPAWAR
NAVSEA
PEOs

- Train and work with Planning Yards (PYs) to develop system models.
- PYs use ISE structures to build systems and interconnections to other systems and then determine boundary conditions, redundancy, and other special conditions. They determine the weights and criticalities.

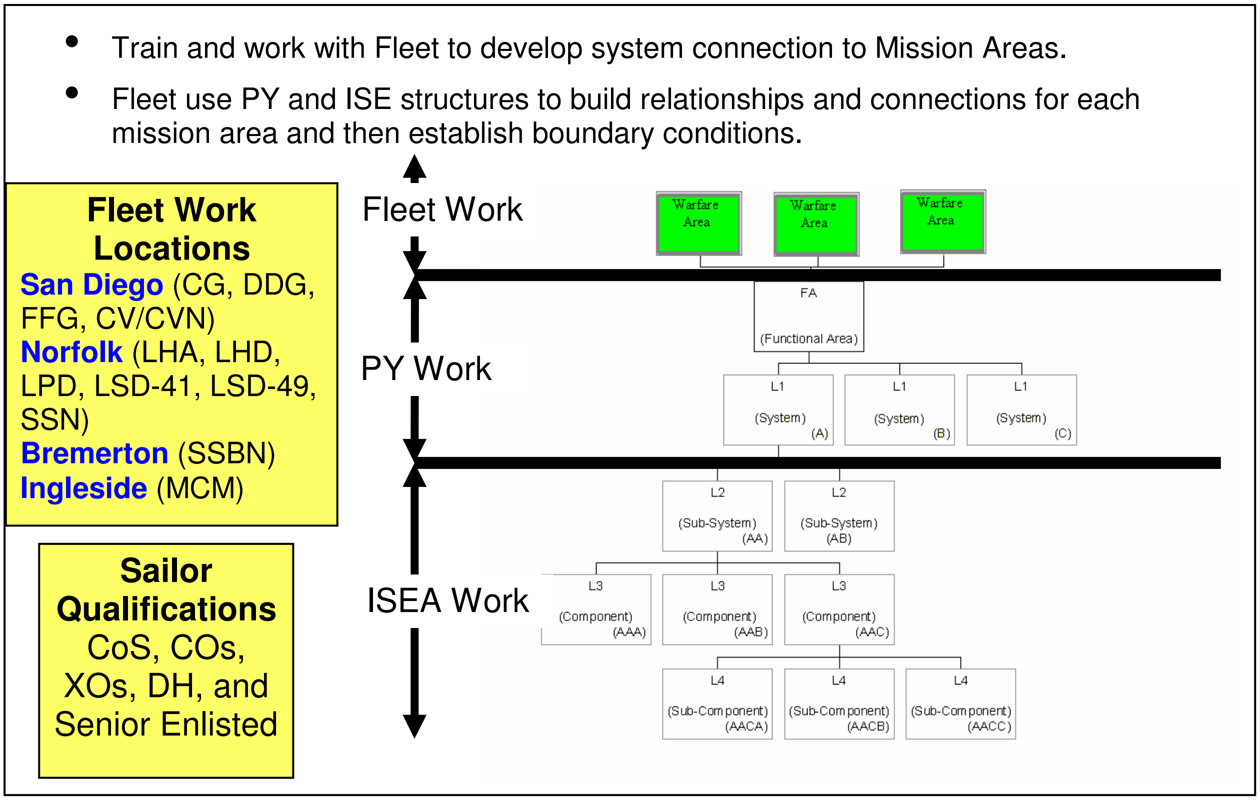


Worked with Planning Yards

Norfolk Naval Shipyard (LHA/LHD)
Puget Sound Naval Shipyard (MCM)
Boston Detachment (FFG, LSD, LPD)
Northrop Grumman Pascagoula (CG)
Bath Iron Works (DDG)

Phase II – The MFOM 2.0 program management team reviewed each ship class model for conformance to the template format, elimination of duplication of items, and identification and resolution of any missing configuration items. All discrepancies were corrected or reconciled before the model was compiled for programming.

Phase III – Each ship class model underwent review, validation, and an operational mapping. The class model was presented to the operational Subject Matter Experts (SMEs), appointed by the TYCOM where they reviewed the structural break down and the impacts of children. The operational SMEs helped determine what parts of the ship at the system level support the Primary Mission Areas and METs, what the operational impact of a lost or degraded system was, and what other scenarios for the ship class are used. Finally, they associated a precedence of scenarios to Primary Mission Areas as well as Warfare Areas. This information supported the initial establishment of the appropriate Warfare Area threshold for a given scenario (i.e., what MFOM value is required).



Phase IV – Developers at the Naval Surface Warfare Center (NSWC) CORONA verify ship class models as well as program individual ship hull model structures. Once the model structure is programmed in a hierarchical structure, redundancy statements, thresholds, and relationships to individual missions were added.

Phase V – This is the User Acceptance Testing (UAT) that is accomplished by the relevant TYCOM for a specific ship class model to verify that it responds as expected to specific equipment casualties, groups of casualties, and specific mission changes. During this testing, each shipboard piece of equipment was set to an EOC of zero and its impact to every Warfare Area and NTA was checked. That same check was then performed on redundant equipment. Finally, the TYCOM validated warfare and NTA thresholds by mission. (You may refer to the business rules titled, "User Acceptance Testing-Application Role Testing," "User Acceptance Testing-Model Sensitivity Testing," and "User Acceptance Testing-Metrics Threshold Testing" for more detailed description dealing with UAT.)

Phase VI – The TYCOM comments from Phase V were incorporated into the model along with any necessary changes. Individual hull models were produced making each model specific for that ship's current configuration.

Phase VII – Each individual ship's CSMP was then applied to the individual hull model that was assembled in Phase VI. Once the model and CSMP were married, the model was put on the production server to report and display metrics in the MFOM 2.0 application.

So why MFOM/MRAS?

Ship's company can utilize the MRAS system while underway, in port, in maintenance availabilities, and in training environments. MRAS aides the Commanding Officer in understanding the ship's current readiness status for each assigned scenario as viewed by other Navy leadership. Further, it allows the CO to preview the impact on that readiness picture before externally releasing equipment degradation information and maintenance work request candidates. MRAS supports the planning and allocation of mission resources, the scheduling and integration of readiness related maintenance activities, the identification of opportunity costs, and the distributing of objective situational awareness among the ship's officers and senior enlisted personnel.

MFOM is the primary waterfront maintenance tool for organizing, planning, budgeting, and distributing resources (O, I, & D level). It improves the interaction between established maintenance tools while leveraging their best and most useful capabilities and functionalities.

Using the models with their calculated index numbers and EOCs, MFOM recommends to an informed human user the appropriate work candidates that should be repaired in order to improve the ship's material condition readiness. This helps prioritize and expedite maintenance of the right kind, at just the right time, and right cost to match a ship's material condition with an anticipated or potential mission tasking.

What's coming next?

Afloat Toolbox for Maintenance (ATM) connects several existing as well as yet to be released tools to increase functionality shipboard. Work began on this toolbox in January 2007 and should be entirely completed by January 2008 with pieces of the tool released in phases. The ATM enables the Ship's Force to enter one user name and password to gain access to all the maintenance programs used in the fleet. One of the ATMs strategic goals is to provide better data to MFOM/MRAS. This will be accomplished with the 2K/Automated Work Notification (AWN) program that will present the Ship's Force with a Turbo Tax like style guiding them to the correct completion of a 2K/AWN ensuring the most accurate data is passed to MFOM/MRAS. The ATM's ultimate goal is to reduce the burden on the sailor for managing and performing maintenance by having a single entry portal with access to many programs the sailor uses on a daily basis. Some of the drawers (maintenance programs) of the ATM that are set for a release date of October 2007 are MRAS, MRAS Training, Item Unique Identification (IUID) (bar-coding maintenance worthy components), Electronic Forms (such as Electronic Departure From Specifications (e-DFS)), Electronic Shift Operations Management (eSOMS), PMS SKED (planning and scheduling maintenance), Automated Work Notification (AWN), Electronic Trial Card (ETC), EDL/ESL Trouble Call Manager, various reports, IPARS, handheld updates, and the Global Distance Support Help Desk. Some of the drawers set for a later release date are Validating, Screening, and Brokering (VSB), Component Line Up, CWP/FWP, LMAIS, Material History, Small Valve Maintenance, ATIS, CDMD-OA, R-Supply, R-Admin, MFOM Shore, Navy Maintenance Data, Navy Data Environment, RMMCO, TMLS, and OMMS-NG. By having all these maintenance programs accessible in one location, this will save the Ship's Force time and increase productivity.

MFOM "Why"
Chapter 1: Inputs

These chapters define in detail what Maintenance Figure of Merit (MFOM) 2.0 is. This book is organized into five chapters that explain MFOM: the primer, **the inputs to MFOM**, the model operation, the outputs of MFOM, and the model maintenance. The primer gives a more in depth description of MFOM, **chapter one discusses what goes into MFOM**, chapter two discusses how MFOM works, chapter three discusses what comes out of MFOM, and chapter four discusses how the model is maintained. Now that the thought process of the organization of this book has been explained, please feel free to dive deeper into the world of **MFOM and its inputs.**

Authorized Reporting Commands

Authorized reporting commands are defined as those communities that have permission to input equipment material condition data into either MFOM 2.0 or source systems such as those mentioned throughout this section. Some of those communities have unique circumstances that require special consideration. For example, to preserve recognized necessity and unique cultures of the submarine force, the Immediate Superior in the Chain of Command (ISIC) for submarines designates the training readiness of assigned submarines. The unit may report material issues that affect capability, such as Casualty Reports (CASREPs), but training status resides solely with the ISIC. Accountability, responsibility, and the necessary chain of custody are maintained by ensuring their construct remains intact. Additionally, the data warehouse from which submarine readiness is derived contains information from a wide variety of sources. This is the most useful feature of the Submarine Tactical Assessment Training Standard (STATS) repository since it allows multiple users to draw data information from a single source – recognizing that the readiness information derived for reporting should only be drawn from "ISIC-authored" data.

There is a need for a method to be established to ensure reported data originates from an authorized source. The reasoning developed to support this issue must account for data provided by both source and internal MFOM 2.0 data collection systems. Failing to account for this will degrade the integrity of data store in MFOM 2.0.

Therefore, the above discussion results in the rationale below.

- Systems Administrators of source systems [Training and Operational Readiness Information Services Core (TORIS Core), STATS, Aviation Data Warehouse (ADW), Carrier "Sierra Hotel" Aviation Reporting Program (CV SHARP), Shipboard Non-tactical ADP Program (SNAP), etc…] are responsible for determining appropriate reporting permissions for units and commands under their control.
- Units must have a means to input equipment material condition data into both source systems and MFOM 2.0 following the current 3M reporting process.

Equipment Material Condition Reporting Frequency

MFOM 2.0 accuracy is extremely dependent on the timely entry of data and ship-to-shore synchronization. Data can be collected and reported on a scheduled basis, i.e. daily, weekly, or monthly. In this case, data is reported based on a specific time. Data may also be collected and reported as an equipment material condition change occurs (on a transactional basis). (Note: Change in Material Condition (CMC) refers to how long it takes the crew to document a change in the material condition of the equipment either to document a deficiency or the correction of a deficiency. Material Condition Reporting (MCR) relates to how often the unit communicates (synchronizes) standard data between the material condition information system (afloat) and MFOM 2.0 (ashore) so CMC + MCR = Total Reporting Time (TRT)). For example, a unit incurs equipment failures multiple times daily, writes a 2K for each failure, and updates MFOM following the entry of each 2K into their Consolidated Ship Maintenance Plan (CSMP). For this case, data would be reported on a transactional basis each time the CSMP had a change entered. It could also be reported weekly as a consolidated input of many CSMP entries. How often data is collected directly relates to the accuracy of the equipment material condition it depicts. For example, data could be reported to MFOM 2.0 on a scheduled basis but then the accuracy of the readiness database would only be valid as of the last scheduled report. There is a tradeoff of accuracy versus security, bandwidth, and workload.

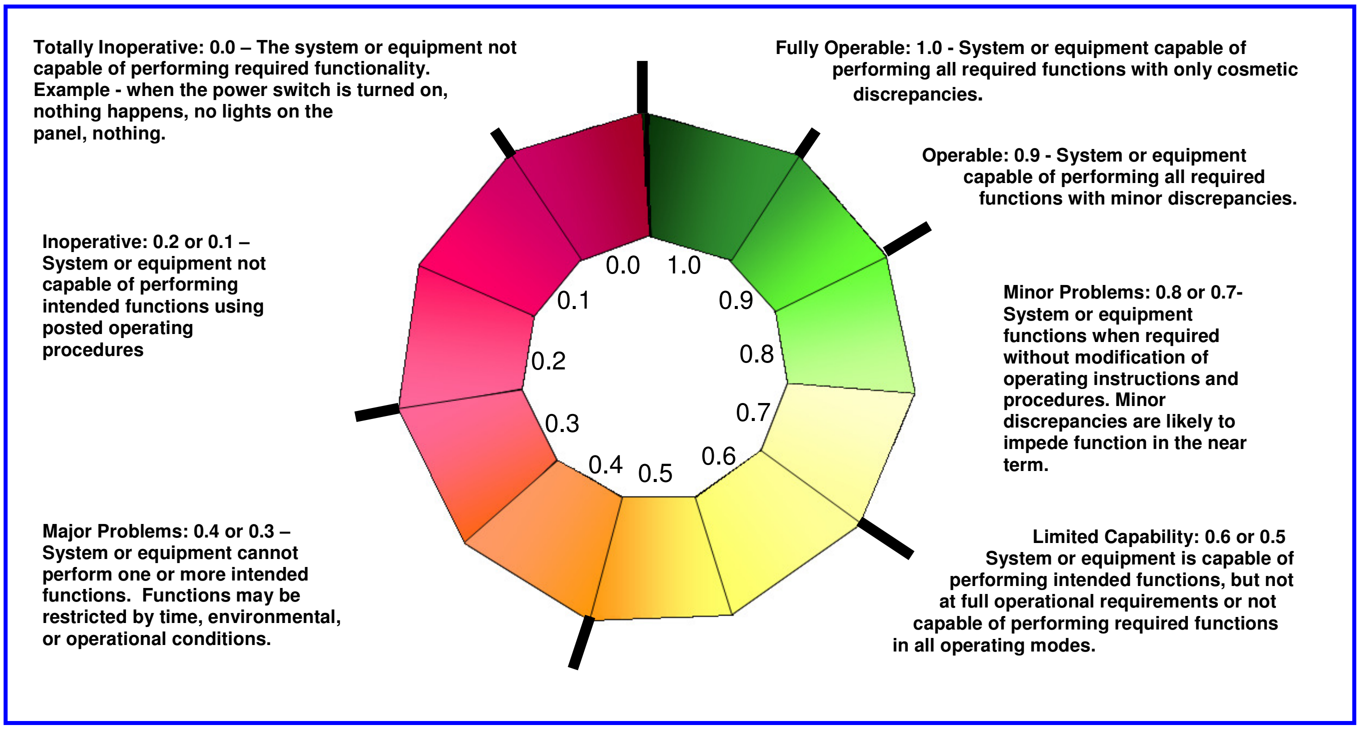
Given these potential issues, it is necessary for MFOM 2.0 to have certain requirements to govern how often equipment material condition is reported.

- Ships will report within eight hours (TRT) changes in equipment material condition that have a status code of 2 (inoperative, as reportable on the 2K) and a correlating Y (Yes) in the corresponding MFOM equipment reporting field. This equates to a screening MFOM value of 60 or below.
- Ships will report all other changes in equipment material condition within 72 hours (TRT). All deployable entities, or their designated representatives, will provide equipment material condition changes whether at sea or in port.
- Ships should not delay reporting in order to collect additional data.
- MFOM 2.0 will report only data that has changed since the last transmission.
- To comply with DRRS-N reporting requirements, MFOM 2.0 will transmit a “no data message” at the interval prescribed above when no data has changed since the last report.
- MFOM 2.0 will recalculate the unit’s equipment material condition and transmit the new equipment readiness to DRRS-N real time for each affected NTA with each material condition update.
- Ships are exempt from “River City” conditions and will continue CSMP transmissions to MFOM 2.0 when under “River City” restrictions.
- All maintenance activities will complete return cost compilation and will report these final costs within 30 days following completion of a unit’s maintenance availability.

Equipment Operational Capability (EOC)

Equipment Operational Capability (EOC) is the Fleet's Measure of Effectiveness. EOC is a dimensionless number from 0.0 to 1.0 used in the model to represent the material condition of a particular item (sub-component, component, sub-system, or system). Using the Scripted Standardized Assessment Procedures, measured objective evidence is obtained and compared to a standard such as a design criteria or normal operating parameters. The result of this comparison is an assigned EOC value. The index value uses the same title, value or range, and description/definition as EOC.

MFOM 2.0 is also dependent on the accuracy of the data entered as work candidates. The EOC is a very critical data element in the MFOM 2.0 equipment material condition index and requires a sound and objective evaluation of a piece of equipment's current operational state. This variable has a significant influence on the impact one piece of equipment can have on the overall material condition index for a Navy vessel. This influence has the potential to be abused, being either understated or overstated. The chart shown below describes the values and definitions that objectively depict equipment operational capability.



Equipment Operational Capability Values and Definitions

During scheduled ship assessments in the past, the trained assessors used several types of software to generate work candidates. They had the capability to capture EOC values and report them against specific configuration items but demonstrated a significant difference in scoring EOCs between assessors.

Currently, material assessment procedures are being reviewed. Several improvements under consideration include training of the assessors as well as revamping of the assessment procedures to ensure that objective and consistent results will be obtained. MFOM use with this EOC schema during assessments will help in standardizing and communicating their results.

Results of bad data will be an incorrect reporting of the ships overall material condition. No assessment work candidate should enter the system without a review by Ship's Force.

Due to these issues, MFOM 2.0 has requirement in order to gather the provided EOCs and what to do if the EOCs do not exist.

- MFOM 2.0 will use EOC values when provided.
- In the absence of an EOC, MFOM 2.0 will automatically generate the EOC for work candidates using the following EOC matrix and EOC logic:

Equipment Operating Capability

F Card from Inspection or If Derived from 2K

If the item is based on a **CASREP** EOC = 0
If the item is based on a 2K
If **Block 7** is blank, then disregard 2K.
If **Block 4** – APL/AEL reads NA, then disregard 2K.
If **Block 13** reads either various or NA, then disregard 2K.
If **Block 15** reads 1 or 2, then EOC = 0.
If **Block 15** reads 3, then EOC = 0.4.
If **Block 15** reads 4, 5 or is blank, then go to **Block 7**.
If **Block 7** reads 1, then EOC = 0.9.
If **Block 7** reads 2, then EOC = 0.2.
If **Block 7** reads 3, then EOC = 0.75.
If **Block 7** reads 0, then EOC = 1.0.

EOC Logic

Block 4: APL/AEL (Allowance Parts List/Allowance Equipment List)

- For equipment not listed in Consolidated Ship's Allowance List (COSAL), enter "NOT LISTED."
- For maintenance actions which are not equipment related such as requests for manufacture of cruise boxes, printing services, etc., enter "NA."

  - If the item is NA or not listed, then the 2K should not be considered for use in the model. If the item does not have an APL or AEL, it should not be considered worthy of incorporation. ACTION: Disregard the 2K.

Block 7: STA (Status)

1 Operational

2 Non-operational

3 Reduced capability

0 Not applicable

- This is a good evaluation by the 2K writer as to the status of the equipment and will be used to calculate the EOC value as follows. ACTION: Use 1=.9; 2=.2; 3=.75; and 0=1.0 for EOC values.

Block 13: IDENT/EQUIPMENT SERIAL NUMBER

On items such as phones, fans, etc., more than one item may be listed on the same 2K as long as all other data in Section I is the same. In these cases, enter "VARIOUS" in the block.

Enter the abbreviation "NA" (Not Applicable) for the following:

- Where no specific identification or equipment serial number is given, or
- Photographic services, plaques, printing, cruise boxes, etc.

If "VARIOUS" is entered in this block, there is no way to determine which equipment should have this EOC value and if NA is entered, the item should not be considered either. ACTION: If either of these values is entered in this block, then disregard the 2K.

Block 15: SAFETY HAZARD

1 Serious Safety Discrepancy – Correct as soon as possible.

2 Serious Safety Discrepancy – Suspension of equipment/system space is required.

3 Serious Safety Discrepancy – Waiver of equipment/system space is granted pending correction of item.

4 Safety Item – Minor

5 Combustible Materials

- This indicates a major problem with the equipment now if this block is used with any of the first three values. The last two values have little bearing on the equipment current EOC value. ACTION: Use 1 or 2 = 0 and 3 = .4.

Block 41: PRI (Priority)

1 Mandatory

2 Essential

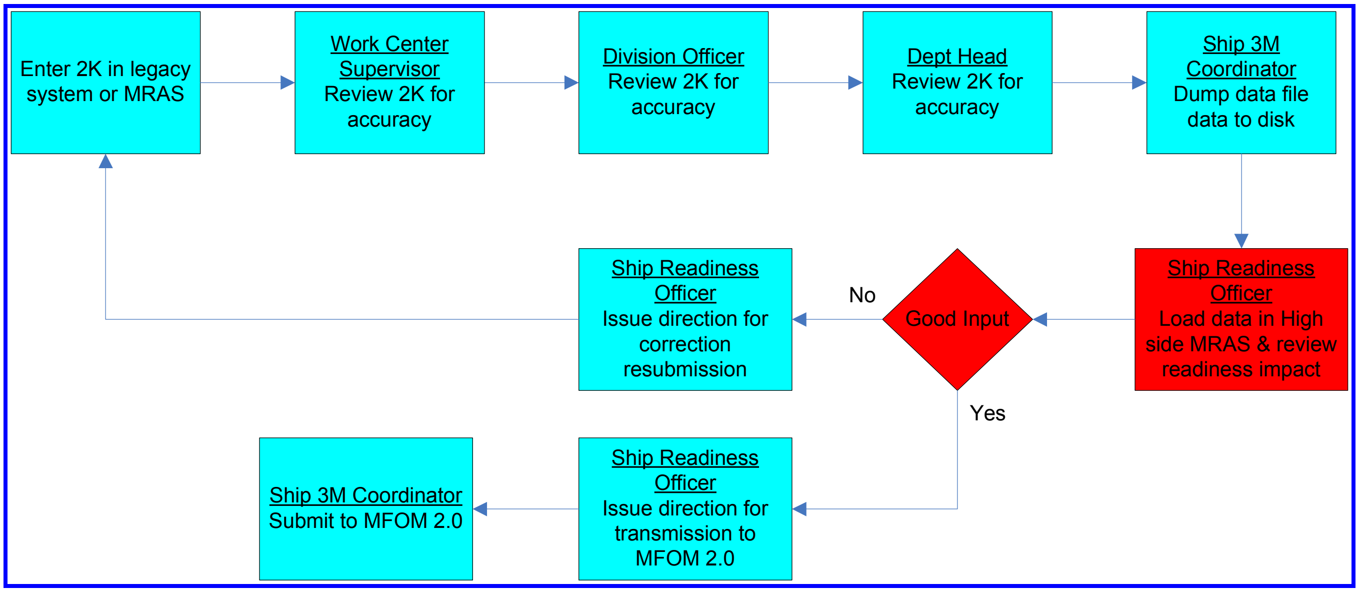
3 Highly Desirable

4 Desirable

- Although a good indication of how the writer views the necessity of completing the job, the value does not indicate anything about the current EOC value. ACTION: Do not use this block to determine EOC value.

Shipboard Readiness Process Flow in MRAS (MFOM 2.0 Afloat)

Mission Readiness Assessment System (MRAS), commonly referred to as MFOM 2.0 afloat, is capable of providing maintenance work candidate (2K) management aboard ship. The software contains functionality to either extract work candidates from legacy on-board systems or for the user to input directly into MRAS. Since these work candidates are used to calculate the material condition metric on a daily basis, a review process is essential to ensure the quality and cost of the maintenance management and the accuracy of the metric. **Further, because this metric will also pass to DRRS-N, the following process is recommended to ensure appropriate review prior to transmission to MFOM.**



As previously mentioned, work candidates can be entered into legacy systems or directly into low side (or unclassified) MRAS. Ships have only one of the two methods for work candidate generation. All entries into low side systems can be reviewed and approved onboard ship prior to being transmitted to low side MFOM 2.0 (ashore). Shore generated work candidates can also be transmitted from MFOM 2.0 (ashore) to MRAS (afloat) on a transactional basis. This way the two representations will stay synchronized.

After being entered in MRAS, the work candidate waits in the “Work Candidate Review” queue for the appropriate Work Center Supervisor. The Work Center Supervisor reviews the work candidate for accuracy and completeness. A correctly identified and located piece of equipment, its degradation, and required repair actions in terms of actions and expected timing are all essential components of information for readiness purposes. The time invested at this stage can positively influence the potential for the right piece of equipment to be fixed, in shortest amount of time, and at the lowest possible cost. The Work Center Supervisor checks for correctness, edits the work candidate as appropriate, and then finally submits it.

Following review by the Work Center Supervisor, the work candidate follows the current 3M approved review process.

The Ship 3M Coordinator provides an output file (MM0001 file) to the Ship Readiness or Ship Maintenance Officer.

The Ship Readiness Officer uploads the data file into the high side (or classified) MRAS application. The officer reviews the readiness impact of the equipment degradations reported in MRAS as they could eventually appear in DRRS-N. For cases where the readiness of specific mission areas or the overall ship is degraded to yellow or red, the causes must be understood. After a review of readiness impact, if the Ship Readiness Officer determines that additional troubleshooting or revision of the work candidate is required, they direct corrective action by the work candidate originator. Once satisfied with the validity of readiness impacts of the equipment degradations, the Readiness Officer directs the Ship 3M Coordinator to process the data to MFOM ashore.

Upon receipt of direction from the Ship Readiness Officer, the Ship 3M Coordinator transmits the new data from legacy systems or MRAS to MFOM 2.0 ashore by pressing the “Submit New Data to MFOM” button which transmits the data transaction immediately or as soon as connectivity is achieved.

This process provides the necessary steps to take in order to manage the work candidate flow in MRAS to ensure the ship’s material condition is accurately reflected in MFOM and ultimately, DRRS-N. Therefore, the below rationale is needed.

- MFOM 2.0 will provide the functionality to support the procedure defined in the process description of this business rule.
- Ships will designate review and approval authorities as appropriate to support the process description of this business rule.

Treatment of Erroneous Data – 2K Configuration Correlation

The quality of the material condition data input to the model has a dramatic impact on its usefulness in depicting the unit's readiness. (Data refers to a unit's material condition in either observed or calculated forms. Data, in this case, shall be considered erroneous if it fails any of the validation rules that are defined below). More simply put, "quality in" equals "quality out" and vice versa. Therefore, the 3M process (NAVSEAINST 4790.8B) provides the means to ensure accurate and timely material condition information. MFOM 2.0 automatically determines the data entry's correlation to the configuration database IAW the EOC. This process is called configuration correlation and it is where MFOM actually assigns a work candidate (2K) to a component of a ship in its model. It also acts as the filter to ensure that the EOC is either present or able to be automatically determined as specified in business rule detailing EOCs. (For more information on EOCs, refer to the business rule titled, "Equipment Operational Capability.") However, if the model cannot successfully correlate the data correctly, it is rejected as unsatisfactory.

The calculations of equipment material conditions based on NMETs and the MFOM 2.0 algorithm create a large and potentially unmanageable amount of data. If MFOM 2.0 is permitted to accept all data, there is a strong possibility that some of it may not be useable and may even cause long processing delays as the software attempts to resolve inaccuracies. Thus, it is critical that erroneous data not be allowed into MFOM 2.0 and the rationale below describe how the data will be checked and how erroneous data will be handled. If erroneous data is transmitted, source systems managers must be informed to prevent the recurrence.

All data sent to MFOM 2.0 will pass through a data validation process. That includes the following checks:

- MFOM 2.0 will check for a Functional Identification Number (FIN) / Record Identification Number (RIN) that matches the configuration database for that ship. If there is no FIN/RIN or the FIN/RIN does not match the configuration database, the 2K is rejected.
- MFOM 2.0 will check for an EOC code between 0.0 and 1.0. If the EOC is outside those limits, the 2K is rejected. If the EOC is blank, the automatic EOC assignment process is executed per the business rule addressing EOCs. If the automatic EOC assignment process cannot determine the EOC, the 2K is rejected.
- MFOM 2.0 will check to ensure only one component is listed on each 2K. If more than one component is found listed, the 2K is rejected.
- Ships will include an Estimated Completion Date (ECD) on all Ship's Force work (TA 4) in the CSMP. MFOM will initially accept TA 4 without an ECD but will notify the ship an ECD is required. MFOM 2.0 will notify the ship weekly via "Ship's Force (TA 4) Overdue Maintenance Action Report" for CSMP TA 4 updates for items more than seven days past due.
- MFOM 2.0 will only accept data from an authorized source. For data reported from a source system, the Source_ID must match a Source_ID contained in MFOM 2.0. For data entered directly in MFOM 2.0, it must be an input from an authorized source. System Developers will ensure a method is created to ensure only data from an authorized source is permitted in MFOM 2.0.

- MFOM 2.0 will reject any record that fails any of the above validation steps and will not include that record in the calculation of material condition.
- TYCOM N43 will designate the user ID(s) within their TYCOM that will receive and adjudicate failing records.

Treatment of Missing Data

There are two situations that can lead to missing data where MFOM 2.0 and its developers need guidance. First, a situation may arise when a piece of equipment assigned to a specific ship does not contain one or many required data elements. When data is missing, it can either be from a required value not being provided by the source system (direct input or web service) or from the fact that no other data is available at a prescribed interval or when a calculation is performed. Thus, it is not possible to complete the required calculation. In order to prevent a system error, a rule must be established to inform developers of the actions to take when this situation is presented. Secondly, another situation may also arise when an NMET is assigned to a ship but the ship requires no equipment to accomplish the NMET. In order to prevent a system error, a rule must be established here to inform developers of the actions to take. Below are the two necessary requirements that give the developers guidance on missing data.

There are two important data categories to keep in mind (missing or otherwise). They are raw (observed) data and calculated data. For the sake of readiness calculations, each has a useful life based on currency. The raw data life cycle focuses on the existing material condition observations while the calculated data life cycle relates to the current material readiness calculations. Both raw data and calculated data remain active in the system until it is time for them to be archived. This period corresponds to the length of time that a current equipment condition remains unchanged, neither worsening nor improving.

- MFOM 2.0 will treat a piece of equipment as fully operational if it contains no material condition observation data. This rule applies when MFOM 2.0 is triggered to calculate material condition or readiness.
- NMETs that have no associated equipment will be identified in advance to the DRRS-N developers so that they will know to expect no input values from MFOM 2.0.

Treatment of New Data

MFOM 2.0 needs to be able to handle multiple instances over time where data is applied to the same measure. In other words, does the system replace old data with new data or does the system average new data with old? In this case, "new" means data that has not been previously used in the calculation of the material condition or readiness factors. It seems logical that the system would simply replace old data with new since the new data truly reflects the current condition of the equipment. The rationale below reflects this statement.

Note: All data sent to MFOM 2.0 from either a source system or user direct input must contain a date-time stamp. All date-time stamps will use Coordinated Universal Time (CUT). This data is required to identify the precise time the value was determined by the source system or user direct input so MFOM knows what data is new and what data is old.

- When new material condition data is acquired, MFOM 2.0 will use that data in the calculation of the material condition and update the date-time stamp of the data.

MFOM "Why"
Chapter 2: Model Operation

These chapters define in detail what Maintenance Figure of Merit (MFOM) 2.0 is. This book is organized into five chapters that explain MFOM: the primer, the inputs to MFOM, **the model operation**, the outputs of MFOM, and the model maintenance. The primer gives a more in depth description of MFOM, chapter one discusses what goes into MFOM, **chapter two discusses how MFOM works**, chapter three discusses what comes out of MFOM, and chapter four discusses how the model is maintained. Now that the thought process of the organization of this book has been explained, please feel free to dive deeper into the world of **MFOM and its model operation.**

MFOM 2.0 Calculation Triggers

Calculation triggers are defined as the system actions or time intervals that initiate calculation and transmission of ship equipment material condition data.

MFOM 2.0 is expected to return calculated equipment material condition data on a near real time basis-24 hours a day, seven days a week. As a result, MFOM 2.0 could potentially be required to process millions of records of information for many ships. This information could be received in successive feeds where new data is received before old data has been completely processed. The data comes in to the unclassified MFOM server via Radiant Mercury or Guard. As soon as it comes into the MFOM server, the data is parsed to the correct ship and matched to specific equipment. Once it is matched, a recalculation of the algorithm and rollup is performed. This action is done sequentially so that if 100 items come in at once, they are processed sequentially until all are complete. If all 100 items are on the same ship, 100 recalculations are performed which may take as long as three minutes. Once the processing of data is complete, the data for that ship is then transmitted to DRRS-N.

MFOM 2.0 is expected to poll system data to determine if data exceeds its use life and to request an equipment material condition update if there is expired data.

Given these potential issues, it is important that MFOM 2.0 has criteria to govern when processing actions shall occur to provide an understanding of data update rate.

- MFOM 2.0 will automatically trigger a recalculation of equipment material condition metrics upon the acquisition of new data for the specific equipment.
- MFOM 2.0 will automatically transmit the results of every recalculation of the material condition algorithm and rollup to DRRS-N via the approved web service.
- MFOM 2.0 will poll equipment material condition data tables daily to determine if any data has exceeded its useful life. The expiration of any data relating to equipment material readiness will trigger a recalculation of equipment material condition for those ship NMETs associated with the expired data.

Treatment of Outdated Data

"Data" refers to material condition data in either observed or calculated forms. The term "outdated" refers to data whose active lifecycle has expired and is no longer valid.

Material condition calculations can be influenced by the time value of observed or calculated data. The term "influence", in this case, refers to the impact historical data may have on the calculation. As reported data ages, it becomes a less accurate indicator of the material condition of the given piece of equipment. This phenomenon can be influenced by personnel turnover, lack of training, lack of assigned preventive maintenance checks, or out-of-the way locations. Thus, some means must be established to account for the time value of the collected (observed or calculated) data so that MFOM 2.0 knows when to use collected data.

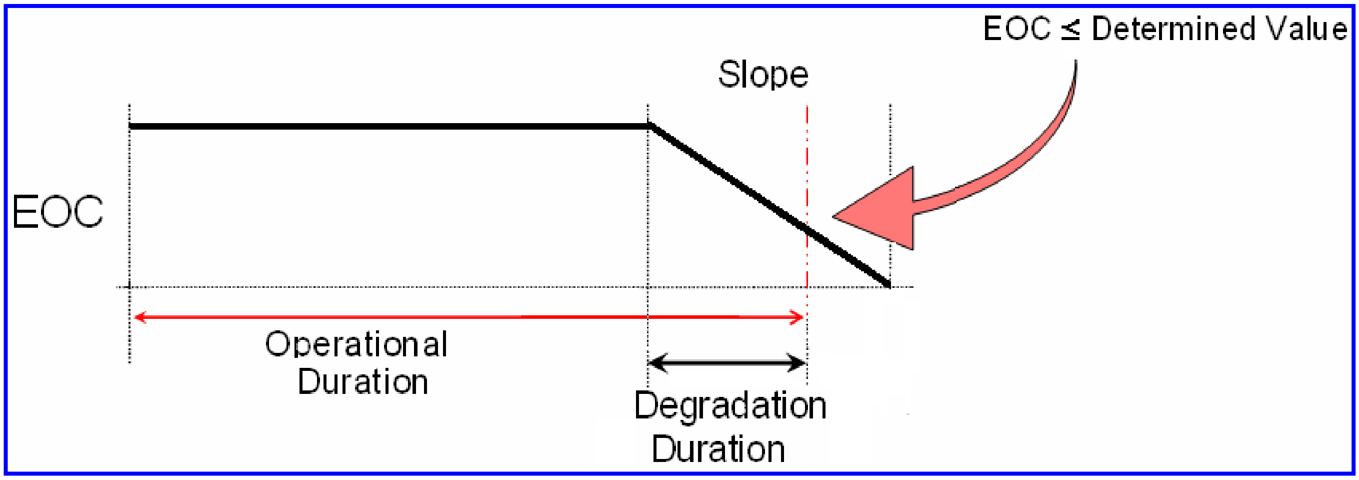
As a means to preserve the accuracy of the CSMP data over time and personnel turnover, a routine review of older maintenance actions is necessary. Maintenance actions that are successfully completed but the 2K is not closed understate the readiness of the ship and overstate the maintenance time and cost required for repair. An annual review of old 2Ks (greater than three years of age) in the CSMP provides the process for validation of the continuing need for the maintenance actions listed. It also enables new maintenance crew members to get up to speed with the material condition status of the ship more efficiently. Data three years of age is retrieved from the system and reviewed for the report by the Ship's Force to determine if the data is still viable.

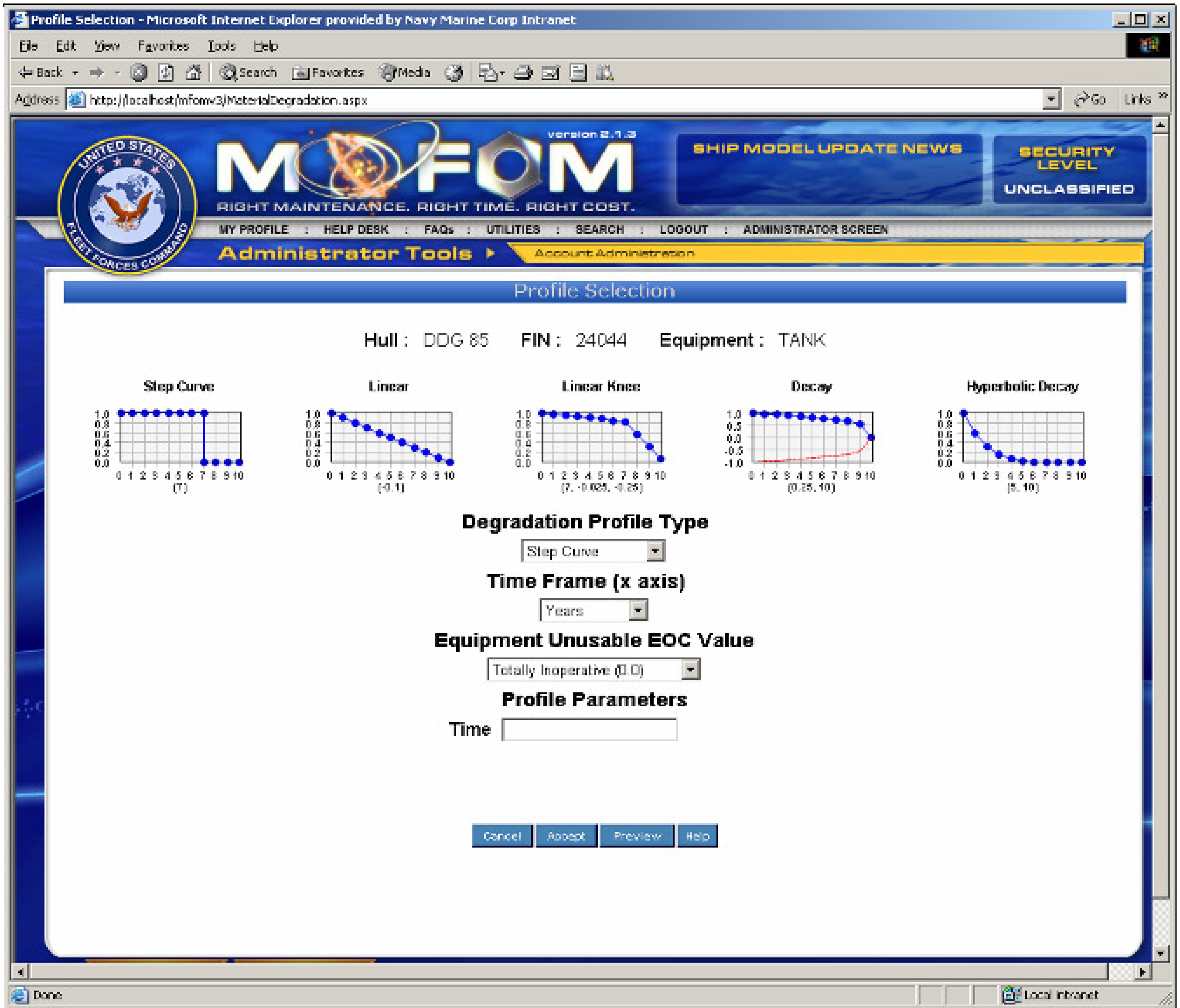
A large amount of ship repairs occur during maintenance availabilities; therefore, it is important for the leadership of the ship and the Fleet Maintenance Officer to know the status of all the planned repair actions for material condition and cost purposes. Since administrative closure of a work candidate can, for a number of reasons, lag physical work completion, Ship's Force personnel must refresh the reported material condition status of the ship as it changes. The audit of all planned availability maintenance actions is necessary to ensure that the maintenance work scheduled was actually completed with the associated paperwork trail accurately reflecting the work performed and its actual cost.

- MFOM 2.0 will consider the date the 2K was originally written as the "start" date for all calculations referring to the "age" of the data.
- MFOM 2.0 material condition data will remain effective indefinitely until it is closed or passed to history.
- MFOM 2.0 will provide a report of all maintenance actions (2Ks) that are older than 1096 days (three years) entitled "Over Three Year Old Maintenance Actions" and update CSMP as appropriate.
- Ships will review "Over Three Year Old Maintenance Actions" report annually to verify that the work is still required.
- Shipyards will, within seven days, take action to cause jobs certified 'work complete' in AIM or AIMXP to close corresponding jobs in the ship's CSMP (RMAIS). 2Ks in RMAIS for depot level work accomplished in CNO availabilities may have their closure method set to either "auto close" or "both," as directed by TYCOM.
- Ships will, within 90 days following the completion of each maintenance availability, refresh the material condition of the vessel by auditing and comparing the actual material condition of the ship to that documented in the CSMP to verify that all remaining equipment degradations are recorded as 2Ks in the CSMP and that those 2Ks that are still on the CSMP are accurate in documenting material condition.

Readiness Degradation of Deferred Maintenance

Planned maintenance that is either time-based, event-based, or duty cycle (i.e. machine hours, time or number) based may be deferred due to time or cost constraints. This deferral results in accelerated degradation of equipment material condition and, eventually, equipment failure. MFOM 2.0 will provide the means to model the future impact (readiness and cost) of deferred planned maintenance. This is done at the component level as specified by the Class Maintenance Plan (CMP/ICMP) task level. As depicted in a following screenshot, MFOM 2.0 provides for five generic types (Slope, Knee, Step, Rapid, and Gradual) of degradation profiles. The Degradation Profile for a given component is specified by the Warranted Technical Authority who determines the Operational Duration, Degradation Duration, Type of Curve, and EOC value.



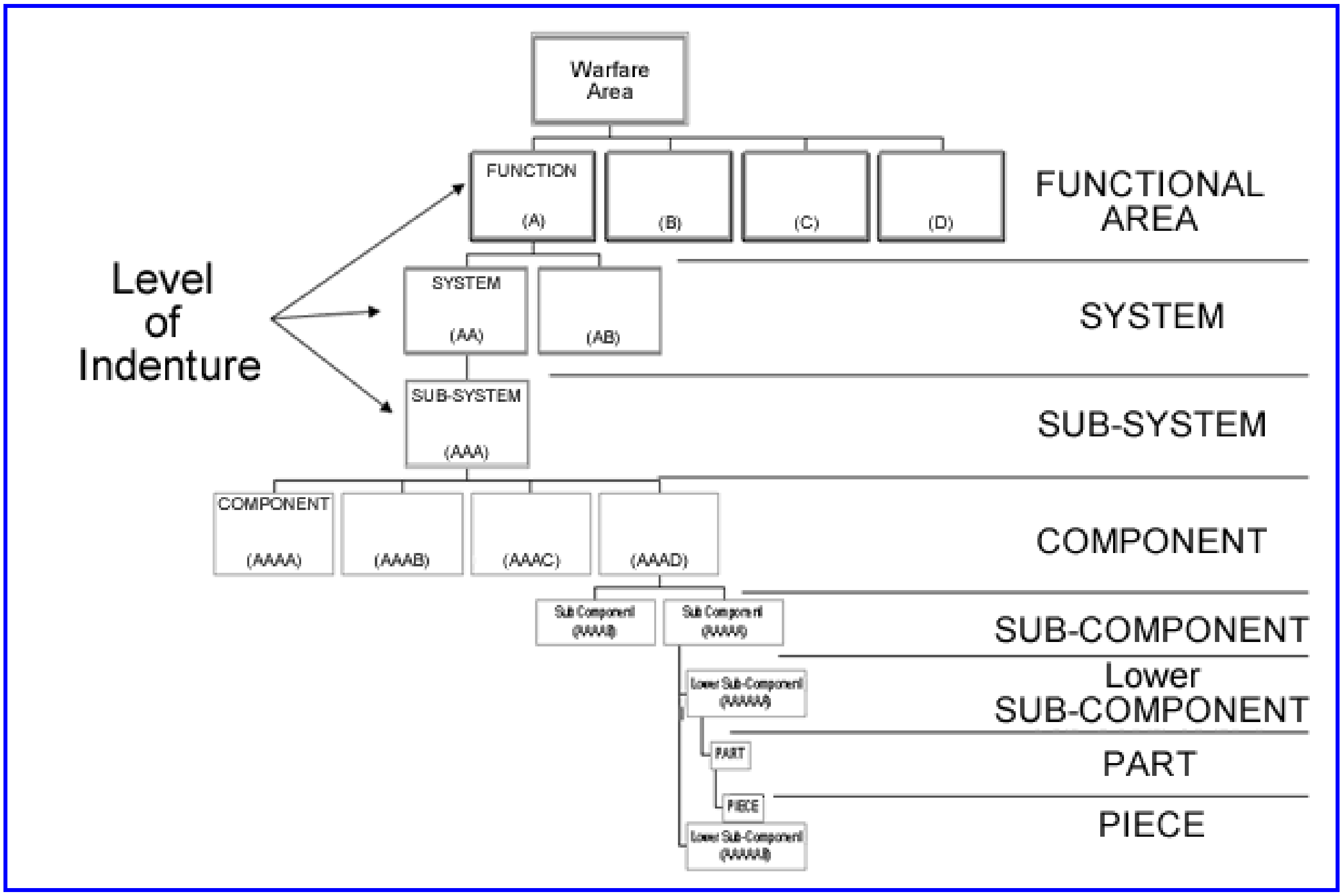


- MFOM 2.0 will provide the means to model the future impact (readiness and cost) of deferred planned maintenance through the use of degradation profiles.
- The Warranted Technical Authority, or their designee who determines the Operational Duration, Degradation Duration, Type of Curve, and EOC value for a given component, will specify the Degradation Profile for that component.
- Delaying the material readiness degradation portrayed in MFOM which is attributed to a degradation profile's timing may be accomplished by a Departure From Specification (DFS) issued by the appropriate technical authority.
- The Master FIN Data Base, as the depository for the master functional hierarchical structure (FIN), will accommodate the required associated links between the degradation profiles, Class Maintenance Plan (CMP/ICMP) task level, and specified objects.

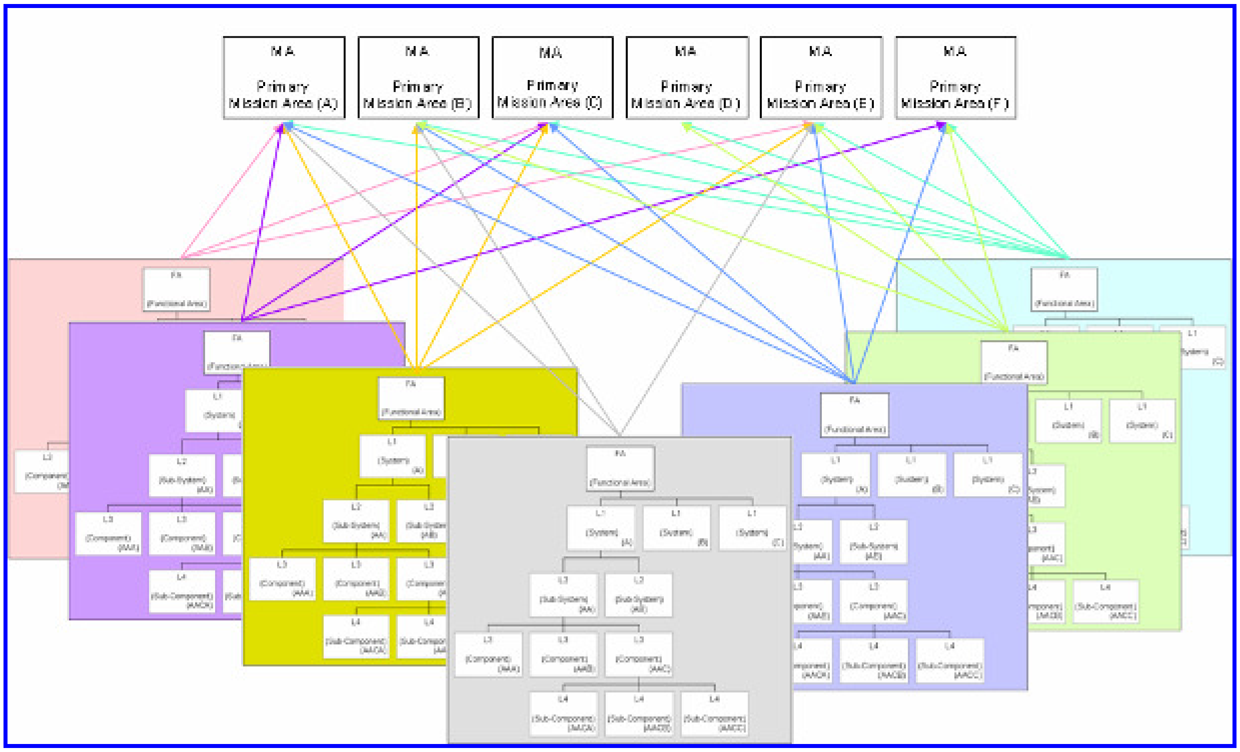
Material Condition Hierarchal Model, Building

This applies to the building of the functional hierarchal model structure for all components found on a platform. This model structure allows for the organization of material condition information permitting screening values and readiness values to be calculated.

Hierarchal Model Structure is composed of top-down arrangement of two or more levels of indenture. The top level for the model is the Warfare Area or other designated mission areas. The Functional Area (FA) is the next lower level of indenture in the structure. The 16 Functional Areas are Auxiliary; Aviation Support and Aircraft Launch and Recovery; C4I; Damage Control; Detection, Computation and Engagement; Electro Magnetic Counter Measure; Mine Hunting; Mine Sweeping; Outfitting and Furnishings; Power Generation; Propulsion; Reactor Systems; Repair Support and Cargo; Strategic Systems; Ship's Control; and Self Defense. These FAs, first presented in business rule titled "Business Rule Overview", provide a logical functional grouping of systems and major components. The next lower level of indenture is Level One (L1) and levels continue down to the lowest indenture level called Lowest Level of Indenture (LLI). Typically, systems are located at the L1, sub-systems are located at L2, and components are located at L3. Components can be grouped into three areas: generation (source of system product), distribution (means to move system product), and end user (user of system product).



The initial Ship Material Condition Model (SMCM) building process consists of several phases as described in MFOM business rule titled, “Business Rule Overview”. The building of the networks used the expertise of respective In-Service Engineering Agent (ISEA), Planning Yard (PY), Planning Activity (PA), and operators designated by the Type Commanders (TYCOM). During the class specific operator seminars, Functional Areas/Level One (systems) are mapped to designated mission/task areas for the respective class. As represented in this diagram, for a respective class, not all of the Functional Areas map to a mission/task area or within a Functional Area, not all of the Level One’s map to the mission/task areas.



The model hierarchal structure used is a vertical hierarchal network, where there are unique families of parent-child relationships. This vertical hierarchal network establishes the dependence relationship of an object (parent) to the objects at a level immediately below (children). The direct relationship between the “health” of the parent (one level above) and its children is called Criticality. The children for the same parent and level of indenture have a relationship to one another; the ranking of the children to one another is called the Weighting Factor. The Weighting Factor allows for discriminating between children exhibiting different influences on the system they affect.

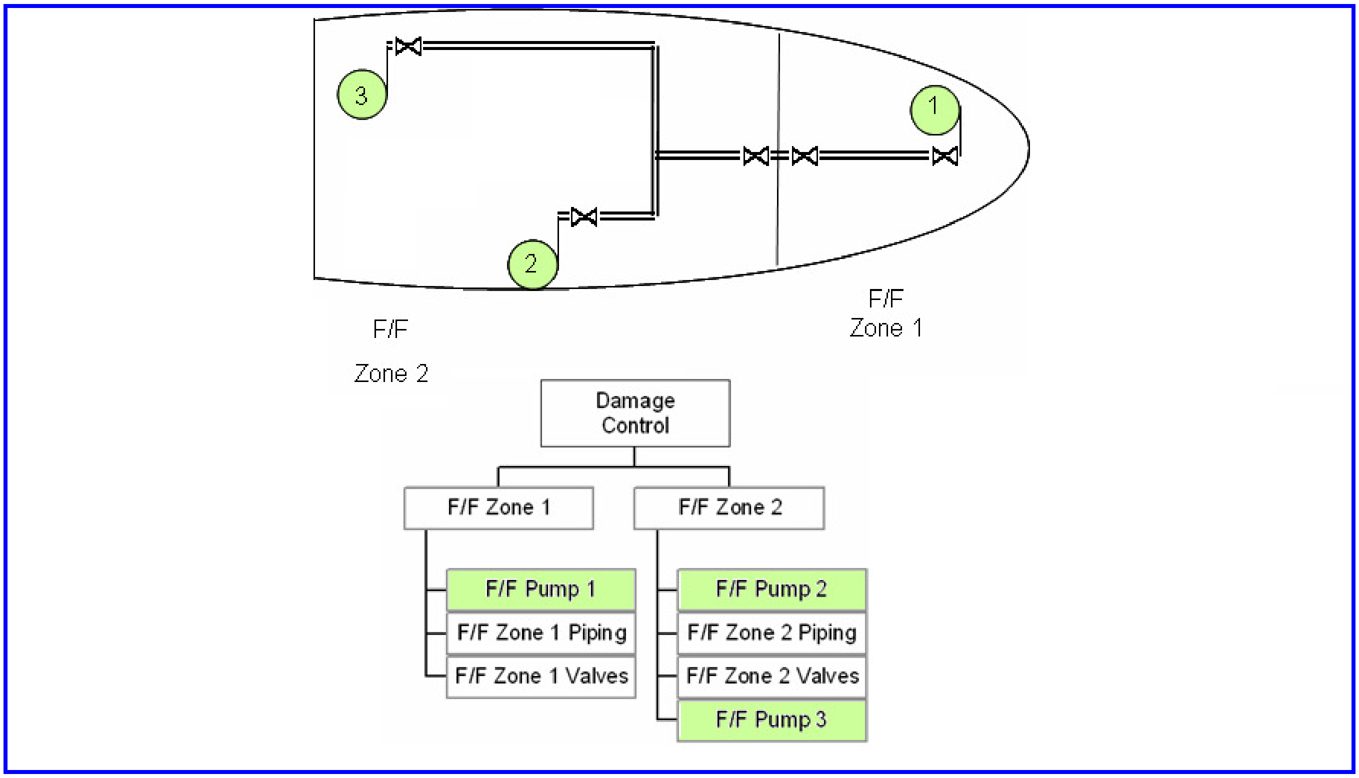
The SMCM is a material condition reporting model in which each object has a Functional Index Number (FIN). A family in the hierarchal network is composed of a parent and at least two or more children. It is recognized that a more sophisticated model to mimic operational relationships or provide logic for system/machinery control using the model network may be desired. These requirements can be met using a horizontal family model network consisting of two or more parents with one or more children each that can be functionally aligned to support another parent. To account for both design requirements and operational requirements, the structure incorporates three types of element linkages referred to as families: the vertical family, the horizontal family, and the operationally linked family.

- **Vertical Family**

  - A model structure that consists of **one parent and at least two or more children <u>all within the same Functional Area</u>**/Level One (system).

  - This model structure may contain many like children to support variable operational demands. The number of children is dependent upon system design criteria.

  - Example: Fire Main System with multiple pumps and zones.

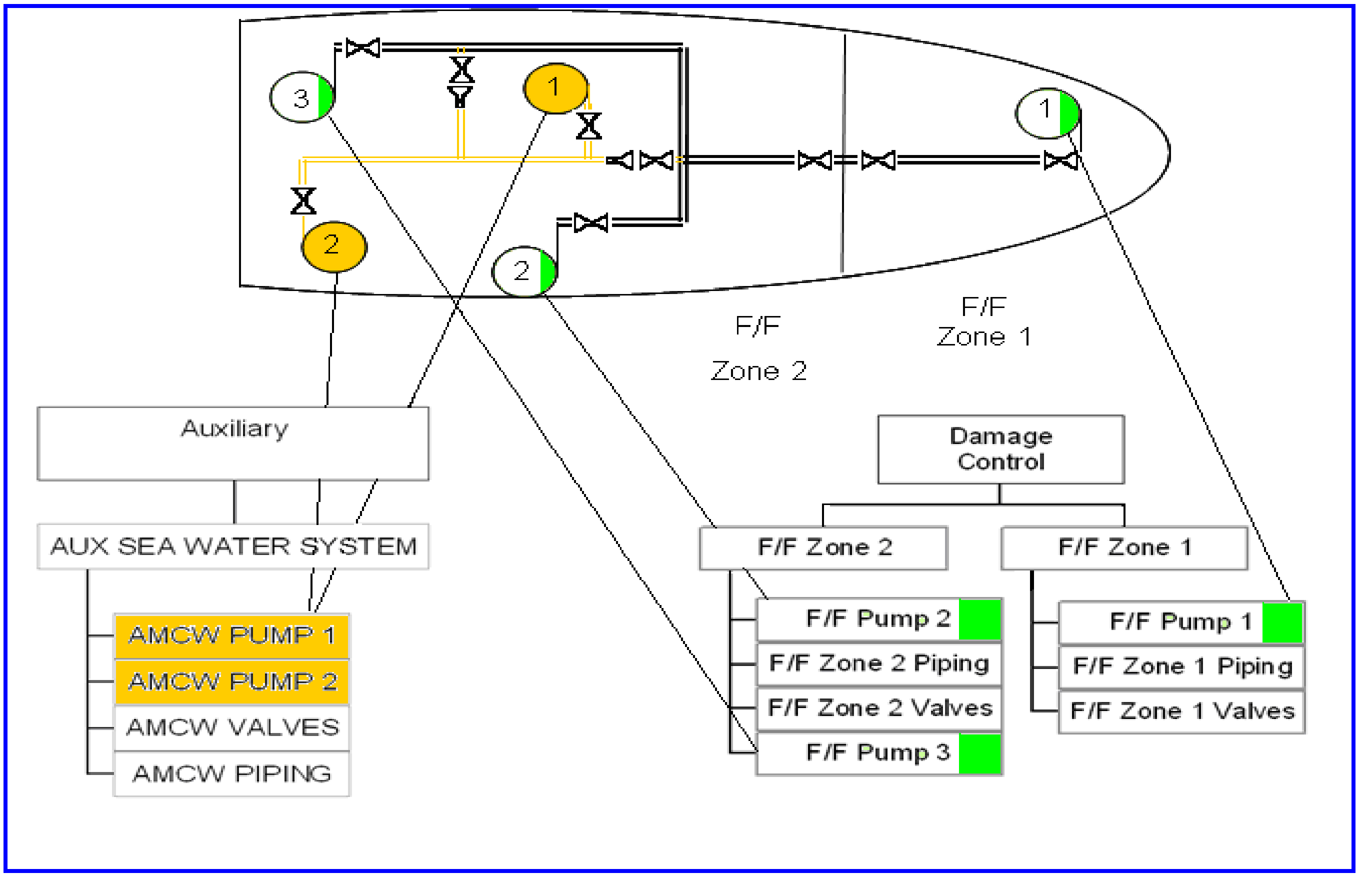


- **Horizontal Family**

    - A model structure that consists of **two or more parents with one or more children in <u>two or more Functional Areas</u>**/Level One (system) that can be **<u>aligned</u>** (cross connected) **<u>to functionally support another parent</u>**. An example would be Trim and Drain Pumps on a submarine or use of AN/SPS-49 Radar when AN/SPN-43 Radar is inoperative.

    - This model structure may also contain like children to support variable operational demands with the number of children linked to the system design criteria.

    - Example: multiple pumps in the Fire Main System or Auxiliary Machinery Cooling Water System.



- **Operationally Linked Family**

    - A model structure that consists of **two or more parents in the same or different Functional Areas**/Level One (system) **<u>where the material condition of families is associated</u>**.

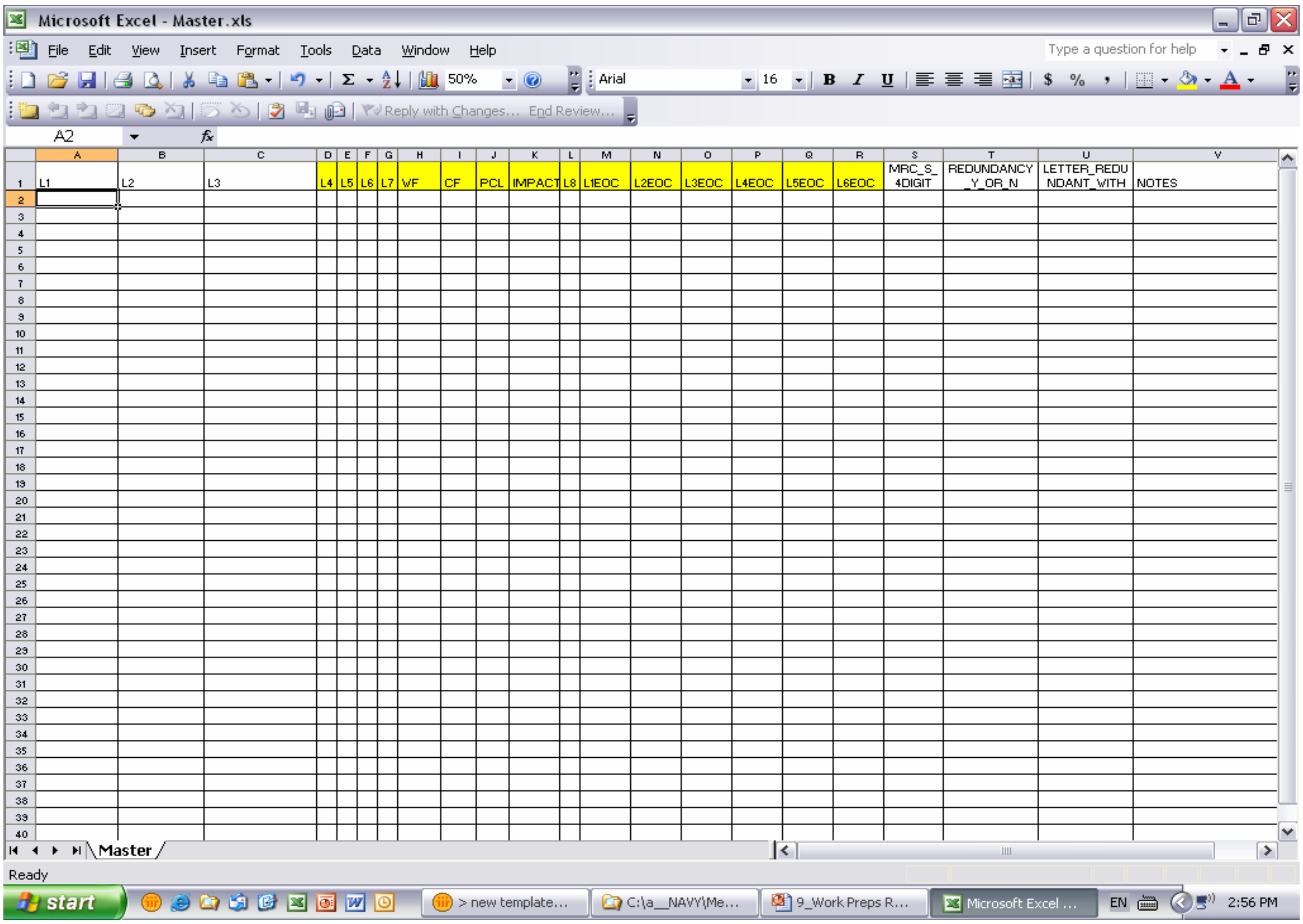
    - Example: Boiler and Boiler Inspection Device or TACAN and Flight Operations.

Modeling Process:

The modeling process is broken into several distinct phases that build on and sequentially support each other. This regimen and discipline minimizes the amount of missed information and misalignment of objects in their respective relationships.

First Phase: Establishing Object Relationships

The **component** functional hierarchal relationship is built out one component at a time. For each component, a title, criticality, weighting factor, redundancy, associated children, and other special conditions are determined and recorded. The Structure Template or Model Builder Application can be used to aid in the construction of the component structure.



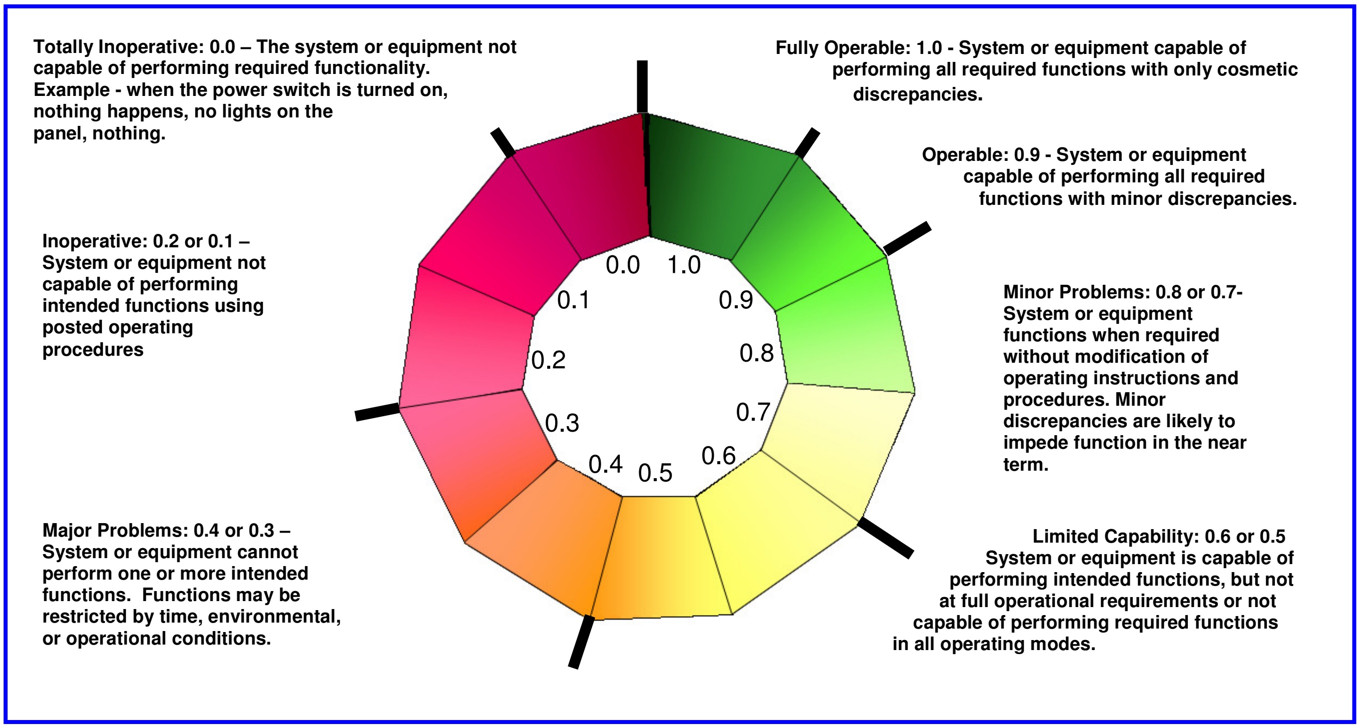
Structure Template

The component is indicated in Column "A" and then respective sub-components are listed in Column "B". If there are lower sub-components, parts, or pieces, they are added in the successive columns with the respective hierarchy entered into the previous column.

Criticality and **Weighting Factor** values for a particular child are determined after capturing two data elements. A two step process:

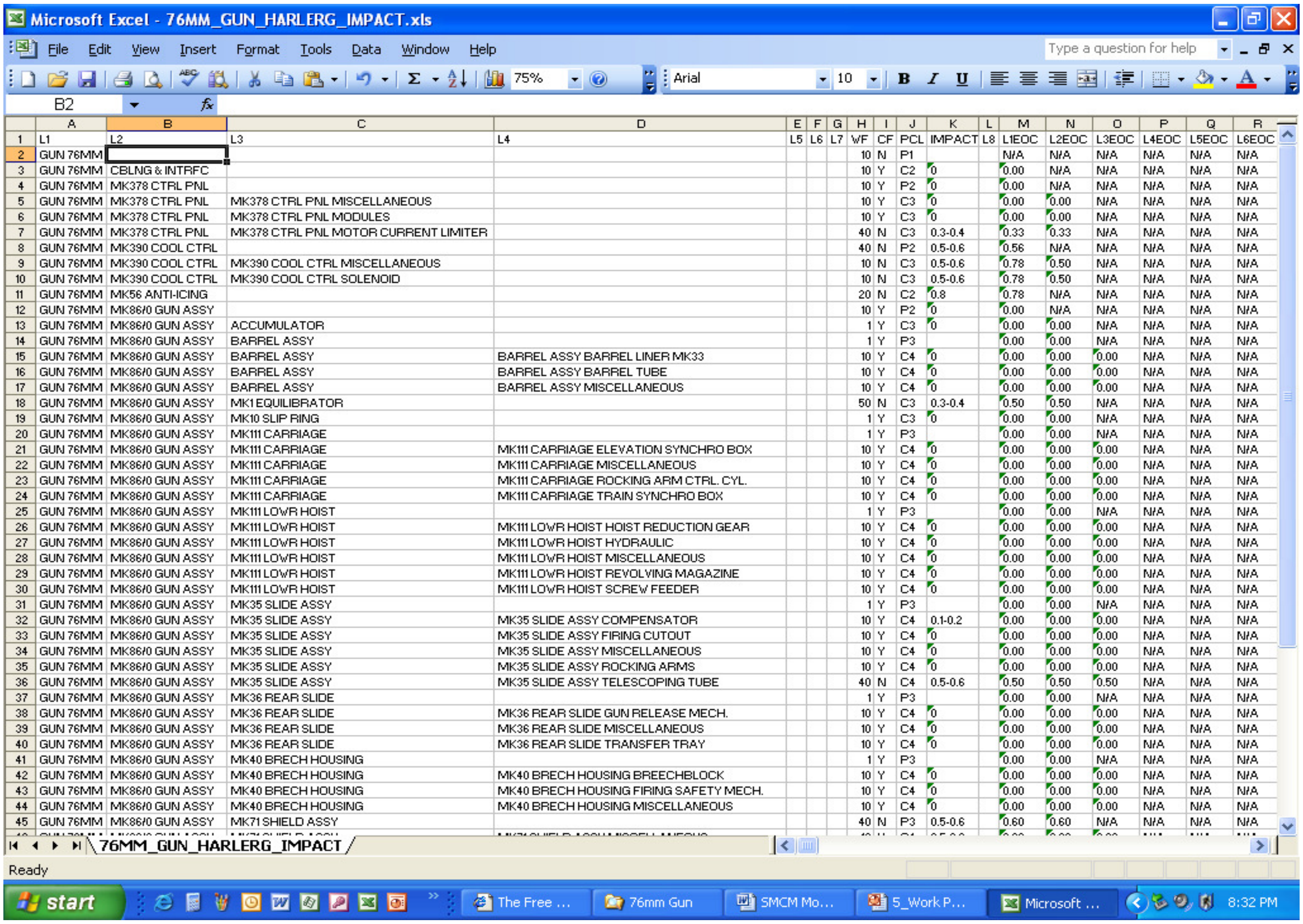
- **First:** determine if the **parent CANNOT operate without the child**, then the **child is critical (Y)**. If the **parent CAN operate without the child**, then the **child is not critical (N).**

- **Second:** determine the **impact of the child on a parent** in the parent/child grouping. One child at a time has its EOC = 0.0 and a corresponding Operational Performance Value is captured. The Operational Performance Values and definitions are the same as EOC values and definitions. Refer to the below diagram.



Operational Performance Value

Below is an example of a completed Structure Template for a Component. Column “K” shows Impact values captured as each child EOC is set to 0.0.



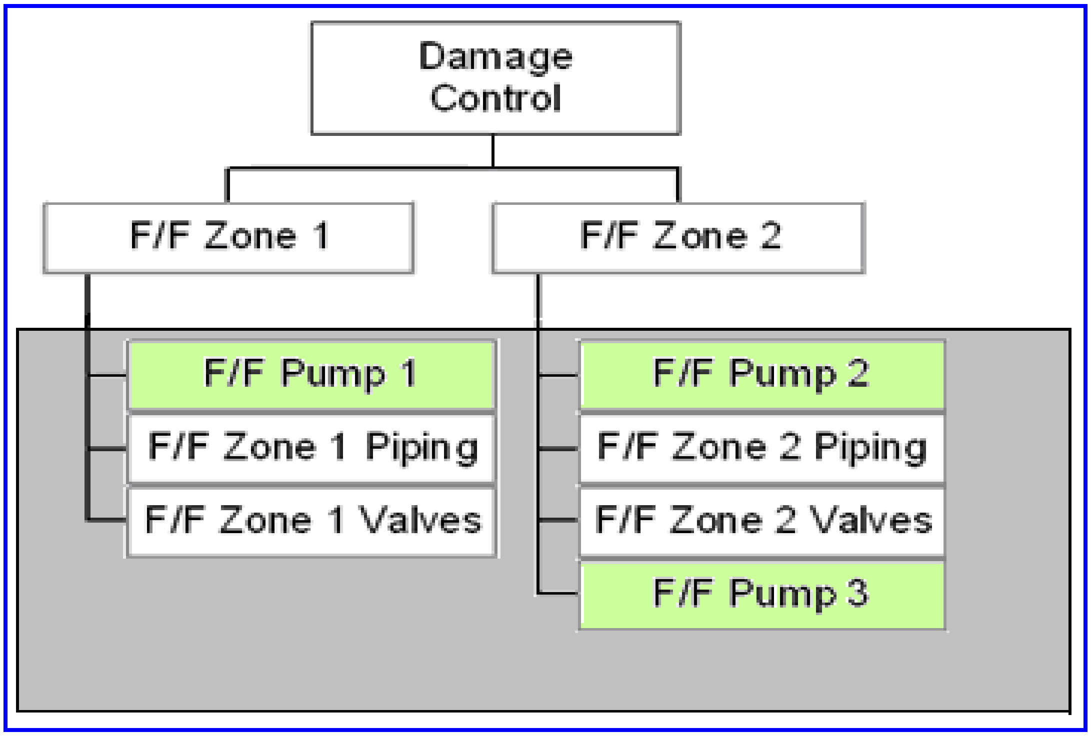
Microsoft Excel - 76MM_GUN_HARLERG_IMPACT.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	L1	L2	L3	L4	L5	L6	L7	WF	CF	PCL	IMPACT	L8	L1EOC	L2EOC	L3EOC	L4EOC	L5EOC	L6EOC
2	GUN 76MM							10	N	P1			N/A	N/A	N/A	N/A	N/A	N/A
3	GUN 76MM	CBLNG & INTRFC						10	Y	C2	0		0.00	N/A	N/A	N/A	N/A	N/A
4	GUN 76MM	MK378 CTRL PNL						10	Y	P2	0		0.00	N/A	N/A	N/A	N/A	N/A
5	GUN 76MM	MK378 CTRL PNL	MK378 CTRL PNL MISCELLANEOUS					10	Y	C3	0		0.00	0.00	N/A	N/A	N/A	N/A
6	GUN 76MM	MK378 CTRL PNL	MK378 CTRL PNL MODULES					10	Y	C3	0		0.00	0.00	N/A	N/A	N/A	N/A
7	GUN 76MM	MK378 CTRL PNL	MK378 CTRL PNL MOTOR CURRENT LIMITER					40	N	C3	0.3-0.4		0.33	0.33	N/A	N/A	N/A	N/A
8	GUN 76MM	MK390 COOL CTRL						40	N	P2	0.5-0.6		0.56	N/A	N/A	N/A	N/A	N/A
9	GUN 76MM	MK390 COOL CTRL	MK390 COOL CTRL MISCELLANEOUS					10	N	C3	0.5-0.6		0.78	0.50	N/A	N/A	N/A	N/A
10	GUN 76MM	MK390 COOL CTRL	MK390 COOL CTRL SOLENOID					10	N	C3	0.5-0.6		0.78	0.50	N/A	N/A	N/A	N/A
11	GUN 76MM	MK56 ANTI-ICING						20	N	C2	0.8		0.78	N/A	N/A	N/A	N/A	N/A
12	GUN 76MM	MK86/0 GUN ASSY						10	Y	P2	0		0.00	N/A	N/A	N/A	N/A	N/A
13	GUN 76MM	MK86/0 GUN ASSY	ACCUMULATOR					1	Y	C3	0		0.00	0.00	N/A	N/A	N/A	N/A
14	GUN 76MM	MK86/0 GUN ASSY	BARREL ASSY					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
15	GUN 76MM	MK86/0 GUN ASSY	BARREL ASSY	BARREL ASSY BARREL LINER MK33				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
16	GUN 76MM	MK86/0 GUN ASSY	BARREL ASSY	BARREL ASSY BARREL TUBE				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
17	GUN 76MM	MK86/0 GUN ASSY	BARREL ASSY	BARREL ASSY MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
18	GUN 76MM	MK86/0 GUN ASSY	MK1 EQUILIBRATOR					50	N	C3	0.3-0.4		0.50	0.50	N/A	N/A	N/A	N/A
19	GUN 76MM	MK86/0 GUN ASSY	MK10 SLIP RING					1	Y	C3	0		0.00	0.00	N/A	N/A	N/A	N/A
20	GUN 76MM	MK86/0 GUN ASSY	MK111 CARRIAGE					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
21	GUN 76MM	MK86/0 GUN ASSY	MK111 CARRIAGE	MK111 CARRIAGE ELEVATION SYNCHRO BOX				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
22	GUN 76MM	MK86/0 GUN ASSY	MK111 CARRIAGE	MK111 CARRIAGE MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
23	GUN 76MM	MK86/0 GUN ASSY	MK111 CARRIAGE	MK111 CARRIAGE ROCKING ARM CTRL. CYL.				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
24	GUN 76MM	MK86/0 GUN ASSY	MK111 CARRIAGE	MK111 CARRIAGE TRAIN SYNCHRO BOX				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
25	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
26	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST	MK111 LOWR HOIST HOIST REDUCTION GEAR				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
27	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST	MK111 LOWR HOIST HYDRAULIC				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
28	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST	MK111 LOWR HOIST MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
29	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST	MK111 LOWR HOIST REVOLVING MAGAZINE				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
30	GUN 76MM	MK86/0 GUN ASSY	MK111 LOWR HOIST	MK111 LOWR HOIST SCREW FEEDER				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
31	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
32	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY	MK35 SLIDE ASSY COMPENSATOR				10	Y	C4	0.1-0.2		0.00	0.00	0.00	N/A	N/A	N/A
33	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY	MK35 SLIDE ASSY FIRING CUTOUT				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
34	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY	MK35 SLIDE ASSY MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
35	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY	MK35 SLIDE ASSY ROCKING ARMS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
36	GUN 76MM	MK86/0 GUN ASSY	MK35 SLIDE ASSY	MK35 SLIDE ASSY TELESCOPING TUBE				40	N	C4	0.5-0.6		0.50	0.50	0.50	N/A	N/A	N/A
37	GUN 76MM	MK86/0 GUN ASSY	MK36 REAR SLIDE					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
38	GUN 76MM	MK86/0 GUN ASSY	MK36 REAR SLIDE	MK36 REAR SLIDE GUN RELEASE MECH.				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
39	GUN 76MM	MK86/0 GUN ASSY	MK36 REAR SLIDE	MK36 REAR SLIDE MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
40	GUN 76MM	MK86/0 GUN ASSY	MK36 REAR SLIDE	MK36 REAR SLIDE TRANSFER TRAY				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
41	GUN 76MM	MK86/0 GUN ASSY	MK40 BRECH HOUSING					1	Y	P3			0.00	0.00	N/A	N/A	N/A	N/A
42	GUN 76MM	MK86/0 GUN ASSY	MK40 BRECH HOUSING	MK40 BRECH HOUSING BREECHBLOCK				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
43	GUN 76MM	MK86/0 GUN ASSY	MK40 BRECH HOUSING	MK40 BRECH HOUSING FIRING SAFETY MECH.				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
44	GUN 76MM	MK86/0 GUN ASSY	MK40 BRECH HOUSING	MK40 BRECH HOUSING MISCELLANEOUS				10	Y	C4	0		0.00	0.00	0.00	N/A	N/A	N/A
45	GUN 76MM	MK86/0 GUN ASSY	MK71 SHIELD ASSY					40	N	P3	0.5-0.6		0.60	0.60	N/A	N/A	N/A	N/A

76MM_GUN_HARLERG_IMPACT

Example of a Structure Template for a Component

The concept of redundancy applies when more than one item in the structure of the model can perform a common function. With one of these items' failure, the parent continues to operate with little or no degradation. Items that perform this functionality are grouped into a **redundancy group**. Associated with each item are **redundancy minimum**, **redundancy maximum**, and **redundancy comments for each redundancy condition**.



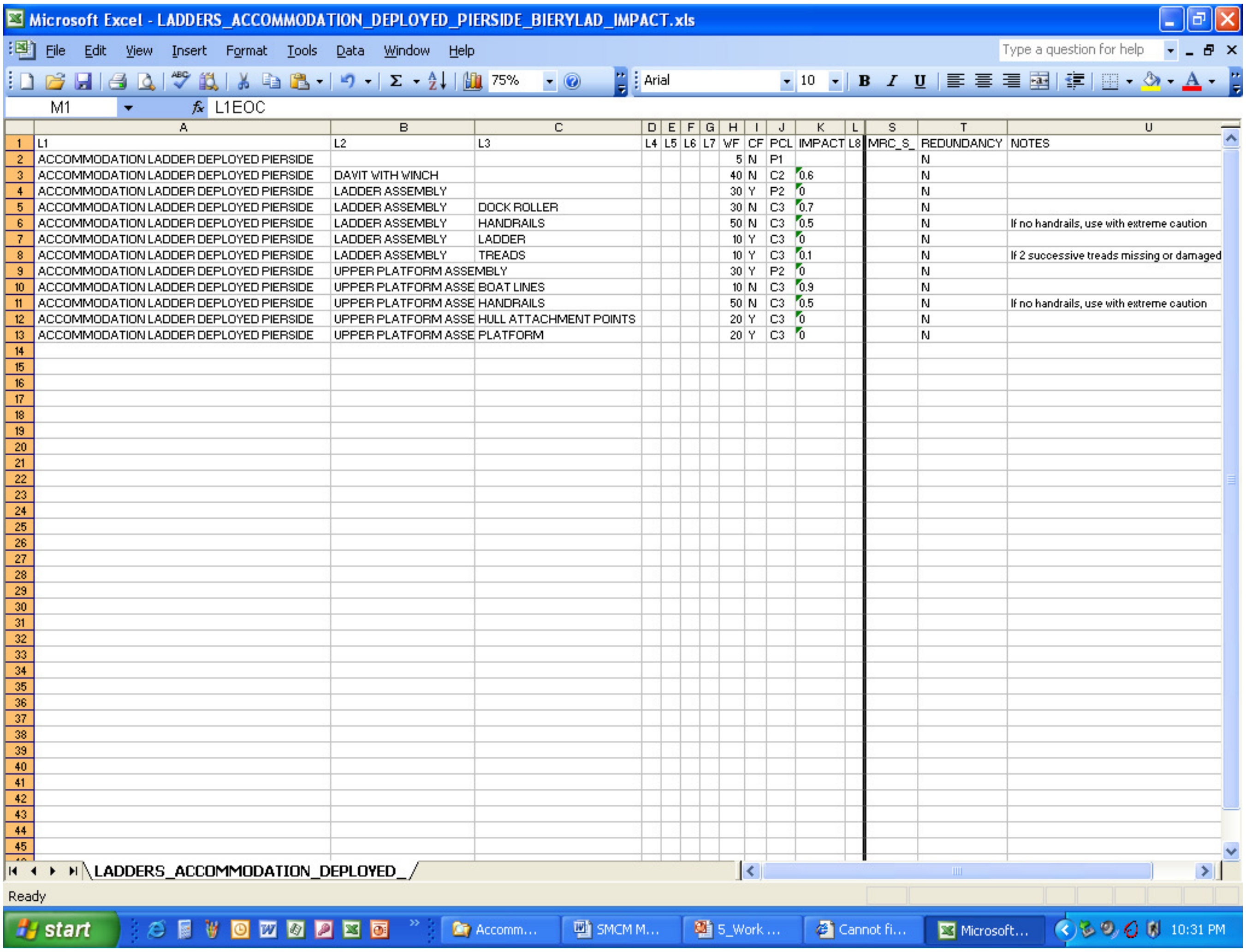
Above is an example of a system comprised of three Firefighting (F/F) Pumps. The redundancy group (shaded) are the F/F Pumps (1, 2, and 3). The system design requirement:

- two pumps with EOC equal to or greater than .7;
- if two pumps have an EOC less than .7, the Damage Control operational performance expectation is zero; and
- additionally, if F/F Pump 1 is less than .7, the Damage Control operational performance expectation is zero.

Associated with each item are redundancy minimum, redundancy maximum, and redundancy comments. Below is a write up of the design requirements.

	Redundancy Min	Redundancy Max	Comment
F/F Pump 1	0	2	2 pumps need with EOC = or > .7 to be operational or parent = 0 and EOC <.7 parent = 0.
F/F Pump 2	1	2	2 pumps need with EOC = or > .7 to be operational or parent = 0.
F/F Pump 3	1	2	2 pumps need with EOC = or > .7 to be operational or parent = 0.

Below is an example of a completed Structure Template for a Component.



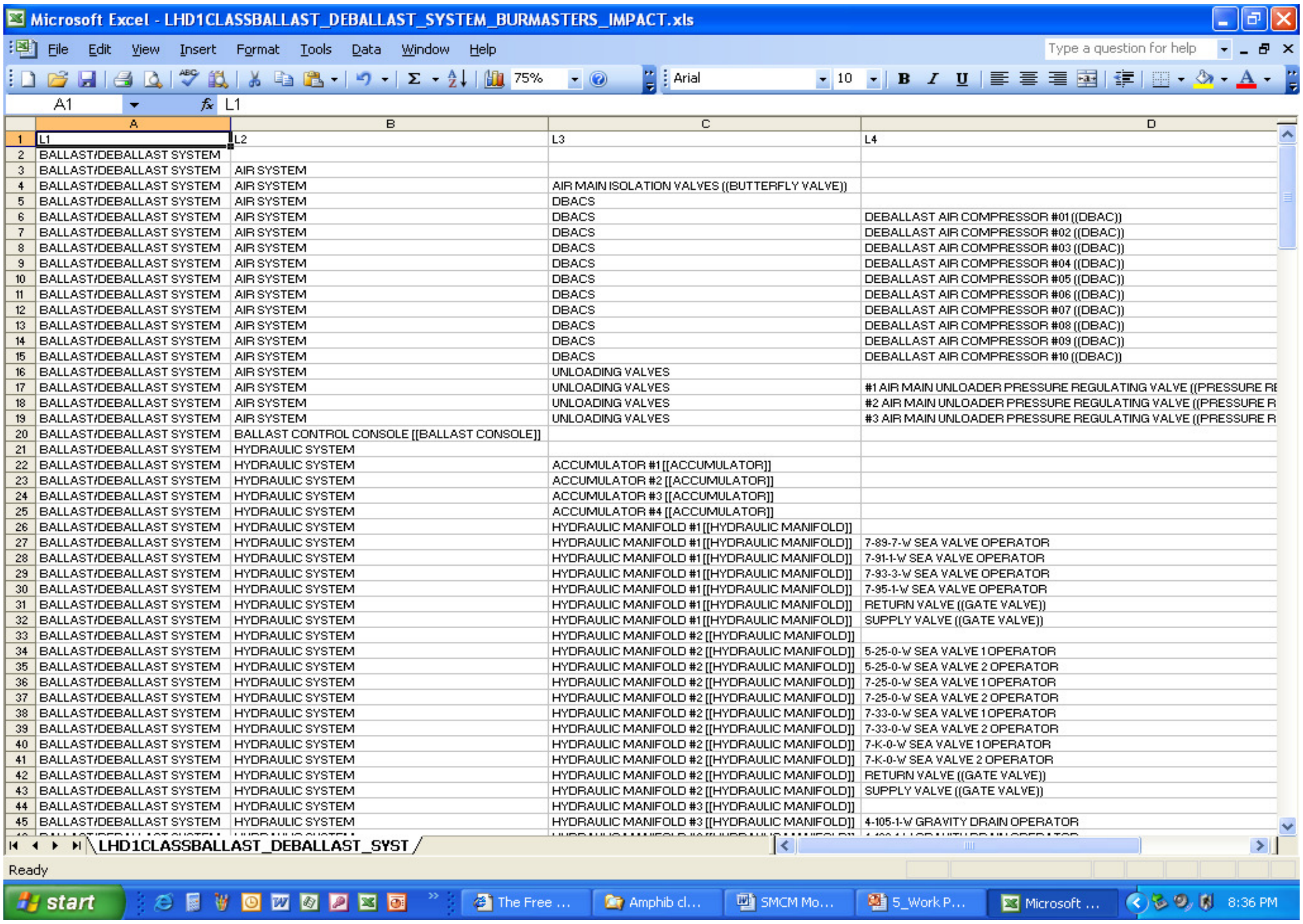
L1	L2	L3	L4	L5	L6	L7	WF	CF	PCL	IMPACT	L8	MRC_S_	REDUNDANCY	NOTES
ACCOMMODATION LADDER DEPLOYED PIERSIDE							5	N	P1				N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	DAVIT WITH WINCH						40	N	C2	0.6			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	LADDER ASSEMBLY						30	Y	P2	0			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	LADDER ASSEMBLY	DOCK ROLLER					30	N	C3	0.7			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	LADDER ASSEMBLY	HANDRAILS					50	N	C3	0.5			N	If no handrails, use with extreme caution
ACCOMMODATION LADDER DEPLOYED PIERSIDE	LADDER ASSEMBLY	LADDER					10	Y	C3	0			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	LADDER ASSEMBLY	TREADS					10	Y	C3	0.1			N	If 2 successive treads missing or damaged
ACCOMMODATION LADDER DEPLOYED PIERSIDE	UPPER PLATFORM ASSEMBLY						30	Y	P2	0			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	UPPER PLATFORM ASSE	BOAT LINES					10	N	C3	0.9			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	UPPER PLATFORM ASSE	HANDRAILS					50	N	C3	0.5			N	If no handrails, use with extreme caution
ACCOMMODATION LADDER DEPLOYED PIERSIDE	UPPER PLATFORM ASSE	HULL ATTACHMENT POINTS					20	Y	C3	0			N	
ACCOMMODATION LADDER DEPLOYED PIERSIDE	UPPER PLATFORM ASSE	PLATFORM					20	Y	C3	0			N	

Example of a Structure Template for a Component with Redundancy Comments

First Phase: System Relationships

A **system** functional hierarchal structure is built out one system at a time. In some cases, the Planning Agent is responsible for many of the components and the system. The *Structure Template* or *Model Builder Application* is used to aid in the construction of the system network.

The system is indicated in Column "A" and with its respective components listed in Column "B". Successive columns are used to fill out the structure. The following figure is an example of a completed Structure Template for a system.



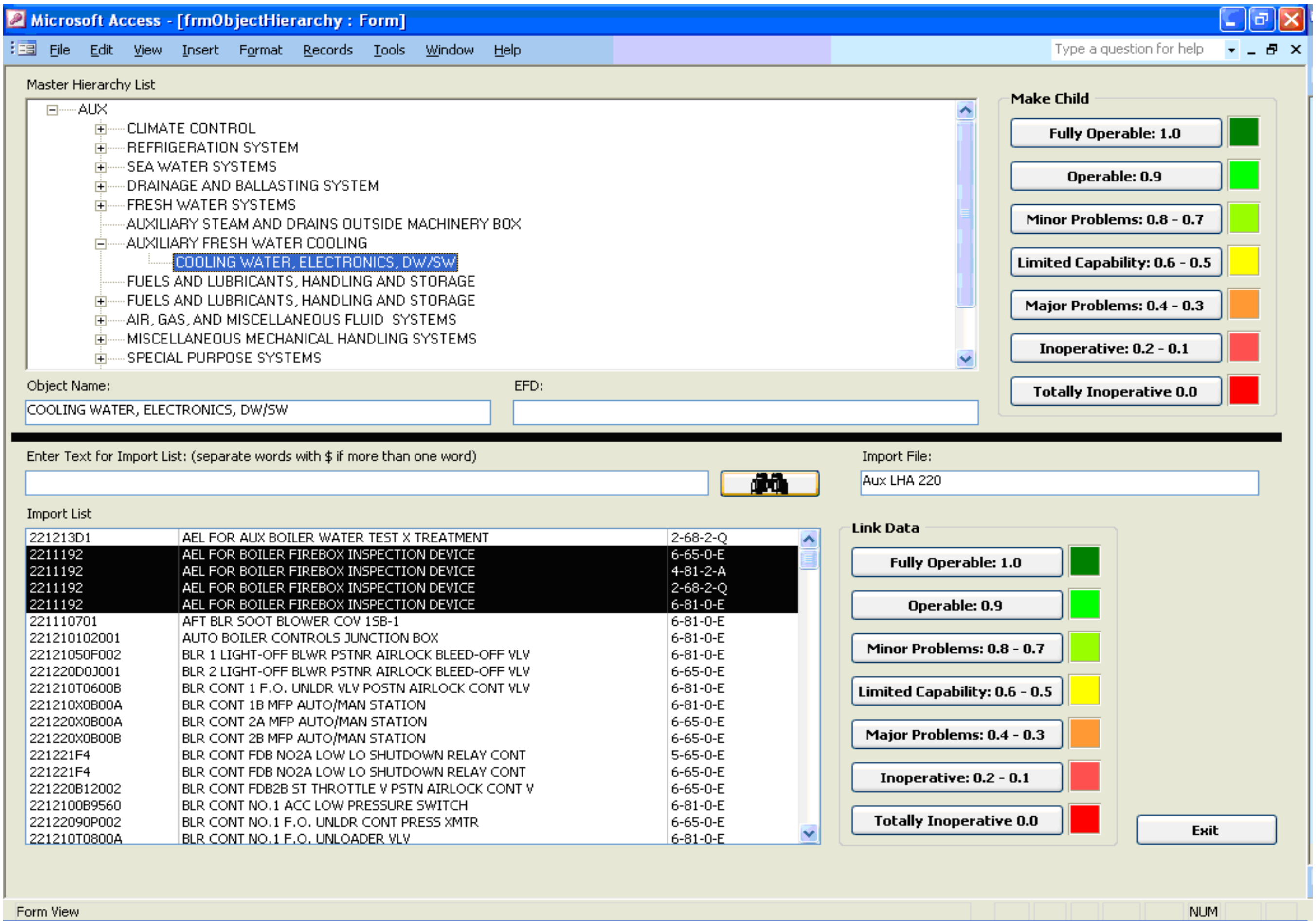
	A	B	C	D
1	L1	L2	L3	L4
2	BALLAST/DEBALLAST SYSTEM			
3	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM		
4	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	AIR MAIN ISOLATION VALVES ((BUTTERFLY VALVE))	
5	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	
6	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #01 ((DBAC))
7	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #02 ((DBAC))
8	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #03 ((DBAC))
9	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #04 ((DBAC))
10	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #05 ((DBAC))
11	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #06 ((DBAC))
12	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #07 ((DBAC))
13	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #08 ((DBAC))
14	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #09 ((DBAC))
15	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	DBACS	DEBALLAST AIR COMPRESSOR #10 ((DBAC))
16	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	UNLOADING VALVES	
17	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	UNLOADING VALVES	#1 AIR MAIN UNLOADER PRESSURE REGULATING VALVE ((PRESSURE RE
18	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	UNLOADING VALVES	#2 AIR MAIN UNLOADER PRESSURE REGULATING VALVE ((PRESSURE R
19	BALLAST/DEBALLAST SYSTEM	AIR SYSTEM	UNLOADING VALVES	#3 AIR MAIN UNLOADER PRESSURE REGULATING VALVE ((PRESSURE R
20	BALLAST/DEBALLAST SYSTEM	BALLAST CONTROL CONSOLE [[BALLAST CONSOLE]]		
21	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM		
22	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	ACCUMULATOR #1 [[ACCUMULATOR]]	
23	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	ACCUMULATOR #2 [[ACCUMULATOR]]	
24	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	ACCUMULATOR #3 [[ACCUMULATOR]]	
25	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	ACCUMULATOR #4 [[ACCUMULATOR]]	
26	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	
27	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	7-89-7-W SEA VALVE OPERATOR
28	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	7-91-1-W SEA VALVE OPERATOR
29	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	7-93-3-W SEA VALVE OPERATOR
30	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	7-95-1-W SEA VALVE OPERATOR
31	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	RETURN VALVE ((GATE VALVE))
32	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #1 [[HYDRAULIC MANIFOLD]]	SUPPLY VALVE ((GATE VALVE))
33	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	
34	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	5-25-0-W SEA VALVE 1 OPERATOR
35	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	5-25-0-W SEA VALVE 2 OPERATOR
36	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-25-0-W SEA VALVE 1 OPERATOR
37	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-25-0-W SEA VALVE 2 OPERATOR
38	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-33-0-W SEA VALVE 1 OPERATOR
39	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-33-0-W SEA VALVE 2 OPERATOR
40	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-K-0-W SEA VALVE 1 OPERATOR
41	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	7-K-0-W SEA VALVE 2 OPERATOR
42	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	RETURN VALVE ((GATE VALVE))
43	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #2 [[HYDRAULIC MANIFOLD]]	SUPPLY VALVE ((GATE VALVE))
44	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #3 [[HYDRAULIC MANIFOLD]]	
45	BALLAST/DEBALLAST SYSTEM	HYDRAULIC SYSTEM	HYDRAULIC MANIFOLD #3 [[HYDRAULIC MANIFOLD]]	4-105-1-W GRAVITY DRAIN OPERATOR

Example of a Structure Template for a System

Criticality and Weighting Factor values are determined. Where applicable, Redundancy Group, Redundancy Comments, Redundancy Condition, Redundancy Minimum, and Redundancy Maximum values are determined and entered.

First Phase: Process Automation

A **Parsing Application** is now available to replace the manual steps that have been described above. The Parsing Application incorporates the applicable modeling rules. The below figure shows a screen shot of the Parsing Application. The hierarchal network is shown in the upper left hand pane and an extract from CDMD-OA is shown in the lower left hand pane. The items (CDMD-OA) highlighted in the lower pane are in the process of being attached to the item (hierarchal network) highlighted in the upper pane.



Example of the First Phase Parsing Application

Second Phase: Reviewing Model Structure

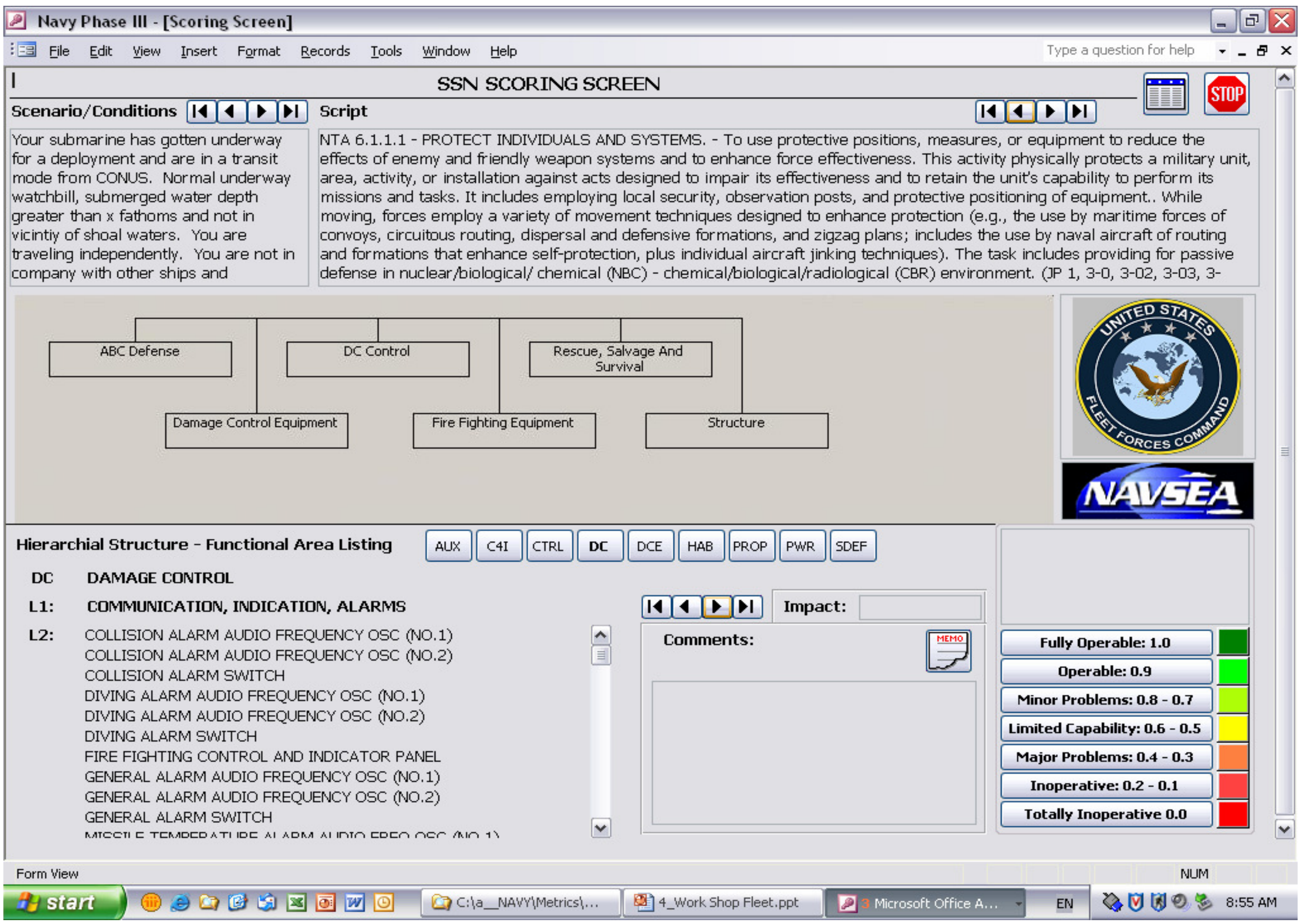
Each ship class model is developed by Functional Area. At the completion of each ship class model building, the completed hierarchal structure is compared to the Functional Area Template for purpose of standardization and modification of the template based upon conventions followed by the In-Service Engineering Agents, the Planning Yards, and other Planning Activities.

Third Phase: Mapping System to the Warfare Area

(or other designated mission/task areas, designation of Operational Performance Values, and determination of operational scenarios.)

Operator seminars are held to determine how Functional Areas/Level One (system) impact Warfare Areas or designated missions or tasks. Each ship class operator seminar determines operational scenarios, maps Functional Areas/Level One (system) to Warfare Areas or other designated mission/task areas, provides Operational Performance Values, and ranks Functional Areas, mission areas, and operational scenarios. Effectively, the operator seminars provide information that determine the Criticality, Weighting Factor, and threshold values for designated mission/task areas and operational scenarios.

The Third Phase Seminar Application was created to support the capturing of Operational Performance Values and the mapping of system to Warfare Area or other designated mission/task areas. The application has tables that are updated and reflect the ship class as well as the applicable mission areas and naval tasks. Below is a screen shot of a typical scoring screen.

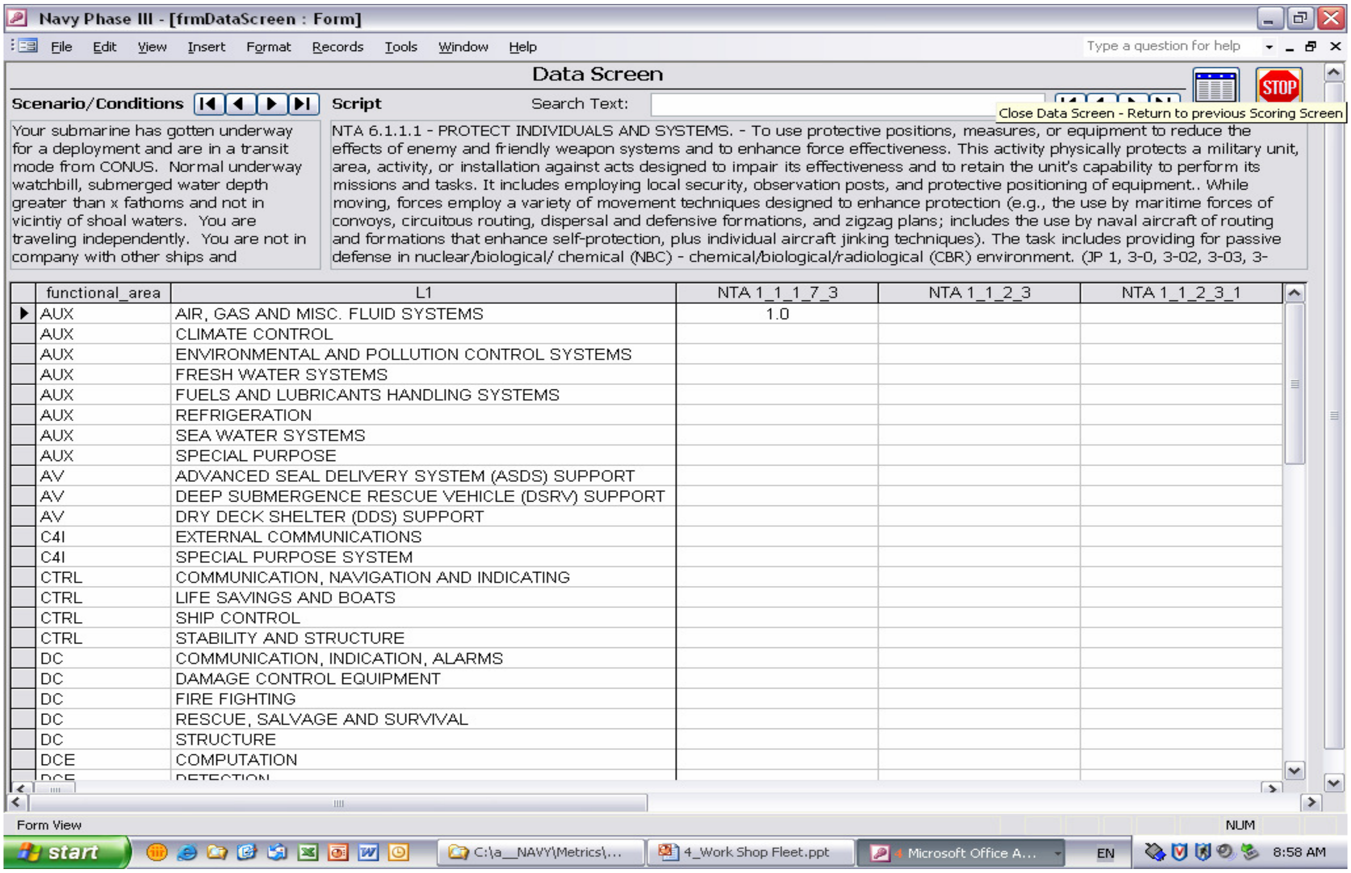


Example of a Third Phase Seminar Application, Scoring Screen (Typical)

The Third Phase Seminar Application Scoring Screen work flow sets up a hierarchy comprised of designated mission/task areas/operational scenarios and Functional Area and system (L1). By keeping mission/task areas/operational scenarios and Functional Area constant, Impact Values are captured for each system as it is cycled through. Upon completion of all the systems for a Functional

Area, a new Functional Area is selected, and the respective systems are displayed and ready for assignment of impact values. This process is repeated for each new Functional Area.

Review of captured results is facilitated on the data screen. Below is an example of the data screen.



Example of a Third Phase Seminar Application, Data Screen

To accomplish modeling, there are several modeling rules to enable the resultant structure to be operated on by an appropriate algorithm.

- Model objects **may be** hardware (Water Tight Door, etc.), software (R-ADMIN, etc.), or a model place holder (Propulsion1). Objects **may not be** checklists or test results.
- Impact Values/Weighting Value and Criticality Factors will be assigned by agents of the Warranted Technical Authority for items below Functional Area level and by Fleet designated operators for the Functional Area level and above.
- Weights for critical children must be the same.
- Single child parents are unnecessary.
- Parents with only critical offspring can be simplified by changing the parent to a child by itself with no children unless the granularity is needed to support subsequent analysis.
- Each child directly impacts its parent. Therefore, children are not at the same level of indenture as their parents.
- For analysis purposes, it's acceptable to create parents (model place holder objects) such as "Propulsion1"and "Propulsion2".
- Composition of systems boundaries varies between the Hull, Mechanical, Electrical, and Combat Systems/C4I areas. The conventions found in the following documentation will be used: Aircraft Carrier ESWBS Manual 2006 CV/CVN Expanded Ship Work Breakdown Structure, Ship "Work Authorization" Boundary (688 Class and older), Ships Work Breakdown Structure (726 Class), Expanded Ship Work Breakdown Structure (021 and later), and conventions provided by the In-Service Engineering Agents and Expanded Planning Yards.
- System components found in three areas (generation, distribution, and end user) will fall under the same Functional Area. However, for critical distributive systems (60 Hz, 120V Power, 400 Hz Power, Direct Current Power, Dry Air, HP/LP/MP Air, Steam, Chill Water, Fire and Flushing Water, Potable Water, Ventilation, etc.), their components will be associated with the end user, usually as a child. Thus, these components will be found in the end user assigned Functional Area. An example would be the chill water valves (inlet/outlet) for a ventilation cooling coil. The valves are assigned as children of the ventilation cooling coil (parent) in the Ventilation System.
- A conditional statement provides amplifying information that expands the capability of the SMCM Algorithm to accommodate the various types of families. During model development, children are grouped with appropriate conditional statements written for like children, horizontal family children, and operationally linked family children.
- Relationships of distributed systems like Hydraulics, Chill Water, Ventilation, and Electrical will reflect:
  - a compartment isolation approach for submarines and
  - a Fire Zone approach for aircraft carriers and surface ships.
- For horizontal and operationally linked families:
  - The input from another family is structured as a child of the receiving parent.
  - The output from a family is for only one child.
  - The output from a family can be the input to many families. No output from higher or lower levels of indenture of receiving families can return back to the original family (prevents infinite loop).

Material Condition Algorithm, Screening Value

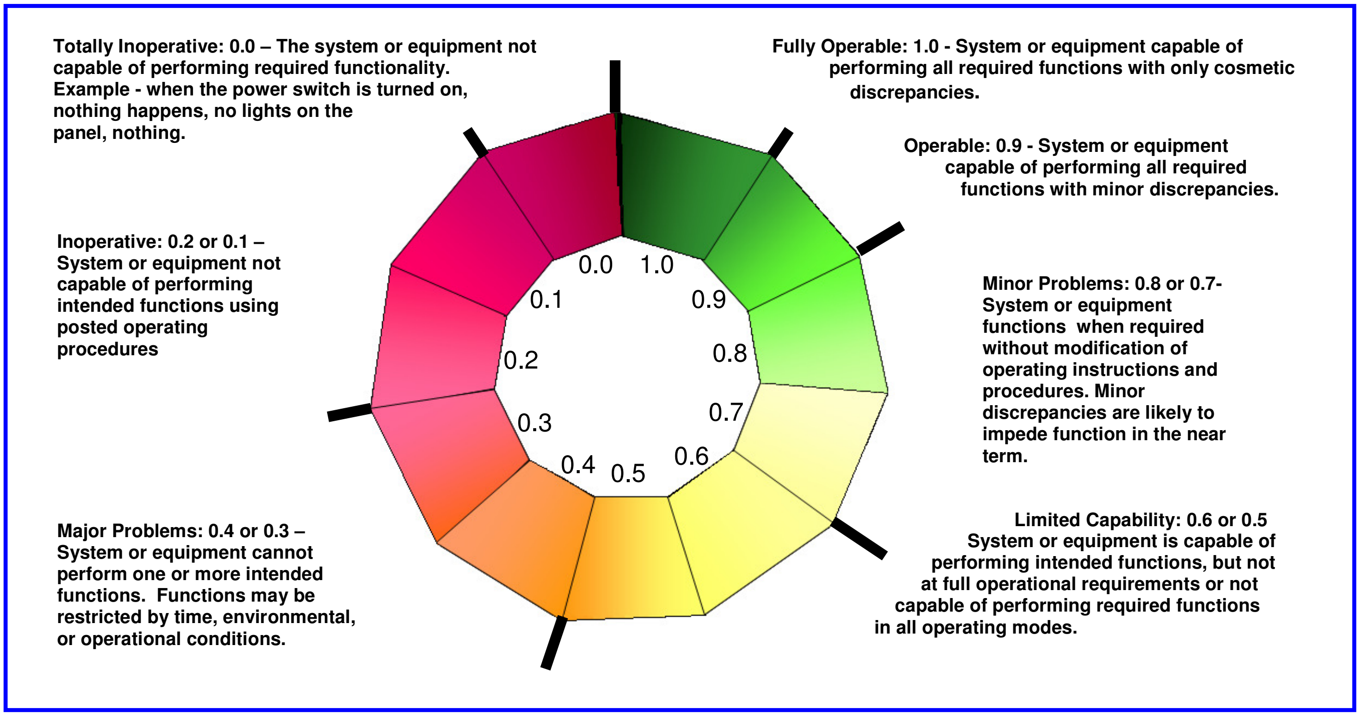
This applies to the numeric algorithm (the application) that operates on the functional hierarchal model structure and simply rolls-up children EOCs to derive the parent Index Value (IV) which ultimately produces MFOM Screening Values for the children.

Material Condition is an objective measure of the parameters of a ship system compared to a standard (e.g. design criteria or normal operating parameters).

Hierarchal Model Structure is composed of top-down arrangement of two or more levels of indenture. The top level for the model is the Warfare Area or other designated mission areas. The Functional Area (FA) is the next lower level of indenture in the structure. The 16 Functional Areas first presented in MFOM's "Business Rule Overview" provide a logical functional grouping of systems and major components (Auxiliary; Aviation Support and Aircraft Launch and Recovery; C4I; Damage Control; Detection, Computation and Engagement; Electro Magnetic Counter Measure; Mine Hunting; Mine Sweeping; Outfitting and Furnishings; Power Generation; Propulsion; Reactor Systems; Repair Support and Cargo; Strategic Systems; Ship's Control; and Self Defense). The next lower level of indenture is Level One (L1) continuing down to the lowest indenture level called Lowest Level of Indenture (LLI). Typically, systems are located at L1, sub-systems are located at L2, and components are located at L3. Components can be grouped into three areas: generation (source of system product), distribution (means to move system product), and end user (user of system product).

A **Family** in the MFOM network is composed of a parent and at least two or more children.

Equipment Operational Capability (EOC) is the Fleet's Measure of Effectiveness. EOC is a dimensionless number (0.0 to 1.0) used in the model to represent the material condition of a particular item (sub-component, component, sub-system, or system). Using Scripted Standardized Assessment Procedures, measured objective evidence is obtained and compared to a standard such as a design criteria or normal operating parameters. The result of this comparison is an assigned EOC value. The figure below sets out the range of values and their standard set of definitions.



Equipment Operational Capability (EOC)

There are times when the EOC value is not obtained through assessment. When a 3M "F Card Type" does not accompany a 2K, then the following decision process is used:

Equipment Operating Capability

F Card from Inspection or If Derived from 2K

If the item is based on a **CASREP** EOC = 0.
If the item is based on a 2K,
If **Block 7** is blank, then disregard 2K.
If **Block 4** – APL/AEL reads NA, then disregard 2K.
If **Block 13** reads either various or NA, then disregard 2K.
If **Block 15** reads 1 or 2, then EOC = 0.
If **Block 15** reads 3, then EOC = 0.4.
If **Block 15** reads 4, 5 or is blank, then go to **Block 7**.
If **Block 7** reads 1, then EOC = 0.9.
If **Block 7** reads 2, then EOC = 0.2.
If **Block 7** reads 3, then EOC = 0.75.
If **Block 7** reads 0, then EOC = 1.0.

Index Value (IV) is an output of the algorithm at any level of the network and can be assigned to various levels of the hierarchal model structure. Index Values are dimensionless numbers (0.0 to 1.0) used in the model to represent the parent's material readiness. The Index Value uses the same title, value or range, and description/definition as the Equipment Operational Capability (EOC).

Index Value:

The "algorithm" simply rolls-up children EOCs to calculate a derived parent Index Value within a family (parent and children) structure. The algorithm continues to roll up into higher levels of indenture and finally, to the warfare/mission areas. There are two variations for the roll-up calculation.

- **Simple Weighted Average** - All **children** are **non-critical** items.

$$\text{Index Value (IV)} = \frac{\sum \text{(EOCs)(Wts)}}{\sum \text{(Wts)}}$$

- **Modified Weighted Average** - At least **one child** is a **critical** item. This case involves a hierarchal structure with the parent object having a critical child in it. The calculated Index Value of the parent cannot be higher in value than the lowest EOC assigned to a critical child. In other words, if a L5 critical sub-component is assigned an EOC of 0, then its L4 parent is calculated to be 0.

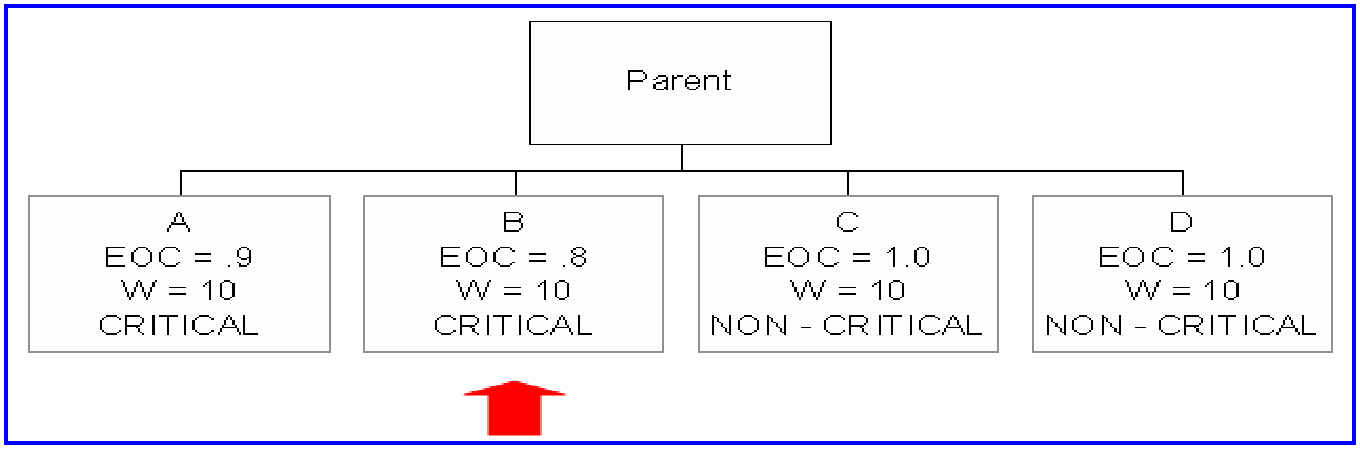
$$\text{Index Value (IV)} = \frac{\text{LCEOC}\left[\text{Wt}_{\text{LCEOC}} + \Sigma\,(\text{other EOCs})(\text{other Wts})\right]}{\Sigma(\text{Wts})}$$

Where:

- LCEOC is *the Lowest Critical EOC* for a grouping where there are multiple critical children and

- Wt_{LCEOC} is the Weighting Factor associated with the child with the Lowest Critical EOC.

For the example shown below, there are four children. Two of the children are critical and the child with the lowest EOC is child "B".



Using the Modified Weighted Average equation, substitute values into the equation shown below:

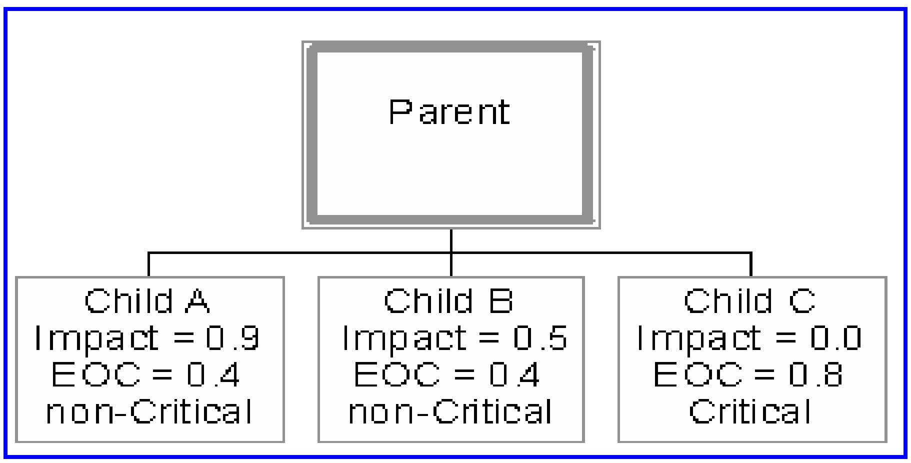
$$\text{Parent Index Value} = \frac{.8[1(10)+1(10)+(10)+.9(10)]}{10+10+10+10} = \frac{.8(39)}{40} = \frac{31}{40} = .78$$

Work with the model has shown that when there are more than 10 children or when there are more than two critical children in a family, a slight change to the Modified Weighted Average equation and the addition of a correction factor eliminates an induced asymptotic behavior. This significantly enhances the display of the calculated values (ultimately, the screening and prioritization MFOM values). Accordingly:

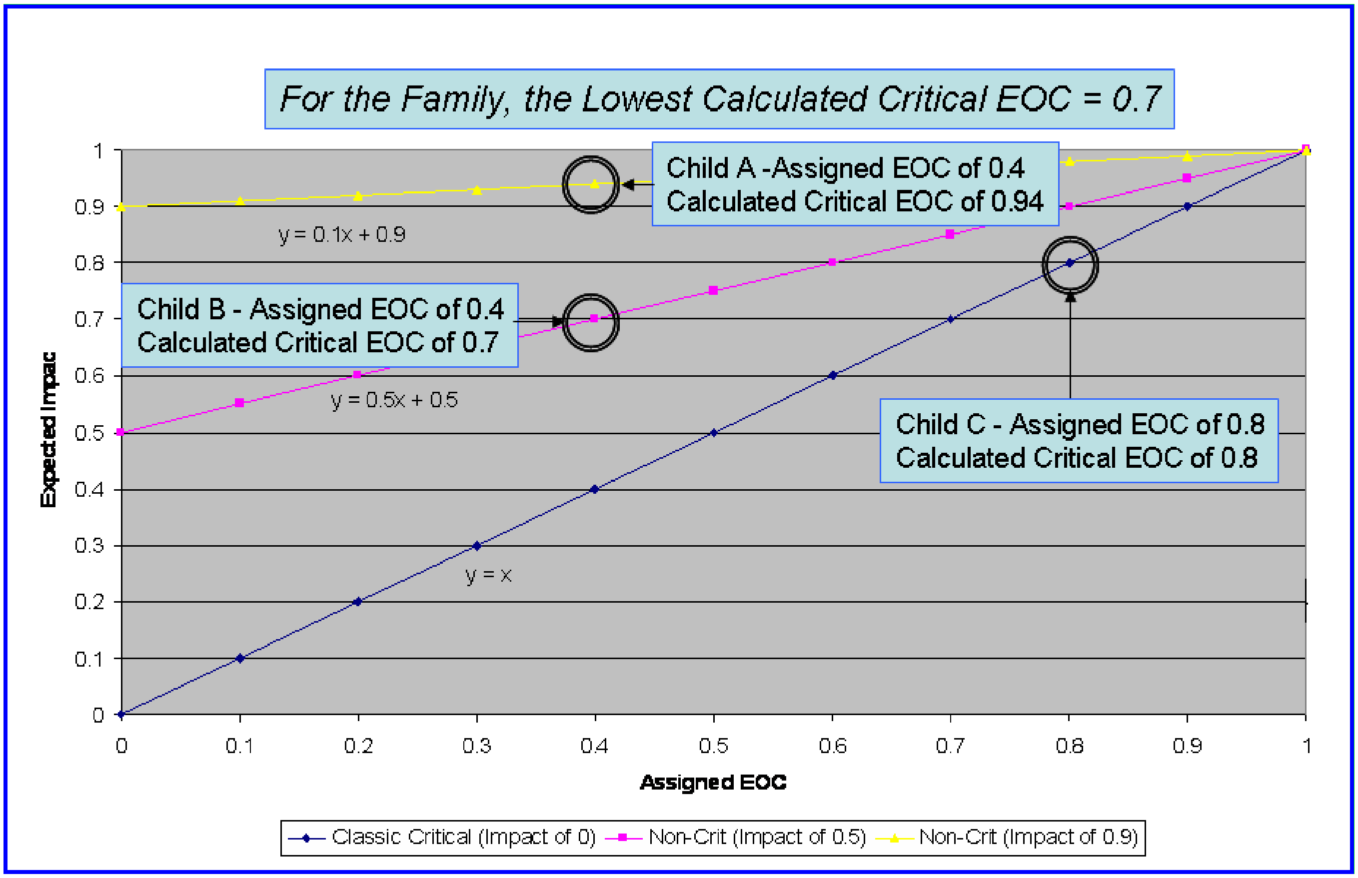
$$\text{Index Value (IV)} = \left(\frac{\text{LCCEOC}\left[\text{Wt}_{\text{LCCEOC}} + \Sigma\,(\text{other EOCs})(\text{other Wts}) \right]}{\Sigma\,(\text{Wts})} \right) \times (\text{correction factor})$$

Where:

- Determination of the Lowest Calculated Critical (LCCEOC) can be best understood with the following example. In this example, there is a family with one critical child and two non-critical children with associated Impacts and EOCs.



Using the equation (y = (1-Impact) * EOC + Impact), the behavior line for each child can be plotted as shown below for comparison. The behavior line for each child starts at the respective impact and the circled portion of the behavior line is the respective EOC values. The Lowest Calculated Critical EOC is the "y" value for the respective EOC. As can be seen in the plot below, Child B has the Lowest Calculated Critical EOC.



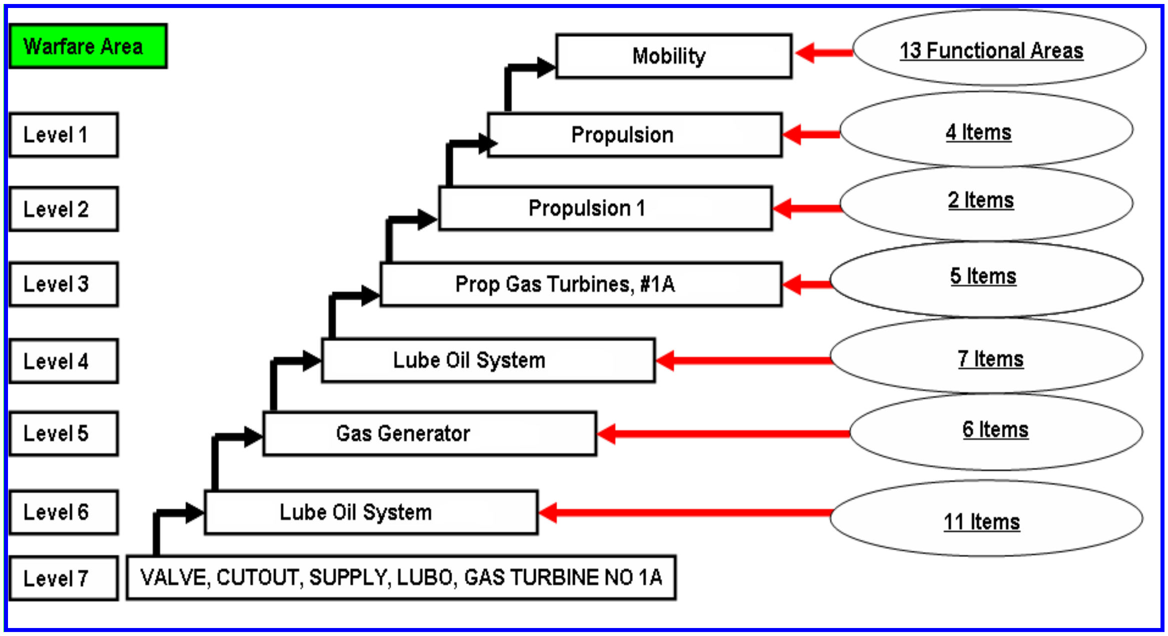
The incorporation of a **Correction Factor** in the calculations eliminates an otherwise induced and undesirable asymptotic behavior:

- Correction Factor = $1 + \dfrac{1}{(1 - e^{(\text{average EOC})\,10 + \ln(2)})}$

and EOC $_{average}$ is the average of all children EOCs.

The following figures will be used to describe the numeric algorithm model "roll-up" or calculation of Index Values.

- The figure below shows a hierarchal structure composed of a number of objects at each level of indenture.

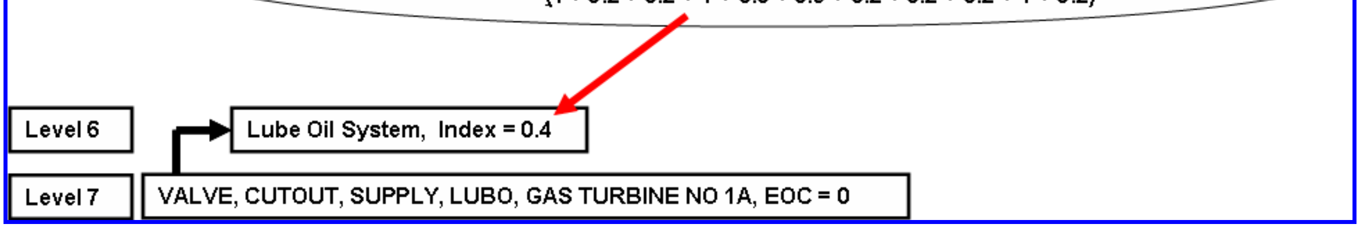


- The figure below shows that at L7, there are 11 objects with their EOC values shown on the table. Using the Index Value equation, an Index Value is calculated for the Lube Oil System.

$$\text{Index} = \frac{[(\text{Min } EOC_C \text{ LVL 7}) \times [(\text{Wt LVL 7}) + (\text{Sum WEOC LVL 7}) - (\text{WEOC LVL7})]]}{(\text{Sum Weights in LVL 7})}$$

L7	Wt	EOC
Lube and Scavenge Pump	1	1
VALVE, CUTOUT, OUTLET, PRESS GAGE, GTRB NO 1A	0.2	1
VALVE, CUTOUT, SAMPLE CONNECTION, GTRB 1A	0.2	1
LUBE OIL COOLER	1	1
Lube Oil Filter DP Transducer	0.3	1
VALVE, CUTOUT, SUPPLY, LUBO, GAS TURBINE NO 1A	0.6	0
SWITCH, CONTROL	0.2	1
VALVE, CUTOUT, SCAVENGE BLANK OFF CONNECTION	0.2	1
VALVE, CUTOUT, VENT, DEHUMIDIFIER, RED GEAR NO 1	0.2	1
Air Oil Separator	1	1
VALVE, CUTOUT, SUPPLY BLANK OFF CONN, GTRB 1A	0.2	1

$$\text{Index} = 0.4 = \frac{(0.4) \times (0.6 + 1\text{x}1 + 1\text{x}0.2 + 1\text{x}0.2 + 1\text{x}1 + 1\text{x}0.3 + 1\text{x}0.2 + 1\text{x}0.2 + 1\text{x}0.2 + 1\text{x}1 + 1\text{x}0.2)}{(1 + 0.2 + 0.2 + 1 + 0.3 + 0.6 + 0.2 + 0.2 + 0.2 + 1 + 0.2)}$$



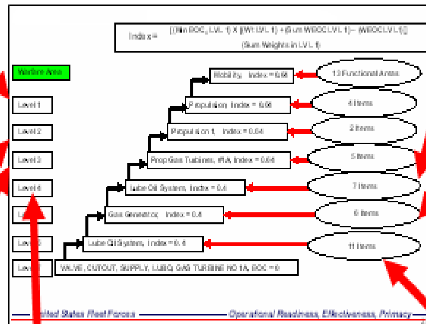
- The Index Value equation was used for the successive higher levels of indenture, calculating Index Values all based upon the EOC values obtained at L7.

L1	Wt	Index
C4I	1	1
AUX	1	1
HAB	1	1
MH	1	1
PWR	1	1
DC	1	1
RP	1	1
SDEF	1	1
DCE	1	1
AV	1	1
CTRL	1	1
PROP	1	0.64
EMC	1	1

L2	Wt	Index
Prop2	1	1
Propulsion Controls	1	1
Prop 1	1	0.64
MP	1	1

L3	Wt	Index
ENGINE ROOM NUMBER 1	0.1	1
Gas Turbine Propulsion	1	0.64

L4	Wt	Index
SYSTEM	1	1
GEARS	1	1
MAIN #B	0.6	1
MAIN #A	0.6	0.4
GT PROPULSION SHAFTING	1	1



L5	Wt	Index
Power Turbine	1	1
Intake	0.9	1
LOSCA	1	1
Uptake	0.8	1
Base Enclosure	0.8	1
High Speed Coupling Shaft	1	1
Gas Generator	1	0.4

L6	Wt	Index
Start & Bleed Air System	1	1
Lube Oil system	0.2	0.4
Inlet Gearbox	0.3	1
Transfer Gearbox	0.5	1
Control & Monitoring System	0.1	1
Fuel and Ignition System	0.1	1

L7	Wt	EOC
Lube and Scavenge Pump	1	1
VALVE, CUTOUT, OUTLET, PRESS GAGE, GTRB NO 1A	0.2	1
VALVE, CUTOUT, SAMPLE CONNECTION, GTRB 1A	0.2	1
LUBE OIL COOLER	1	1
Lube Oil Filter DP Transducer	0.3	1
VALVE, CUTOUT, SUPPLY, LUBO, GAS TURBINE NO 1A	0.6	0
SWITCH, CONTROL	0.2	1
VALVE, CUTOUT, SCAVENGE BLANK OFF CONNECTION	0.2	1
VALVE, CUTOUT, VENT, DEHUMIDIFIER, RED GEAR NO 1	0.2	1
Air Oil Separator	1	1
VALVE, CUTOUT, SUPPLY BLANK OFF CONN, GTRB 1A	0.2	1

MFOM Screening Value:

The algorithm calculates MFOM Screening Values for each child after it calculates parent Index Values. The equation is:

$$MFOM_S = [100 - 100 * (1\text{-EOC or IV or FI}) * \text{Warfare}_{\text{Factor}} * \text{Functional Area}_{\text{Factor}} * \text{Priority} * \text{Time Accelerator} * \text{Screening Case}]$$

Where:

- **EOC** is Equipment Operational Capability,
- **IV** is Index Value,
- **FI** is Future Impact Value which is a value (0.0 to 1.0) that is assigned to a CMP, Ship Alteration, PMS, or other item that may be added to the Shore CSMP. This value enables the SMCM algorithm to produce reports in support of maintenance availability planning that show **future requirements and their anticipated impact if work is not accomplished in the future**. The FI value will decrease (a greater

and greater negative impact) if the time or cycle requirement is not met. The rate of change in the FI value is based upon a degradation profile established by the Technical Authority. The SMCM algorithm in support of maintenance availability planning will use FI values when the FI value is lower than the reported EOC value. The SMCM Algorithm does not use the FI value when calculating or reporting on material condition impacting on warfare.

- **Warfare $_{\textbf{factor}}$** is a dimensionless value (1.0 to 1.2) that represents the priority that operators place on a particular Warfare Area during the Third Phase Model Building operator boards.

- **Functional Area $_{\textbf{factor}}$** is a dimensionless value from 0.8 to 1.5 that represents the priority of the applicable Functional Areas to a particular Warfare Area or mission/task areas. This priority is established in the seminar during the mapping of system to Warfare Area or other designated mission/task areas.

- **Priority** is from the CSMP PRIORITY CODE (2K – Blk 41) (PRI 1 – Mandatory, PRI 2 – Essential, PRI 3 - Highly Desirable, and PRI 4 – Desirable)

- **Time Accelerator** is a dimensionless value (1.0 to 2.0) that represents the amount of time remaining before a ship begins an underway period.

- **Screening Case** allows for different characters of children associated with a parent and to accommodate vertical, horizontal, and operationally linked family structures.

    - **Case One** applies to an **object** in the structure that **is not redundant**. For this object, the Screening Case value is determined by failing that item alone and calculating the difference from 1.0 at the system level.

    - **Case Two** applies to an **object** in the structure that **is redundant** and the number of **redundant item failures or impacts have not caused the system to fall below the minimum operational expectation** (i.e. two of three compressors are still available with a minimum of two compressors required to be operational). For this object, the Screening Case value is determined by obtaining the difference between lower system failure impact and redundant item impact and dividing the result by the number of redundant items. Then, the difference from 1.0 is calculated at a higher level of indenture.

        - For example - If one of three air compressors is failed in a system requiring two of three to be operational, the item failure value is calculated. Then, the system failure is calculated by failing a second air compressor. The difference is then calculated between the system failure value and the single item failure value and the result is divided by the number of redundant items in the system which, in this case, is three. This result is then added to the original single equipment failure value and becomes the Screening Case value.

    - **Case Three** applies to **objects** that **are redundant** and the **number of redundant item failures or impacts have caused the system to fall below the minimum operational expectation** (i.e. one of three compressors are still available with a minimum of two compressors required to be operational).

The Screening Case value is determined with the lower system failed and calculating the difference from 1.0 at a higher level of indenture.

- For example - If two of three air compressors are failed in a system requiring two of three to be operational, the air system failure value is calculated and rolled up to the higher level of indenture, in this case, Compressed Air Systems and then considered to be the System Failure Impact value.

The previous discussion leads to the need for the following Screening Value requirements:

- The lower the MFOM Screening Value, the more important it is to correct the material discrepancy.
- When new work is recorded or work is accomplished, new MFOM Screening Values are calculated.

Material Condition Algorithm, Readiness Value

Material Condition is an objective measure of the parameters of a ship system compared to a standard (e.g. design criteria or normal operating parameters).

Hierarchal Model Structure is composed of top-down arrangement of two or more levels of indenture. The top level for the model is the Warfare Area or other designated mission areas. The Functional Area (FA) is the next lower level of indenture in the structure. The 16 Functional Areas first presented in MFOM's "Business Rule Overview" provide a logical functional grouping of systems and major components (Auxiliary; Aviation Support and Aircraft Launch and Recovery; C4I; Damage Control; Detection, Computation and Engagement; Electro Magnetic Counter Measure; Mine Hunting; Mine Sweeping; Outfitting and Furnishings; Power Generation; Propulsion; Reactor Systems; Repair Support and Cargo; Strategic Systems; Ship's Control; and Self Defense). The next lower level of indenture is Level One (L1), continuing down to the lowest indenture level called Lowest Level of Indenture (LLI). Typically, systems are located at L1, sub-systems are located at L2, and components are located at L3. Components can be grouped into three areas: generation (source of system product), distribution (means to move system product), and end user (user of system product).

A **Family** in the MFOM network is composed of a parent and at least two or more children. MFOM reports material condition readiness values against mission/warfare areas.

AAW	Anti-Air Warfare
AMW	Amphibious Warfare
ASU	Anti-Surface Ship Warfare
ASW	Anti-Submarine Warfare
C2W	Command and Control Warfare
CCC	Command, Control and Communication
FSO	Fleet Support Operations
INT	Intelligence
LOG	Logistics
MIW	Mine Warfare
MOB	Mobility
MOS	Missions of State
NCO	Non-Combatant Operations
NSW	Naval Special Warfare
STW	Strike Warfare

Mission Areas / Warfare Areas

Defense Readiness Reporting System-Navy (DRRS-N) requires that each resource pillar (Personnel, Equipment, Supply, Training, and Ordnance) provide both an integer $0 \le x \le 100$ and color code indicator for each NMET assigned to each unit. Color indicators are explained in the rule titled, "Material Condition Color Indicators". In the case of the equipment resource category, these two indicators will reflect the equipment material condition for each NMET assigned to each unit. Furthermore, DRRS-N requires that the data used to determine the equipment material condition support a data drill down capability.

The previous discussion leads to the need for the following Readiness Value criteria:

- MFOM 2.0 will compute the Equipment Material Condition Metric using the following methodology:
- MFOM 2.0 will provide one indicator for each NMET assigned to each unit expressed as an integer $0 \leq x \leq 100$ (where 100 is good and 0 is bad).
- Values reported to DRRS-N for each NMET that are in the upper threshold are indicated in green.
- Values reported to DRRS-N for each NMET that are in the range of the thresholds are indicated in yellow.
- Values reported to DRRS-N for each NMET that are below the threshold are indicated in red.
- Values are reported automatically to DRRS-N at the conclusion of each transacted 2K update to MFOM.

Material Condition Color Indicators

MFOM 2.0 will generate material readiness values for a ship by Warfare Area and NMET. This is intended for MFOM users and for electronic feed to DRRS-N for the "E" (Equipment) portion of the ship's readiness. DRRS-N requires each resource category to provide an integer $0 \leq x \leq 100$ assigned to each unit. In the case of the equipment resource category, this indicator will reflect the equipment material condition supporting **Major Combat Operation (MCO)** assigned to each unit.

MFOM 2.0 will employ three colors in association with each of the equipment material condition NMET indicators. These colors are green, yellow, and red.

The "**green**" indicator means the organization can accomplish the task to prescribed standards and conditions with its equipment in the current condition. The value associated with this threshold should be clearly supportable. The "green" indicator always denotes the highest state of material condition readiness.

The "**yellow**" indicator means the organization can accomplish the task to the prescribed standards and conditions but a portion of the organization's equipment is impaired and thus, there is risk. The value associated with this threshold should be clearly supportable. The "yellow" indicator is still a "yes"—it sends Force Managers the signal the organization's equipment is expected to accomplish the task to standard, under most conditions, but not all required equipment is fully operational. The yellow indicator always denotes an equipment material condition below green and above red.

The "**red**" indicator means the organization is unable to accomplish the task to prescribed standards and conditions due to inoperable equipment. The value associated with this threshold should be clearly supportable by observed and evaluated values. The red indicator always denotes the lowest equipment material condition.

Thresholds:

Thresholds are the numerical break points or boundaries between green and yellow as well as yellow and red.

The upper bound of the green threshold shall be fixed at 100. USFF N43 will set the lower bound of the green threshold. The upper bound of the yellow threshold shall be fixed at one less than the lower bound of the green threshold. MFOM 2.0 shall set the lower bound of the yellow threshold automatically at 75% of the lower bound of the green threshold. The upper bound of the red threshold shall be fixed at one less than the lower bound of the yellow threshold. The lower bound of the red threshold will be fixed at zero.

System Developers will ensure the color-coding for equipment material condition is configurable within MFOM 2.0 such that the color thresholds may be changed at any time for a given NMET.

The lower thresholds for color indicators, green and yellow, in DRRS-N are fixed at 80 and 60 respectively. In order to ensure that the color indicators in MFOM match the color indicators in DRRS-N, a normalization of the numerical readiness value will be done in MFOM 2.0 prior to transmitting to DRRS-N. This normalization is detailed in business rule called, "Material Condition Algorithm, Screening Value".

The previous discussion leads to the need for the following Material Condition Color criteria:

- MFOM 2.0 will employ three colors in association with each of the equipment material condition NMET indicators. These colors are green, yellow, and red.
- In MFOM 2.0, the lower thresholds for color indicators for MCOs, green and yellow, matching the DRRS-N display, are fixed at 80 and 60 respectively.
- FFC N43 will configure the color code (green, yellow, red) thresholds for material condition by Warfare Area and NMET for each authorized responsible organization.
- MFOM 2.0 will compare calculated equipment material condition to the equipment material condition color code thresholds set for each task to determine which color to associate with the value.
- MFOM 2.0 will provide functionality for those with the appropriate role to change the color-coding for equipment material condition thresholds.
- A bi-annual review (and update where appropriate) of the thresholds in each NTA for their respective vessel classes will be conducted by each TYCOM N43.

Material Condition Metric Normalization Required for DRRS-N

The material readiness is calculated in MFOM 2.0 using the material readiness algorithm for each Warfare Area and NMET. The determination of the range of numbers constituting red, yellow, and green for each Warfare Area is determined as stated in the business rule addressing the Material Condition Color Indicator. These will vary from platform to platform, Warfare Area to Warfare Area, and scenario to scenario.

DRRS-N presents the readiness of all five resource areas P – E – S – T – O (Personnel, Equipment, Supply, Training, and Ordnance) on the same screen for the commanders to use in evaluating their readiness. It is necessary to standardize and present a simple, meaningful screen which naturally contains a large number of metrics. As a result, all **breakpoints in DRRS-N** are standardized at **100 – 80 green**; **79 – 60 yellow**; and **59 – 0 red**. In order for MFOM 2.0 to register in DRRS-N readiness data that is comparable to the readiness determined in MFOM 2.0, a calculation to normalize the MFOM 2.0 material readiness values is required.

MFOM 2.0 provides the functionality for a CO to view the readiness impact of his current CSMP within MRAS prior to transmitting the MRAS information to MFOM ashore and ultimately to DRRS-N. (The business rule addressing the Shipboard Readiness Process Flow in MRAS applies.) In order to accomplish this, MFOM must transform regular output to normalized values and present them in the same manner that will be later presented in DRRS-N in the appropriate scale.

NOTE: The normalization functionality should not be activated within MFOM 2.0 until all the MFOM 2.0 breakpoints are validated following implementation. As a consequence, it is recognized that until the MFOM 2.0 breakpoint validation is completed, a material condition readiness value will be the same in both MFOM 2.0 and DRRS-N but the color indicator will possibly be different in the two systems.

The previous discussion leads to the need for the following Metric Normalization criteria:

- MFOM 2.0 will calculate normalized values for submission to DRRS-N. This can be found in the rule titled, “Material Condition Algorithm, Screening Value”.
- USFF N43 will configure the color code (green, yellow, red) thresholds for material condition by Warfare Area and NMET for each authorized responsible organization.
- MFOM 2.0 will present the normalized values in the MRAS and MFOM 2.0 high side (CLASSIFIED) application using a similar GUI to DRRS-N.

Material Condition Upgrade Recommendation

Material condition upgrade recommendation refers to a specific functionality in MFOM 2.0 that will enable the user to determine which maintenance actions to complete in order to achieve the minimum required maintenance for a given scenario and mission area.

The unit CSMP and CMP contain repair work as well as time-based maintenance actions that influence readiness. MFOM 2.0 is planned to provide prioritization functionality based contribution to readiness and the associated cost of the maintenance selected to achieve a particular level of readiness. A challenge to the maintenance leadership is oftentimes not entirely controlled by a strict priority of overall readiness impact. In a surge or emergency response scenario, a unit must be capable of determining which maintenance actions are required to meet minimum mission requirements.

MFOM 2.0 utilizes the selected scenario and its associated threshold values for each Warfare Area to determine recommended maintenance actions to meet those minimum threshold values. The user may specifically include or exclude maintenance actions used in determining the recommended maintenance actions list. MFOM displays the Warfare Areas in order of highest precedence on the left towards the lowest on the right for the selected scenario. MFOM 2.0 will select the necessary maintenance actions to meet the threshold value for each successive Warfare Area. MFOM chooses the maintenance action that will have the overall best impact on readiness (increase material condition) without consideration to cost. It does this by using the screening MFOM value assigned to each individual maintenance action, choosing the lowest screening MFOM value (100 being the highest) until it meets the established threshold. In doing so, MFOM may exceed the threshold value by selecting the next highest priority maintenance action vice the one that would provide the exact value closest to the threshold. Because of the integrated nature of systems, maintenance actions chosen will have an impact on other Warfare Areas indicated to the right of the Warfare Area currently being calculated. MFOM will include that collateral impact when selecting maintenance actions for subsequent Warfare Areas.

The previous discussion leads to the need for the following Metric Normalization criteria:

- The software will automatically select the most limiting scenario between today's date and the next scheduled availability in Web Sked.
- User may select a different scenario associated with the employment of the platform to determine ship material condition readiness thresholds.
- MFOM 2.0 will select maintenance actions from the CSMP including CMP items already in the CSMP, starting at the highest in precedence Warfare Area working towards the last Warfare Area on the right, using the screening MFOM value to meet or exceed the minimum threshold value (unless a maintenance action was specifically included or excluded by the user).
- MFOM 2.0 will highlight (in light and dark green) the maintenance actions it selected to meet the minimum threshold value and display the estimated cost to perform those maintenance actions (man-days and material) as a rollup value.

Unit Equipment Configuration

Unit equipment configuration is the list of physical components of a unit by type, quantity, and location.

The model must have a database from which to draw for the unit equipment to be modeled. This is the cornerstone of establishing the parent-child relationships and associated weighting. In order for the model to correctly depict the impact of changes in material condition of one of the components in a unit, it is critical for the model to have access to a current set of equipment. (Configuration Data Managers Data - Open Architecture (CDMD-OA)) is the initial configuration database that will be relied upon by MFOM 2.0 as the authoritative source of unit configuration data.)

The configuration data holds the status and maintenance of naval equipment and its related logistics items (drawings, manuals, etc.) for naval activities around the world. The status of a given piece of equipment in a unit determines what and how many spare parts will be stored for it in that unit, making this tracking extremely important in terms of cost, unit storage space and weight, and the operational availability of the unit. Configuration data was designed specifically to aid the tracking of unit configuration by shore-based configuration managers. As part of the client/server architecture of CDMD-OA, a single repository of all naval configuration and logistics data from around the world is available for querying. CDMD-OA incorporates the latest technological innovations to maintain data integrity and speed transmission of updates between the units, Naval Inventory Control Point (NAVICP), and the Configuration Data Managers (CDMs).

The accuracy of configuration data will be maintained through MFOM 2.0 by ensuring the model in MFOM 2.0 is kept current and complete.

- The MFOM Program Manager will ensure the unit model configuration is reviewed annually.
- Units will ensure all work notifications are properly dispositioned and any configuration changes are submitted within 90 days following a maintenance action (e.g. repair, replacement, modification, alteration, etc.).

MFOM 2.0 Data and Information Flow

MFOM 2.0 uses existing information systems to receive material condition and operational data from afloat and ashore units electronically; therefore, it does not require new reporting or information systems.

The readiness values calculated and reported by MFOM 2.0 are highly dependent on the quality and accuracy of the supplied data. MFOM 2.0 is supplied with raw data with no data conditioning. Using existing legacy information systems has highlighted issues of data quality that can only be resolved by transitioning to more capable systems.

MFOM 2.0 will transition legacy paper processes and stand alone data collection systems to new MFOM applications and to other supporting collaborative data bases. This transition will enhance the "create once, use many times" philosophy, establishing for the first time an authoritative pedigree associated with collected data and eliminating the need for duplication of data entry.

MFOM 2.0 users are in multiple locations both ashore and afloat. The information displayed by MFOM 2.0 to support the users' functional requirements contains information that may be classified, restricted, and/or business sensitive. MFOM 2.0 controls access through structured user permission levels. The system also limits access through classification of certain data and communication through restricted paths. For these reasons, MFOM 2.0 is hosted on separate classified and unclassified servers both afloat and ashore.

For both afloat or ashore, the flow of a unit's material condition and operational data typically starts with the user entering data into existing maintenance information systems on the unclassified LAN. For an **afloat** unit (except submarines), the data is fed to the Distance Support Server from which it is transmitted ashore, then rides RADWEB, and finally arrives in MFOM 2.0. For **shore** units, the path is shorter since they will work directly in unclassified MFOM 2.0 (and its supporting feeds from a web service). The communication path will follow the shore side (the right hand) of the diagram below.

For units that have the maintenance information system on the classified LAN, a separate data flow capability is being developed. Submarine units will enter work notifications and other basic maintenance data into MRAS in the afloat classified circuit as generally depicted in the following diagram (upper half).

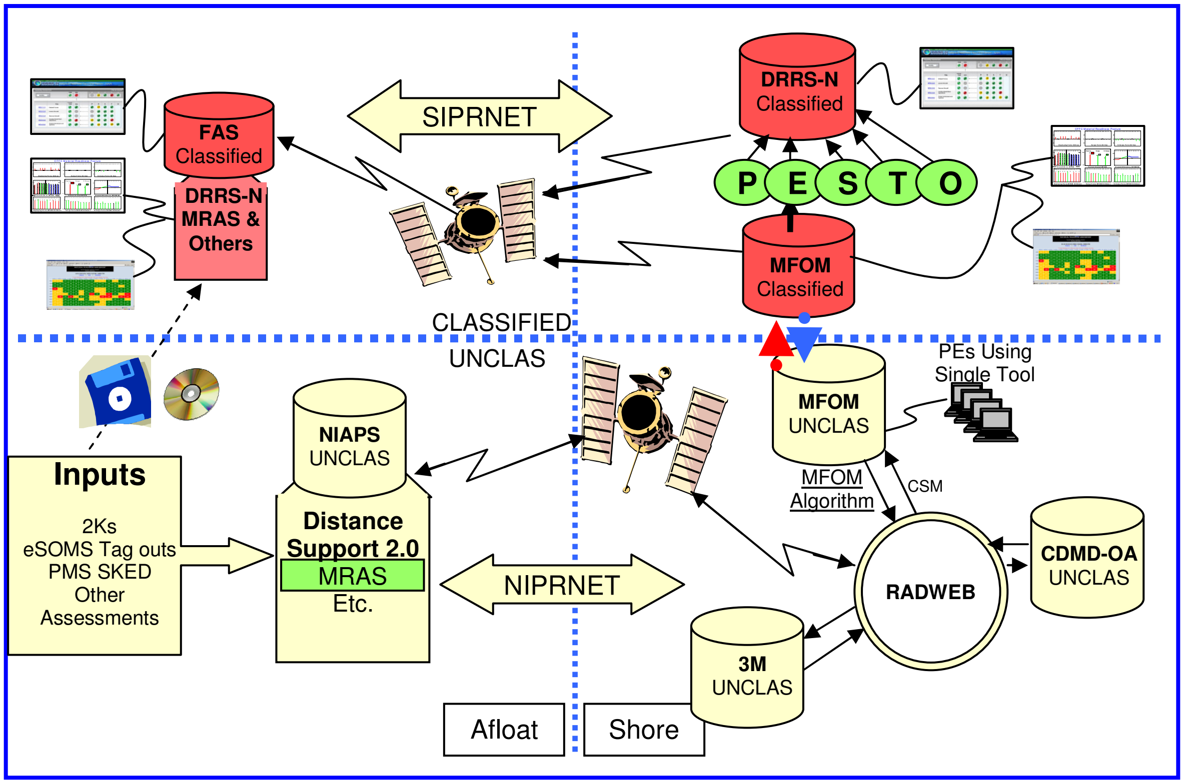
The transfer of data between the ashore MFOM 2.0 unclassified and classified domains will be through a government approved data communication connection (Radiant Mercury). This cross domain solution allows for the transfer of data in both directions but prevents the transfer of classified data to the unclassified domain.

Displays ashore of MFOM 2.0 information will be provided to afloat units as well. Unclassified data will use the RADWEB/Distance Support Server path, while classified data will be handled through the SIPRNET.

The Commanding Officer or others afloat may preview the effect of an equipment degradation on overall material readiness as it is calculated, reported, and viewed in the ashore environment. Afloat units with the MRAS (MFOM 2.0 afloat) application may test CSMP data through a hand transfer process from the unclassified instance of MFOM to the classified instance of MFOM resident in the unit.

Afloat and ashore instances are identical as long as the systems are communicating. Synchronization will immediately take place upon re-connection of the systems after an interruption in communications.

The general data flow is depicted in the following diagram.



Data Flow

It follows then that:

- For MFOM/MRAS to universally portray the most accurate and representative maintenance readiness, work candidate inputs must pass through RADWEB from afloat units AND return to the originating unit the resulting MFOM and DRRS-N status.
- For MFOM/MRAS to portray the most accurate and representative maintenance readiness universally, both ashore and afloat models of that unit must be the same version.

MFOM "Why"
Chapter 3: Outputs

These chapters define in detail what Maintenance Figure of Merit (MFOM) 2.0 is. This book is organized into five chapters that explain MFOM: the primer, the inputs to MFOM, the model operation, **the outputs of MFOM**, and the model maintenance. The primer gives a more in depth description of MFOM, chapter one discusses what goes into MFOM, chapter two discusses how MFOM works, **chapter three discusses what comes out of MFOM**, and chapter four discusses how the model is maintained. Now that the thought process of the organization of this book has been explained, please feel free to dive deeper into the world of **MFOM and its outputs.**

First Pass Yield (FPY) % - 2K Configuration Correlation

The 2K Configuration Correlation % FPY metric that is shown below is the FPY presentation of the quality of data filtered per the business rule titled, "Shipboard Readiness Process Flow in MRAS". The quality of the material condition data input to the model has a dramatic impact on its usefulness in depicting the unit's readiness. More simply put, "quality in" equals "quality out" and vice versa. The 3-M Process (NAVSEAINST 4790.8B) provides the means to ensure accurate and timely material condition information. MFOM 2.0 automatically determines the data entry's correlation to the configuration database IAW the business rule that details Equipment Operational Capability. If the model cannot successfully correlate the data correctly, it is rejected as unsatisfactory. This rejection is tracked and used to compute a FPY analysis. These rejections and this metric provide timely and accurate feedback on data input quality to the ship maintenance leadership.

The volume of 2K entries varies from unit to unit and day to day making a daily or weekly metric of limited value due to limited numbers of data points. For this reason, the metric is computed daily using the data from the past 30 days, i.e. a rolling 30 day view, and results are posted on each unit's Current Stats MFOM – E screen.

The result from the above discussion leads to the following rationale.

Calculation:

2K Configuration Correlation % FPY = Correlated Correctly / Total Entries x 100

Total Entries - The number of entries submitted for the last 30 days.

Correlated Correctly - The number of entries which were correctly correlated to the configuration database in the last 30 days. A data entry was NOT completed correctly (First Pass Yield Miss) when MFOM 2.0 rejects the data entry.

Frequency:

Data should be calculated daily using data from the past 30 days and presented on each unit's Current Stats MFOM – E screen.

Absent any further guidance, **no output** information **will be less restricted than** any classified **input data used to derive it**.

Pareto Analysis – 2K Configuration Correlation

The purpose of collecting and then displaying the 2K rejections in a Pareto Analysis table allows for the listing of what the causes of the rejection were and how many times they were rejected, providing a prioritization of problem solving the unsatisfactory FPY performance.

The rejection causes used by the model are:

FIN required - The 2K entry either had no FIN or a FIN that did not correlate with that unit's configuration data.

EOC required – The 2K entry either had no EOC entry, one that could not be calculated automatically, or one that was outside the allowable EOC limits of 0.0 – 1.0.

FIN and EOC required – The 2K had a combination of one of each of the problems listed in the two errors above.

Multiple components on 2K – The entry had more than one component specified in the 2K.

Again, the volume of 2K entries varies from unit to unit and day to day making a daily or weekly metric of limited value due to limited numbers of data points. For this reason, the metric is computed daily but uses the data from the last 30 days, i.e. a rolling 30 day view.

Below is the rationale resulting from the previous discussion of Pareto analysis.

Calculation:

The model will collect the number of rejections by type and unit. These will be tabulated in a two column table listing the rejection cause in the left column and the number of rejections for each cause in the right column. The two column titles will be "2K Rejection Cause" and "Last 30 Days."

Frequency:

Data should be calculated daily using data from the past 30 days and presented on each unit's metrics page.

Cycle Time – 2K Submission – Total Reporting Time (TRT)

This metric presents the static cycle time of the TRT requirement where static cycle time is the average number of calendar days elapsed from the date that TA-1, TA-2 or TA-3 2K items are discovered until the 2K is entered into the CSMP shore file (RMAIS). This also includes any delays in the initial entry into the ship's CSMP, along with any delays in approving the 2K and in uploading the CSMP from the ship. The purpose of this metric is to drive the Ship's Force to write, chop, and up line 2Ks in a continuous and timely manner.

Both data fields that are used in this metric are obtained from Regional Maintenance Automated Information System (RMAIS) and are collected by MFOM 2.0 executing an automated script. As mentioned in the previous sections, the volume of 2K entries differ from unit to unit and day to day making a daily or weekly metric of limited value due to limited numbers of data points. For this reason, this metric is computed daily using the data from the last 30 days, i.e. a rolling 30 day view.

Below is the rationale resulting from this discussion involving TRT.

Calculation:

For TA-1, TA-2, and TA-3 2Ks, the "when discovered date" is subtracted from the "RMAIS entry date" (static cycle time). The individual durations are summed and the result is divided by the number of durations to obtain an average cycle time. This is done within each homeport, by ship class, and by ship.

Frequency:

Data should be calculated daily using data from the past 30 days and presented on each unit's Current Stats MFOM – E screen in MFOM 2.0.

Additions to Chapter 3 in Future Releases

- Pareto Analysis – TRT Cycle Time
- RFT – E Carrier Metric

MFOM "Why"
Chapter 4: Model Maintenance

These chapters define in detail what Maintenance Figure of Merit (MFOM) 2.0 is. This book is organized into five chapters that explain MFOM: the primer, the inputs to MFOM, the model operation, the outputs of MFOM, and **the model maintenance**. The primer gives a more in depth description of MFOM, chapter one discusses what goes into MFOM, chapter two discusses how MFOM works, chapter three discusses what comes out of MFOM, and chapter **four discusses how the model is maintained.** Now that the thought process of the organization of this book has been explained, please feel free to dive deeper into the world of **MFOM and its model maintenance.**

Security Classification of MFOM Related Information

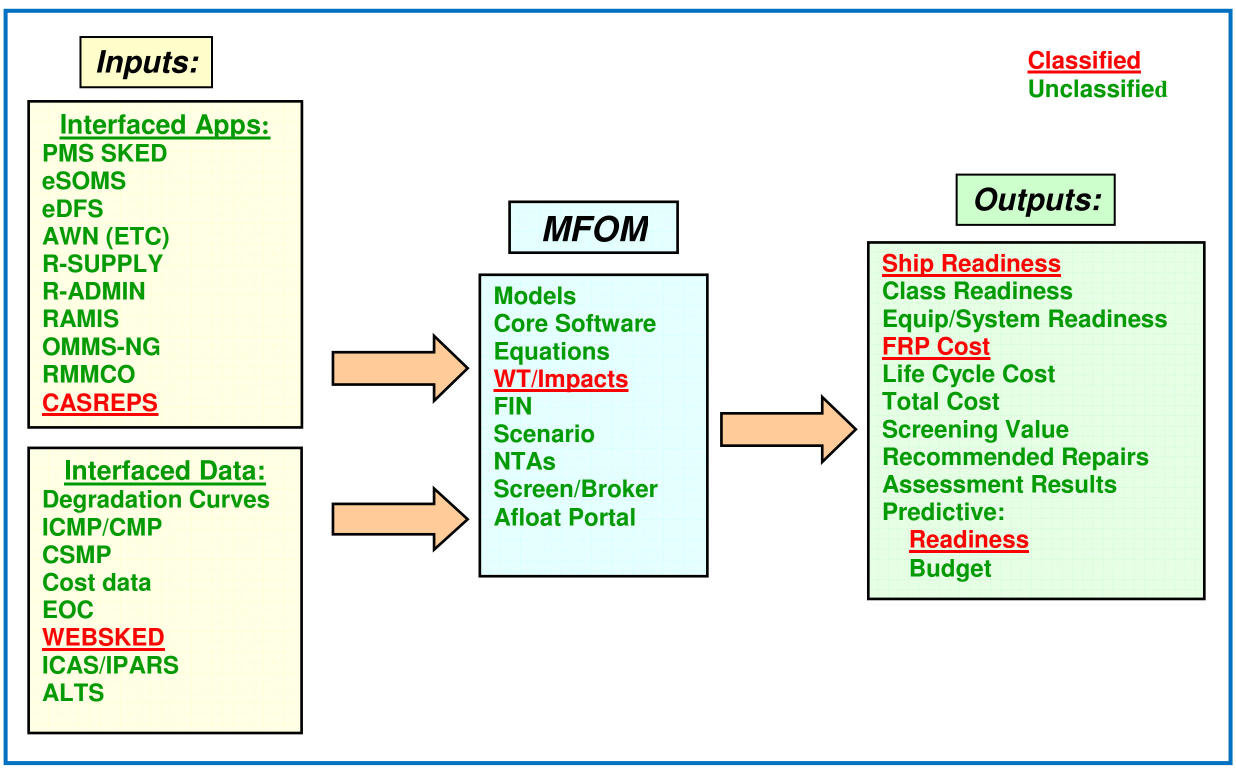
The eventual inclusion of a variety of input and the subsequent output of detailed and critically sensitive information during the development of MFOM 2.0 leads to the requirement to distinguish between pieces of the information which are sensitive and pieces of information which are not. Other business rules deal with sensitive information such as NOFORN, PCMS, and U-NNPI.

The following graphical depiction of MFOM and its associated inputs and outputs help explain the ingredients that normally comprise the classified portions of information. By policy, CASREP documents and WEBSKED timelines have already been well established historically as classified. Further, the classification of any sensitive input data is NOT diluted by MFOM.

Other MFOM 2.0 business rules establish that a weight or impact associated with a particular component in a ship's model (a family tree for equipment) is set up to describe how important that item is to the material readiness of the vessel in a certain scenario or mission or against a specific NTA. In other words, it exactly describes the seriousness of a failure or degradation of a component in actuality. Therefore, when someone has an **impact OR** a **weight** associated with a component, it **allows anyone to easily calculate the other value** because of their simple relationship:

$$1 - \text{Impact} = \text{WT}$$

Because of this simple relationship, information about component weights and impacts must be protected. Certain readiness information derived from this information also becomes sensitive and therefore, it needs to be classified. Rolled up or generalized readiness related information above the vessel level that insulates the visibility to single components or to individual vessel performance for a specific time period is not sensitive.



The result from the above discussion leads to the following rationale.

- Absent any further guidance, **no output** information **will be less restricted than** any classified **input data used to derive it**.
- ANY MFOM 2.0 display, record, or file containing **weights and/or impacts associated with components** or systems **is** classified **at least CONFIDENTIAL.**
- ANY MFOM 2.0 display, record, or file containing **individual ship readiness, FRP costs, or predictive readiness** information **is** classified **at least CONFIDENTIAL.**
- **Rolled up material readiness** data **averaging more than five like items** (vessels, systems, components, etc) are **not classified.**
- **Rolled up material readiness** data **averaging less than or equal to five like items** (vessels, systems, components, etc) is to be **classified consistent with other current directives governing the data type, content, and format** but will be **at least CONFIDENTIAL.**
- Once an appropriate classification level is attributed to a particular MFOM information set, it should remain classified for 15 years.
- Screening values are UNCLASSIFIED.

User Acceptance Testing – Part I

User Acceptance Testing (UAT) is the systematic and thorough examination of the software by technically skilled users to determine if the software meets the stated expectations for functionality. MFOM 2.0's UAT has three parts.

MFOM 2.0 has multiple security features, administrative roles, and functionalities that are assigned to all users. These features must be tested to ensure they are programmed properly and functioning as envisioned. Additionally, MFOM 2.0 is programmed to limit visibility of certain metrics, functions, or details associated with a ship's material condition.

An individual's sign-on in MFOM 2.0 determines exactly what they may see or do. For example, one TYCOM cannot view or make changes to another TYCOMs ships or associated data. As currently programmed, the SYSCOMs, OPNAV, and DOD do not have access to the detailed data, are limited in their drill down capability, and cannot access all displays available to the TYCOM unless they are specifically authorized to do so. MFOM 2.0 is a tool designed for the TYCOMs and their maintenance support activities to more efficiently and effectively manage their maintenance process while reporting only the material condition readiness up line (above the Feet level).

Part of the MFOM 2.0's overall security is based on the user sign-on, also known as user roles. These administrative and functionality features require testing to ensure they work as programmed. Test scripts are provided to test all associated functionality (metrics, availability dates, availability funding, and schedule) in the application by each role. Additionally, the user attempts to perform functionalities or similar functionalities outside the permissions of the assigned role to ensure MFOM does not allow it (i.e. change similar values for ships assigned to another TYCOM). That user (role) records the results of the testing and which part of the user's business process would utilize this functionality. A table of roles that shows the associated permissions is available in the business rule called, "Access and Roles."

The results of the role testing are expected to validate the programmed relationships of MFOM 2.0's sign-on roles. A given user can perform all roles as assigned while being blocked from those roles not assigned. This test is necessary to ensure the proper program security and that the programming supports the user's business process.

Test data is provided to verify that the functionality of the application worked as well as the subsequent calculations or actions were completed and within set values.

Therefore, the following requirements are needed to ensure the success of Part I UAT.

- Enterprise N43 will designate a Part I UAT team within their enterprise which accurately represents the appropriate user community for MFOM 2.0 Phase I testing in their enterprise.
- MFOM 2.0 developers will provide Part I UAT team members with test scripts for each user role describing what the UAT team members are expected to do and what results they are expected to observe.
- Part I UAT team members will execute the test script for each user role and document deviations from expected results. They will also provide input on either missing or excess functionality for each role determined during the execution of the test script.
- Part I UAT team members will map their respective MFOM 2.0 functionality to their current business process diagrams. They will also provide input on either missing or excess functionality for each role found during the user role mapping.

User Acceptance Testing – Part II

The Part II UAT phase deals with how the model for each ship class began with the information found in CDMD-OA class functional file. Respective work by In-Service Engineering Agents, Planning Yards, Planning Activities, and fleet personnel built on the model by adding to that structure to create the resulting ship class models as well as determining the child to parent relationships.

MFOM 2.0 is designed to operate on various inputs and to provide material condition readiness metrics. Additionally, MFOM 2.0 establishes relationships between readiness and cost that are used throughout the maintenance community. Avoiding incorrect or inaccurate metrics is vital; therefore, the model structure needs to be tested at two levels to ensure quality: at the Warfare Area and at the DRRS-N Naval Task (NTA) levels. The class models contain major system groupings starting at Level One proceeding through the various levels of indenture. Within a particular Level One structure, there are “family groupings” which facilitates using test data.

The testing of the Level One groupings and below structures requires the loading of three types of data sets detailed in the following paragraphs. First, individual major configuration items are made totally inoperative (an EOC value of 0.0) and index values for the parents through the Warfare Area and Naval Tasks are recorded. Major configuration items are initially chosen from CDMD-OA mission critical items that are labeled with criticality codes of 3 or 4. The list is provided to the TYCOM to validate during which time the TYCOM may add or delete other items from this test list. Once the list is finalized, all items are run through the model individually and an Excel spreadsheet is provided with the model rollup value for each item against the Warfare Area(s) and Naval Task(s). The TYCOM reviews the numerical material condition readiness value and compares that against the operational performance values and definitions provided in the Operational Performance Values and Definitions Table (refer to Chapter 1: Inputs or the business rule titled, “Equipment Operational Capability). These values are compared with the operational experts understanding on how that equipment would affect the ship’s ability to support a system, Warfare Area, or Naval Task. If the TYCOM agrees with the roll up value, then initials are placed in the Excel spreadsheet next to the value and if not, then an exception is recorded with the reason for dissent.

Secondly, redundant item testing is performed by setting redundant items to an EOC of 0.0. The TYCOM reviews the numerical material condition readiness value and compares that against the operational performance values and definitions provided in the Operational Performance Values and Definitions Table (refer to Chapter 1: Inputs or the business rule titled, “Equipment Operational Capability). These values are compared with the operational experts understanding of the effect that redundant equipment would have on the ship’s ability to support a system, Warfare Area, or Naval Task. If there are three redundant items in a system, each is successively set to an EOC value of 0.0 and values are recorded against each Warfare Area and Naval Task. Once all three sets of values are recorded (one for each successive piece of equipment), all items are reset to an EOC of 1.0 and the next system with redundant items is ran through the model. If the TYCOM agrees with the roll up value, then initials are placed in the Excel spreadsheet next to the value and if not, then an exception is recorded with the reason for dissent.

Finally, all major configuration items as a group are incrementally lowered to totally inoperative (i.e. EOC values are changed from 1.0 to 0.9, then to 0.8, etc. until all equipment is at EOC values of 0.0). Index values for the parents through the Warfare Area and Naval Tasks are recorded. This test shows any potential breaks in the model such as if all equipment is at an EOC value of 0.8 and the resulting index values of 0.0 for all Warfare Areas are seen, then a potential problem exists with the model. The TYCOM reviews the numerical material condition readiness values and compares them against the Operational Performance Values and Definition Table. These values are compared with the operational experts understanding of the effect that degraded equipment would have on the ship’s ability to support a system, Warfare Area, or Naval Task. If the TYCOM agrees with the roll up value, then initials are placed in the Excel spreadsheet next to the value and if not, then an exception is recorded with the reason for dissent.

The above discussion leads to the need for the following requirements for Part II UAT.

The results of the Warfare Area and Naval Tasks testing are analyzed. TYCOM recommended changes are thoroughly investigated and vetted through the technical subject matter experts (ISEAs, LCMs, and Planning Yards). Recommended changes in impacts or structures are captured. These results are also analyzed and compared to values provided by fleet operators during Model Building Phase III Seminars. Recommended changes to structures or impacts are finalized and these changes are forwarded for TYCOM review before being accomplished.

The following requirements have been established for the Part II UAT of MFOM 2.0.

- Enterprise N43 will designate a Part II UAT team for each ship class within their enterprise which accurately represents the appropriate user community for MFOM 2.0 Part II testing in their enterprise.
- MFOM 2.0 developers will provide Part II UAT team members with an output based on running the three tests described above.
- Part II UAT team members will review and document the results of the output from the test scripts to determine whether individual equipment, systems and redundant equipment provide the desired degradation in the shipboard model when they are set to inoperative EOCs.
- Part II UAT team members will review and document the results of setting all major equipment through incremental steps of equipment degradation to determine if the model responds in an appropriate manner.

User Acceptance Testing – Part III

Since the MFOM 2.0 application is designed to provide metrics that would assist in the screening of maintenance actions and to reflect the readiness of a specific hull to perform a selected scenario, the Part II UAT deals specifically with this matter. Scenarios are class dependent and are derived from inputs from the operators. Scenarios are designed to help identify when a ship is ready to perform a specific mission or task. Additionally, scenarios assist the model in making recommendations on what maintenance actions should be completed for the largest impact on readiness. The scenario threshold value varies for each ship class and for each scenario.

Generally, the scenario threshold is determined based upon the minimum equipment required to perform the Warfare Area or Naval Tasking. For the current operation of the MFOM 2.0 application, a series of scenario thresholds are established mathematically based on operator input. Specific system failure questions are asked to operators and then used to mathematically calculate the current set of thresholds that exist in the application. These thresholds can be more thoroughly calculated if operators agree on a set of minimum equipment needed for each scenario for each ship class. The new minimum equipment is input into the model and the resulting roll-up then results in the thresholds associated with each scenario for each Warfare Area and Naval Task.

The process of the Part III UAT is described below. First, the fleet operator determined scenarios are provided to the TYCOM for review and validation. If the TYCOM desires to add or delete scenarios, they may. Descriptions of the scenarios and the naming convention are provided to assist the TYCOM with adding or deleting in this part of the testing. The list of mission critical equipment tested in Part II of the testing is paired down to major equipment and sent to the TYCOM for validation along with a list of the personnel originally used to create the scenario and thresholds. Operational experts should review the minimum equipment needed to perform each mission or scenario for each class of ships. Once validated, the remaining major equipment is set to an EOC value of 0.0 entered (totally inoperative) so that the resulting material condition metrics values represent the minimum equipment and material condition needed for each mission or scenario. These values are then reviewed and validated by the TYCOM. The TYCOM will review the numerical material condition readiness values and compare them against the Operational Performance Values and Definition Table. If the TYCOM agrees with the roll up value, then their initials are placed in the Excel spreadsheet next to the value and if not, then an exception is recorded with the reason for dissent. Once agreed to, these values become the thresholds for each Warfare Area and Naval Task for each scenario. If the TYCOM disagrees with these values, action is taken to rectify the results based on the process discussed previously.

The results of the scenario threshold to Warfare Area and Naval Tasks testing are analyzed and compared to rankings provided by fleet operators during Model Building Phase III Seminars. Scenario standard threshold values are set based upon the validation results with the approval of the TYCOM.

USFF has approved the following requirements for the Part III UAT of MFOM 2.0.

- Enterprise N43 will designate a Part III UAT team for each ship class within their enterprise which accurately represents the appropriate user community for MFOM 2.0 Phase III testing in their enterprise.
- MFOM 2.0 developers will provide Part III UAT team members with an application that will record team member requirements for minimum equipment for various scenarios.
- Part III UAT team members will review the resultant minimum equipment requirements and the scenario thresholds and verify that the minimum equipment is based on a Fleet established requirement such as that provided by INSURV, etc. Results will be analyzed and compared to rankings provided by Fleet operators during Model Building Phase III Seminars and any changes then recommended to Enterprise N43 as standard threshold values.
- Enterprise N43 will review and approve recommended standard threshold values and obtain any necessary Type Commander or Fleet approvals.

Material Condition Hierarchal Model, Model Maintenance

This discussion applies to the maintenance of the functional hierarchal model structure used to reflect all components for all units (ship or activity). Model maintenance ensures current and accurate organization of material condition information so that screening and readiness values can be calculated.

As previously mentioned in Chapter 2, the **Hierarchal Model Structure** is composed of top-down arrangement of two or more levels of indenture. The top level for the model is the Warfare Area or other designated mission/task areas. The Functional Area (FA) is the next lower indenture level down. The next lower level is Level One (L1), continuing down to the lowest indenture level called Lowest Level of Indenture (LLI). The hierarchal structure as described in the business rule titled, "Material Condition Hierarchal Model, Building," is composed of unique families of parent-child relationships. These objects may be software programs (Microsoft Access program, etc.), services (crane and rigging, design, etc.), and model place holders (used to provide continuity in the model structure).

Maintenance of the functional hierarchal model structure allows for various types of change such as additions, modifications, inactivations, and deletions of objects, NMETs, Warfare Areas of units, and even units themselves. The maintenance of the functional hierarchal model is necessary because it takes the above types of changes and validates or modifies the criticality, impact, and weighting factor for each child and parent in the structure.

In order for the maintenance of the functional hierarchal model to take place, the following reasoning is needed.

- To accomplish maintenance of the hierarchal model structure, there are several maintenance rules that enable the resultant network to be operated on by the algorithm.
- Models for each platform will be validated and updated as necessary after every configuration change is submitted. Models for each platform will be:
  - Updated to reflect the results of installation and operational testing of new components/systems.
  - Updated to reflect the results of component/systems removal or inactivation.
- Models for each platform will be validated and updated as necessary for changes in mission and task assignment based on changes in DRRS-N.
- Impact values/weighting values and criticality factors will be assigned by agents of the Warranted Technical Authority for items in levels below the Functional Area and by Fleet designated operators for the Functional Area level and above.
- To ensure the updated model will function properly, the following validations shall be accomplished for vertical, horizontal, and operationally linked families:

- Validate (and revise as required) that the input from another family is structured as a child of the receiving parent.
- Validate (and revise as required) that the output from a family is for only one child.
- Validate (and revise as required) that the output from a family can be the input to many families.
- No output from higher or lower levels of indenture of receiving families can turn back to the original family (prevents the infinite loop).

Additions to Chapter 4 in Future Releases

- Access and Roles
- Help Desk Support
- Configuration Management Board (CMB)
- Audit Trails and Archiving
- NMET Construction Guidelines
- Treatment of NMETs With No Equipment Requirements
- MFOM 2.0 Scenarios
- MFOM 2.0 Data Dictionary
- Data Date and Time Stamp Protocol
- Authorized Source Systems
- UAT Feedback – Configuration Revision Process

Acronyms

ACRONYM	MEANING	CH
ACDS	Advanced Combat Direction System	3
ADW	Aviation Data Warehouse	1
AEL	Allowance Equipment List	1
AESS	Aircraft Electrical Servicing System (US Navy)	3
AFFF	Aircraft Fire Fighting Foam	3
AIM	Advanced Industrial Management	2
AIMD	Aircraft Intermediate Maintenance Detachment	3
AIMXP	AIM Express	2
ALRE	Aircraft Launch and Recovery Equipment	3
APL	Allowance Parts List	1
BUMED	Bureau of Medicine	3
C2X	Composite Training Unit Exercise	3
C5I	Command, Control, Communications, Computers, Collaboration, and Intelligence (defense)	3
CASREP	Casualty Report	1
CDM	Configuration Data Managers	2
CDMD-OA	Configuration Data Managers Database-Open Architecture	1
CEC	Combat Essentiality Code	3
CFF	Class Functional File	1
CHT	Contaminated Holding Tank	3
CK	Configuration Change (OPNAV 4790 Form CK)	2
CMC	Change in Material Condition	1
CMP	Class Maintenance Plan	2
CNO	Chief of Naval Operations	2
COMM PLAN	Communication Plan	3
COSAL	Consolidated Ship's Allowance List	1
CQ	Carrier Qualifications (Aviation launching and recovery)	3
CRT	Cathode Ray Tube	3
CSMP	Consolidated Ship Maintenance Plan	1
CTG	Coolant Turbine Generator	3
CUT	Coordinated Universal Time	1
CV	Aircraft Carrier	3
SORTS	Ship Operational Readiness and Training System	3
CVSHARP	Carrier "Sierra Hotel" Aviation Reporting Program	1
CIWS	Close In Weapon System	3
DOD	Department of Defense	1
DPIA	Docking Planned Incremental Availability	3
DRRS-N	Defense Readiness Reporting System-Navy	1
DTG	Date Time Group	3

ACRONYM	MEANING	CH
DU	Distilling Unit	3
ECD	Estimated Completion Date	1
EDG	Emergency Diesel Generator	3
EHF	Extra High Frequency (radio communication)	3
EOC	Equipment Operational Capability	1
EOSS	Electro-Optic Sensor System	3
FA	Functional Area	2
FI	Future Impact Value	2
FIN	Functional Identification Number	1
FPY	First Pass Yield	3
FRP	Future Readiness Planning	4
GBS	Global Broadcast System	3
GSSC-M	Global SATCOM (Satellite Communications) Support Center (US DoD)-Maritime	3
GYRO	Gyroscope	3
HF	High Frequency (radio communication)	3
HPAC	High Pressure Air Compressor	3
HUD	Heads Up Display	3
IAW	In Accordance With	1
ICMP	Integrated Class Maintenance Plan	2
IFF	Identification Friend (or) Foe	3
IFOLS	Improved Fresnel Lens Optical Landing System	3
ILARTS	Integrated Launch and Recovery Television Surveillance/System	3
INTEL	Intelligence	3
ISEA	In-Service Engineering Agent	1, 2
ISIC	Immediate Superior in the Chain of Command	1
IV	Index Value	2
JBD	Jet Blast Deflector	3
JTFX	Joint Fleet Exercise	3
L1	Level 1	2
LCCEOC	Lowest Critical Calculated Equipment Operational Capability (EOC)	2
LCEOC	Lowest Critical Equipment Operational Capability (EOC)	2
LCM	Life Cycle Maintenance	4
LLI	Lowest Level of Indenture	2
LOS	Line of Sight or (loss of Signal)	3
LSO	Landing Signal Officer	3
MCR	Material Condition Reporting	1
MERG	Main Engine/Reduction Gear	3
METL	Mission Essential Task List	1
METs	Mission Essential Tasks	1

ACRONYM	MEANING	CH
MFOM	Maintenance Figure of Merit	1
MFP	Main Feed Pump	3
MOVLAS	Heads Up Display	3
MRAS	Mission Readiness Assessment System	1
NATOPS	Naval Aviation Training and Operations (program)	3
NAVICP	Naval Inventory Control Point	2
NAVSSI	Navigation Sensor System Interface	3
NETPREC	Network Precedence (Navy)	3
NIPR	Non-Secure Internet Protocol Router	3
NMET	Navy Mission Essential Tasks	1
NOFORN	No Foreign National (viewing)	4
NSSMS	NATO SEASPARROW Surface Missile System	3
NSWC	Naval Surface Warfare Center	1
NTA	Naval Task	1
OPNAV	Chief of Naval Operations staff	4
OPS	Operations	3
OTCIXS	Officer in Tactical Command Information Exchange Subsystem	3
PA	Planning Activity	2
PALS	Portable Airfield Light Set	3
PCMS	Passive Countermeasures System	4
PESTO	Personnel, Equipment, Supply, Training, and Ordnance	2
PIA	Planned Incremental Availability	3
PLAT	Pilot Landing Aid Television	3
PMS	Preventative Maintenance System	3
PY	Planning Yards	1, 2
RAM	Residual Asset Management	3
RFT-E	Ready For Tasking - Equipment	3
RIN	Record Identification Number	1
RMAIS	Regional Maintenance Automated Information System	2, 3
RMC	Regional Maintenance Center	2
SATCOM	Satellite Communication	3
SHF	Super High Frequency	3
SIPR	Secure Internet Protocol Router	3
SMCM	Ship Material Condition Model	2
SME	Subject Matter Expert	1
SNAP	Shipboard Non-tactical ADP Program	1
SSAC	Ship’s Service Air Compressor	3
SSDS	Ship Self Defense System	3
STA	Status (block 7)	1
STATS	Submarine Tactical Assessment Training Standard	1

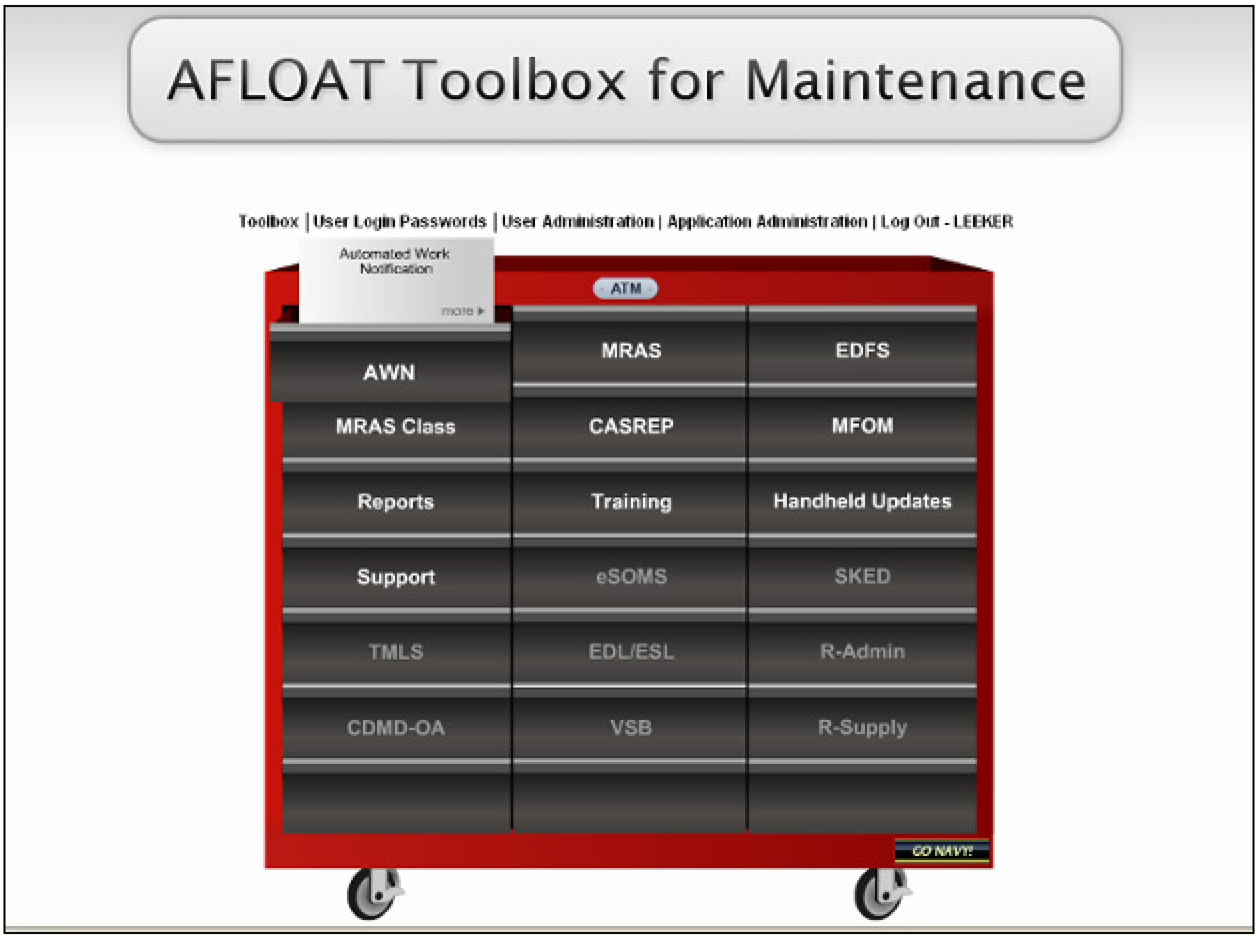
ACRONYM	MEANING	CH
SYSCOMS	Systems Commands	4
TA	Time Accelerator	2
TADIXS	Tactical Data/Digital Information Exchange System/Subsystem	3
TORIS Core	Training & Operational Readiness Information Services Core	1
TRT	Total Report Time	1
TSTA	Tailored Ships Training Availability	3
TYCOM	Type Commander	1
UAT	User Acceptance Testing	1, 4
UHF	Ultra High Frequency	3
U-NNPI	Unclassified-Naval Nuclear Propulsion Information	4
UNREP	Underway Replenishment	3
URN 25 TACAN	Tactical Air Navigation (system)	3
WEBSKED	Web Sked (program)	4

Appendices

A. About ATM

The Afloat Toolbox for Maintenance (ATM) connects existing maintenance shipboard tools already in existence as well as some new tools with one simple login and password. Thus, the ATM provides the Ship's Force with a single portal for all maintenance management. This tool reduces the burden on the sailor for managing and performing maintenance and even improves the visibility to the maintenance plan (CSMP, EDL, the Chief's wheel book) while feeding MFOM/MRAS with better data by simplifying the 2K by offering auto fill and pull downs in various fields and by capturing non-2K impacts effecting the unit's readiness.

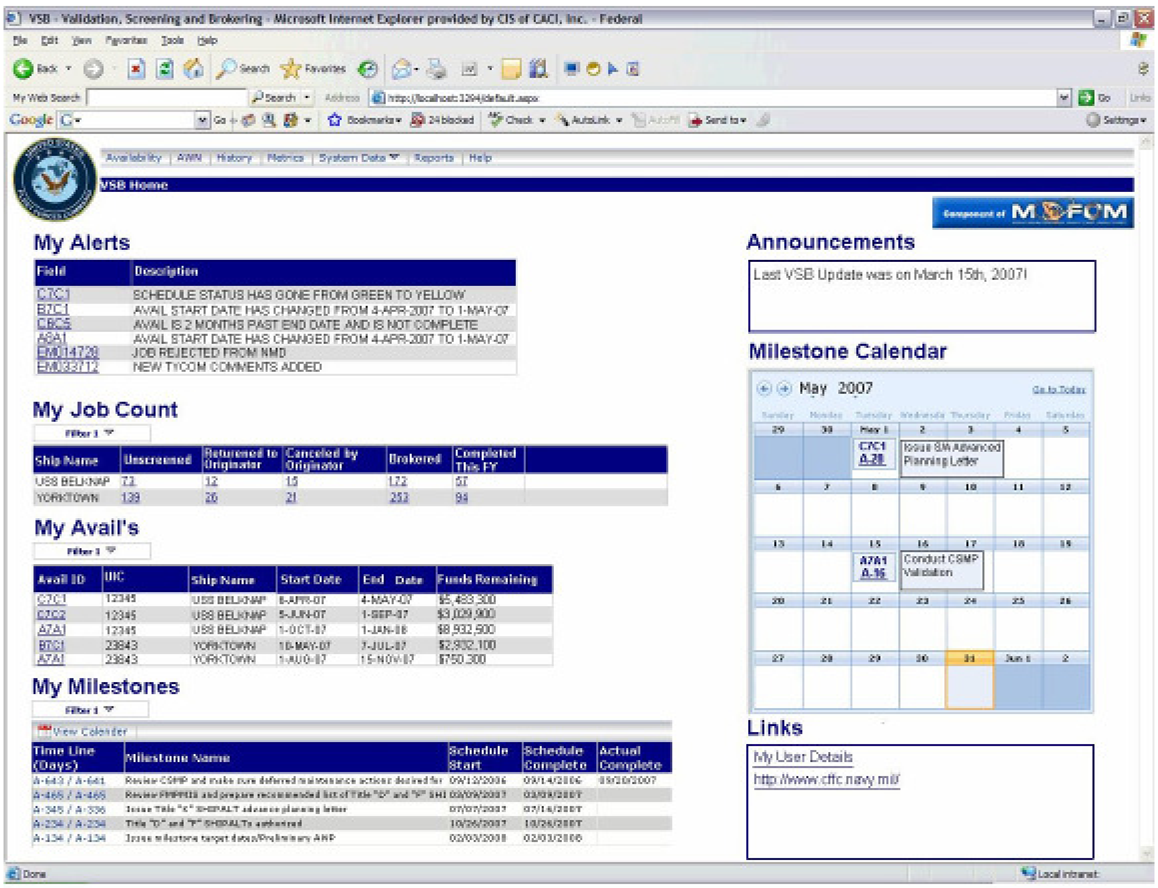
After the sailor logs into the ATM from the login page, they will see the below screen. From this screen, the sailor can select the drawer for access to that specific program. The drawers in white distinguish programs available to that individual while the programs in gray are not available.



The ATM is planned to be released in two phases: the Phase I release includes the drawers for MRAS, Training, IUID, IPARS, EDFS, Handheld Updates, ESOMS, Global Distance Support Help Desk, PMS SKED, AWN and ETC, EDL/ESL, and Reports and the Phase II release includes the drawers for ATIS, CDMD-OA, R-Supply, R-Admin, MFOM Shore, VSB, Component Line Up, Navy Maintenance Data, CWP/FWP, Navy Data Environment, LMAIS, RMMCO, TMLS, OMMS-NG, and Small Valve Maintenance. The ATM will facilitate the sharing of data between all of these maintenance programs so when a sailor performs a maintenance action in one program it is captured in the other programs, ultimately, saving the sailor's time.

B. About VSB

Validation, Screening and Brokering (VSB) is a component of the Maintenance Figure of Merit Fleet initiative (MFOM) to improve Navy maintenance and readiness reporting. VSB supports the Navy's vision by providing a new approach to maintenance planning actions. Maintenance actions are equipment driven through Functional Index Number (FIN) integration. This system provides Navy Maintenance Teams with a content driven, streamlined tool by leveraging alerts and user customization. In an effort to minimize the learning curve and empower users, VSB provides the user with an intuitive design, a content sensitive help system, CBTs, and automates data collection and validation. This system promotes a more efficient maintenance planning process by leveraging the screening value generated in MFOM and automatically establishing screening priorities. The VSB Home Page (the screen shot below) provides a user customized summary of schedule alerts, count of jobs in each status, availability summary information, and calendar view of milestones allowing the user to take the right maintenance actions at the right time.

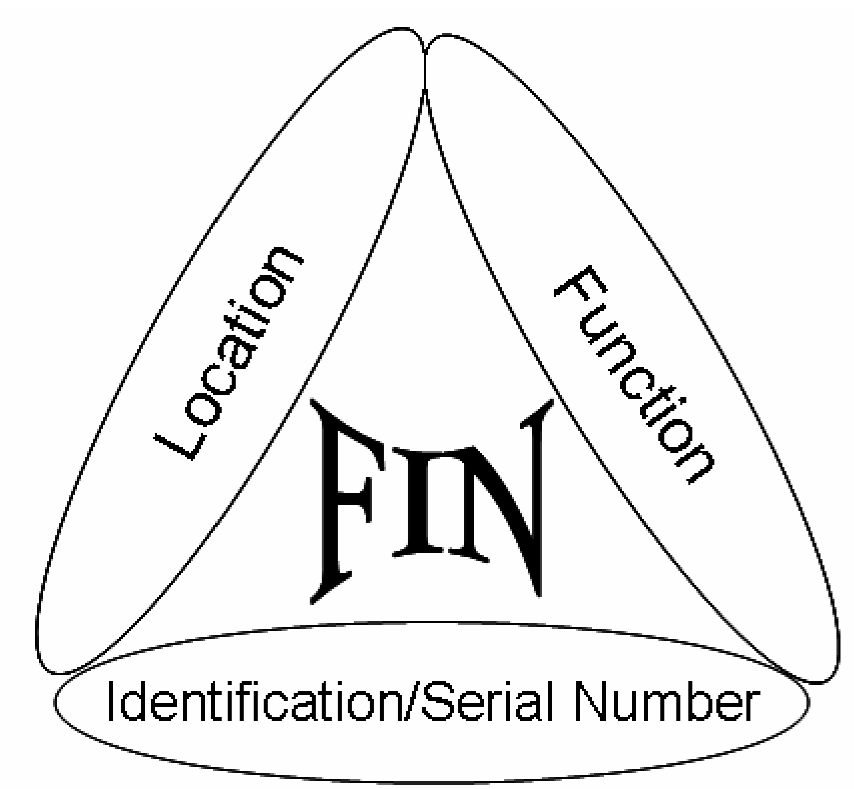


The VSB program team leverages .Net and foundation software which standardizes the look and feel throughout the application while maintaining performance standards. VSB provides a service oriented collaborative interface environment allowing systems to communicate using common industry web service standards. Therefore, VSB implements an east coast production environment mirrored with the west coast to support users around the globe.

C. About FIN

Functional Index Number (FIN) is an alpha/numeric value assigned to all objects in the ship's functional hierarchal structure. The FIN and its title are intended to resolve issues (non-standardized across platforms, etc.) associated with the Hierarchal Structure Code (HSC) currently used in CDMD-OA. Responsibility for the technical content of the FIN is within the purview of the Warranted Technical Authority and may be delegated to its agent (Engineering Area Manager (EAM) or Cognizant Engineer (CE)).

The FIN composition has undergone several modifications in order to meet emerging requirements. The title associated with a FIN describes the functional character of the object. The FIN consists of three data groups: equipment **location**, equipment **function**, and **identification/serial number** which is reflected in the drawing below.



Location of the object is defined as afloat, ashore (warehouse or at a plant) and in-transport. The afloat schema currently exists while the other two remain for further development. The afloat location is composed of three groups: activity UIC, compartment number, and compartment name.

Function defines the functional operational contribution, action, purpose, or activity of an object. As an object is part of a system, it is defined by the pedigree.

Identification/Serial number applies a unique identifier to an object. The identifier can be composed two different ways, using the IUID or Material Identification Number.