

**Enhanced
Automated
Graphical
Logistics
Environment**

**EAGLE RELIABILITY, MAINTAINABILITY AND
TESTABILITY (RMT) MANUAL
VERSION 7**

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The EAGLE Software Package has become the best of its kind thanks, in large part, to its clients. We would like to take this opportunity to thank all of you for your suggestions, insights and support. In addition, we want to renew our commitment to you, our valued clients.



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SECTION I



RMT SYSTEM INTRODUCTION

SECTION 1 RMT SYSTEM INTRODUCTION

1.0 INTRODUCTION

EAGLE's mission is to enable complete weapon system life-cycle support services. By integrating design, manufacturing and ILS into one interconnected database structure, EAGLE enables Logistics Support Analysis to be performed concurrent with development by including LSA functionality in the early stages of product development and engineering change. The addition of Reliability, Maintainability and Testability (RMT) to the EAGLE Discipline suite is the next step in completing that mission.

The RMT Discipline is the assimilation of Reliability Analysis, Failure Mode Effects Analysis, Criticality Analysis, Testability Analysis, and Maintainability Analysis functionality into EAGLE, providing logistics expertise to the engineering process, which thereby enhances reliability and maintainability. The resulting product forms a new logistics process that allows the end user access to information embodied in an interconnected database structure which provides tangible advantages in cost, quality, and timeliness. Integration of these systems and processes also enhances end user performance and responsiveness as well as reducing or potentially eliminating requirements for end users to acquire complex technical information systems of their own, thus providing an efficient way to deliver the required information to their customer.

To influence design, Logistic Support Analysis always requires time and resources, both of which are heavily influential to cost. Because cost minimization is a key factor in LSA design, the ability to capitalize upon past work efforts can be deemed critical. The availability, accuracy, and relevancy of experience and historical data on similar existing systems can be crucial to increasing the operational effectiveness of a new weapon system in a manner that decreases the cost, improves the quality and increases the timeliness of that weapon system.

1.1 RMT SYSTEM PURPOSE

The RMT Discipline is based on the original requirement of taking an existing LSAR, performing analysis upon it utilizing the included toolkits, and producing a new LSAR as a baseline for production on the new weapon system. This requirement came about in response to the perceived business need of decreasing the time required to bring a new product to market as well as decreasing the associated costs.

When developing a new product line, the most often used method is to build upon the design of a similar product. For example, a modern missile contains the same basic building blocks as a Chinese Fire Arrow (Figure 1-1). Table 1 shows the relationship between a Chinese Fire Arrow and a modern missile; while the technology has changed, the basic design and the purpose of the weapon system has not changed -- even after several hundred years:

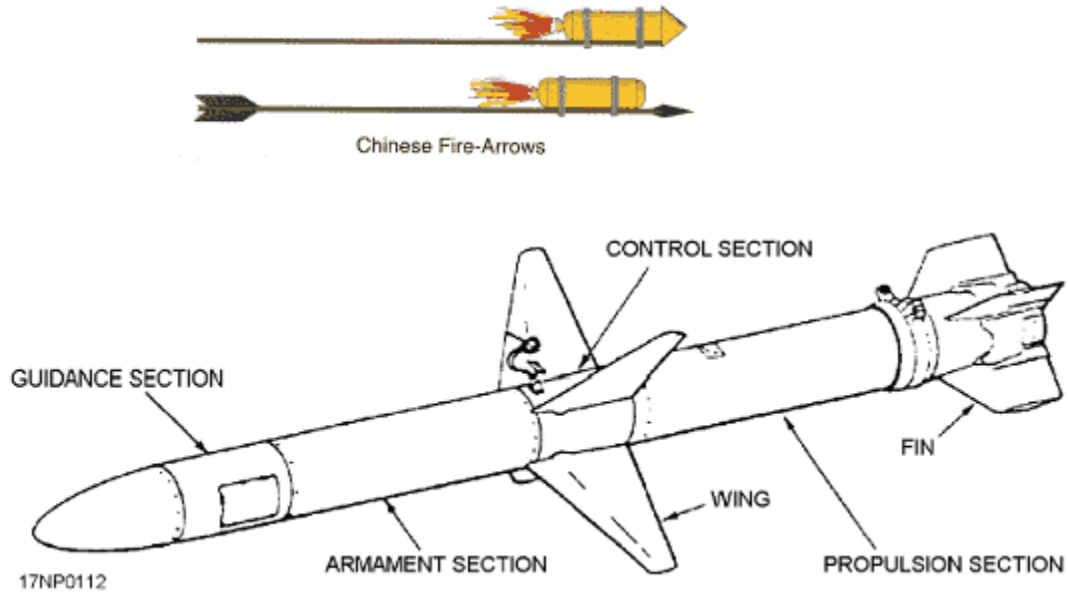


Figure 1-1. Sample Weapons.

Chinese Fire Arrow ¹	Modern Missile
Feather Fletching	Fin
Shaft	Fuselage
Archer	Propulsion Section
Bow	Launcher
Tube with Gunpowder	Armament Section

Table 1. Arrow / Missile Relationship.

¹ Chinese Fire-Arrows graphics from ABOUT.COM

1.2 RMT SYSTEM OVERVIEW

The EAGLE RMT Discipline is composed of the following four applications:

- Reliability Analysis - Reliability is defined as the ability of an item to perform its intended function under stated conditions. EAGLE RMT provides the capability to perform failure rate calculations, perform reliability modeling, and generate various reports associated with these analyses.
- Failure Mode, Effects and Criticality Analysis is defined as the consequence of the mechanism through which the failure occurs and the consequence of a failure mode and its frequency of occurrences. EAGLE RMT provides the capability to perform Failure Mode, Effects and Criticality Analysis, Reliability Centered Maintenance Analysis, and generate reports associated with these analyses.
- Testability Analysis is defined as a design characteristic which allows the status (operable, inoperable, or degraded) of an item to be determined and the isolation of faults within the item to be performed in a timely manner. EAGLE RMT provides the capability to establish detection groups, establish built-in-test for failure modes, identify parts that a failure mode can be isolated to and calculate testability failure rates.
- Maintainability Analysis – The measure of the ability of an item to be retained in or restored to a specified condition when maintenance is preformed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. EAGLE RMT provides capabilities to define various maintainability scenarios and perform predictions using Procedure 2 and/or Procedure 5 of MIL-STD-472. Several options are provided for calculating availability (both operational and achieved), mean man hours, mean time to repair and mean maximum maintenance time for both corrective and preventive maintenance, as well as the capability to generate reports associated with these analyses.

1.3 THE RMT PROCESS DATA LIFE CYCLE

The EAGLE RMT Process can be seen as a data life cycle process. The life cycle² of data begins when an organization's business requirement necessitates the acquisition of individual facts, statistics or information. The information is collected and incorporated into such common storage mechanisms as word processing documents, spreadsheets, files and databases. The data is classified as Active Data, data in which is referred to on a regular basis during normal business

² The useful life of something such as an organization, institution, a manufactured product or information.

operations, and Inactive Data, which is data that, over time, has lost its importance and/or relevancy to the original business requirement. Inactive Data is then archived or disposed of.

There are four phases in the RMT Project Data Life Cycle utilized to create a new LSAR. They are described as follows:

- Phase I – This is the establishment of a new project. This data could exist as a production LSAR database. It could also be a BOM or a Full File from an external LSAR source. The Phase I source data has its own life cycle and will continue on independently of this project, however as part of the RMT Project Data Life Cycle, Phase I data life ends when it has been transferred into Phase II.
- Phase II - Phase II data is the Phase I data now in an EAGLE LSAR database having its own unique End Item. This is where the RMT work begins; the RMT analyst will exercise the different functionality of the Reliability Analysis, Failure Mode, Effects and Criticality Analysis, Testability Analysis, and Maintainability Analysis applications.
- Phase III – Phase III data then is the end of the RMT Project Data Life Cycle and the beginning of the new weapon systems production LSAR Data life cycle. The RMT Analyst has completed performing his/her Reliability Analysis, Failure Mode and Criticality Analysis, Testability Analysis, and Maintainability Analysis. Everything from Failure rates being calculated to task and task times assembled is complete. The RMT Analyst then creates the new LSAR that is born in this process. Upon Completion the user will have:
 - Cross Functional Requirement Tables XA, XB, and XH.
 - Operations and Maintenance Requirement Tables AA, AB, and AG.
 - Reliability, Availability, and Maintainability Requirement Tables BA, BF, BG, BH, BI, BJ, BK, and BL.
 - Task Requirement Tables CA, CB, CC, and CD.
 - Personnel Skill Consideration Tables GA and GB.
 - Packaging and Provisioning Requirement Tables HA, HB, HG, and HJ.
- Phase IV – This is the final phase of the RMT Process Life Cycle: the Archiving and Disposition of data. The organization responsible for the requirement that necessitated this process will determine the disposition. Each organization will most likely handle this phase somewhat differently. The simplest method is a three step process:
 - Use the EAGLE Fullfile utility to do extract all the Phase II data associated with the project.
 - Compress and archive the extracted copy of the Phase II data on the organization's preferred medium. This medium could be tape, floppy disk, CD-ROM, or something much more sophisticated such as a storage area network in a secure and remote location.
 - Delete the Phase II data from the EAGLE database.

1.4 THE RMT PROCESS AND SECURITY

Security in EAGLE is defined in the EAGLE Security Manual and the RMT system falls under the security umbrella just as any of the other EAGLE disciplines do. However, to facilitate the use of the RMT Process a brief discussion is required to ensure all understand how the process was designed and how it fits into EAGLE's Security System.

In EAGLE, security is handled within the database. This allows EAGLE to have an open architecture. "Open" being defined as a system in which the users have the ability to use third party tools such as Crystal Reports to produce their own special reports or an AdHoc tool to view the data and still maintain a secure database. To implement security within EAGLE it is necessary that each table contain two specific columns in addition to the other data columns. The first is the End Item Acronym Code (EIACODXA), which, from a security view, can be considered to be the project a user is assigned to. The second is Row/Group Association (USERIDZU). This Row/Group Association can be considered to be analogous to which team on the project you are assigned to. A user can be assigned to multiple projects and multiple teams within that project.

For example, suppose an individual is on the RMT team. The Security Administrator can restrict this individual to a single end item such as the end item for Phase II of the RMT project. In this manner, this particular individual can only access the data with the end item assigned to that second phase. Likewise, suppose a different individual is assigned to the logistics team. The logistics team might be allowed access to several different end items in the database including the source data for the Phase II RMT Project data but not the current in-work Phase II RMT Project data.

The actual steps taken and the details on establishing security are acknowledged later in this document. For the time being, it is only necessary to point out that each phase of the first three phases above has a different end item. The security administrator has the capability to place row level control on each of those end items (phases). This allows the security administrator the assurance that the RMT analyst cannot update the original production LSAR database and that the logisticians cannot update the RMT project data, or to enforce whatever division of responsibility is desired.

SECTION 2



PHASE I ESTABLISH INITIAL STRUCTURE

SECTION 2 PHASE I ESTABLISH INITIAL STRUCTURE

2.0 INTRODUCTION

Once the decision has been made to use an established weapon system as a baseline for the development of a new similar weapon system, the organization will want to capitalize upon the availability of current weapon systems data. With EAGLE, data reuse is far simpler to perform than with other products.

As stated in Section 1.1, the RMT System is based on the original requirement of taking an existing LSAR and performing RMT Analysis on it, resulting in a new LSAR as a baseline for production of the new weapon system. This requirement came about in response to the business need of decreasing the time it takes to get a new product to market as well as decreasing the associated costs.

2.1 ESTABLISH SECURITY

The RMT Analysts are given the requirement to perform reliability, availability, and maintainability analysis on a new weapon system. They are directed to use an existing weapon system's LSAR database as a baseline for this new system. In our example, the current system with the most similarity to the newest product line our organization is going to build has an end item of 'WS1'.

The EAGLE Security Administrator now has several tasks to complete. The first task is to meet with the lead individuals from the Logistics Team and the RMT Team to determine security requirements. For the benefit of brevity in this example, suppose that the result of the meeting was that the Logistics Team did not need access to the RMT Team's data, and the RMT Team needed read-only access to the logistics team's 'WS1' data, and that the new data will have an end item (project name) of 'WS2'.

The next task for the EAGLE Security Administrator is to enable read-only authority in the 'WS1' end item for the RMT analysts, through the use of the User Security Maintenance Function in EAGLE (Figure 2-1). With respect to the logistics team, no action is required by the EAGLE Security Administrator at this time, since there is no 'WS2' data for the new system. Then, the EAGLE Security Administrator must establish read and write authority for the members of the RMT Analyst Team on the new program 'WS2'.

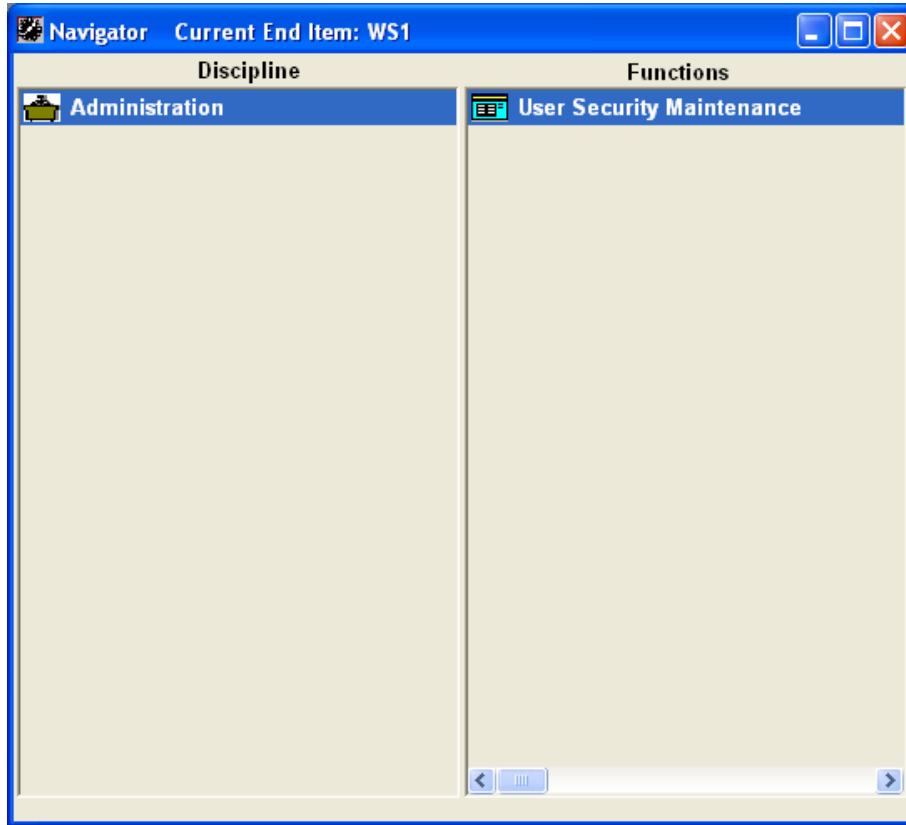


Figure 2-1. Navigator – Security Maintenance.

Lastly, the customization of the Navigator window (Figure 2-2) is done if the organization is large enough or complex enough that a division of responsibility is warranted. For example, the organization may want the RMT Analyst Team subdivided into groups where, for example, there may be a group that controls the adding and deleting of parts to the system. In that case the EAGLE Security Administrator needs to meet with the lead individual from the RMT Team to make this determination.

Once the EAGLE Security Administrator has completed the assigned tasks, the RMT Analysts are ready to begin working. They have several tasks to perform. The first task for them is to build or initialize the 'WS2' database. Note that the RMT analysts were given read-only access to the 'WS1' end item and read/write access to the 'WS2' end item. Without read access to 'WS1' and write access to 'WS2', they would not be able to initialize the 'WS2' database.

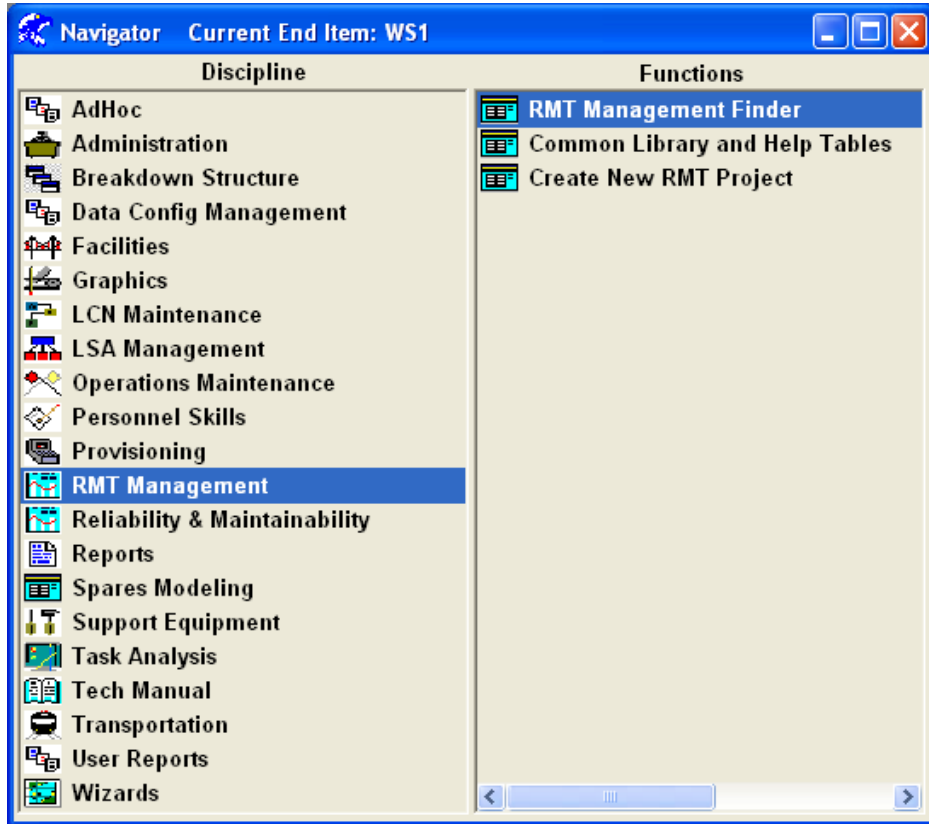


Figure 2-2. Navigator.

2.2 INITIALIZE THE RMT DATABASE

The RMT Analysts will login to EAGLE and select the 'WS1' end item. Using the 'Create RMT Project' function (Figure 2-3) in the RMT Management discipline in the Navigator, the RMT Analyst will select the previously agreed upon end item 'WS2' from the pull down list under 'New RMT End Item'.

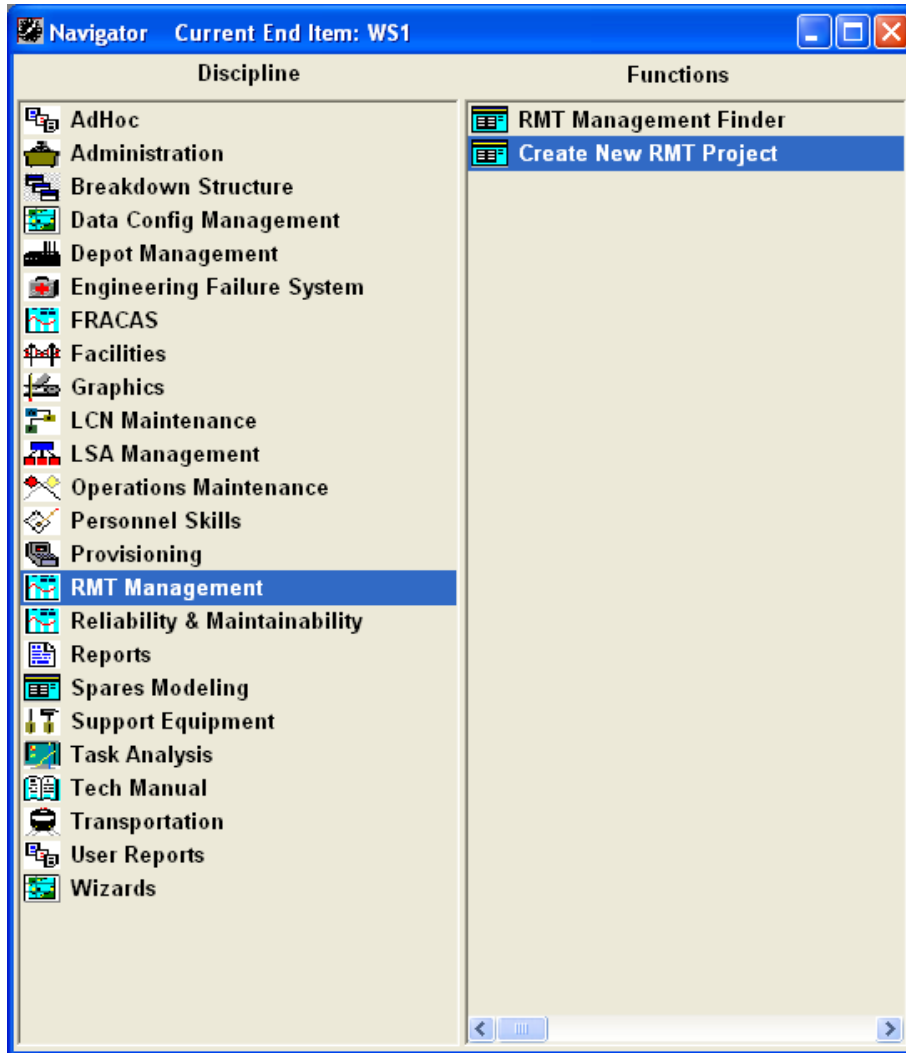


Figure 2-3. Create New RMT Project Function

Once the new end item has been selected the 'Create New RMT End Item' button will become active (highlighted) and the RMT Analyst should select it (Figure 2-4).

This build process copies the data, from certain specifically selected tables, containing the end item 'WS1' to those same tables but with the new end item 'WS2'. This 'Create New RMT End Item' utility then effectively builds a new (development) LSAR database (end item 'WS2') from the mature production LSAR database ('WS1'). The LSAR data is copied from the following tables: XA, XB, XH, HA, HB, HG, and HJ. Note that a "Failure Rate Method" must also be specified for the purposes of initially populating the RMT toolkit support tables.

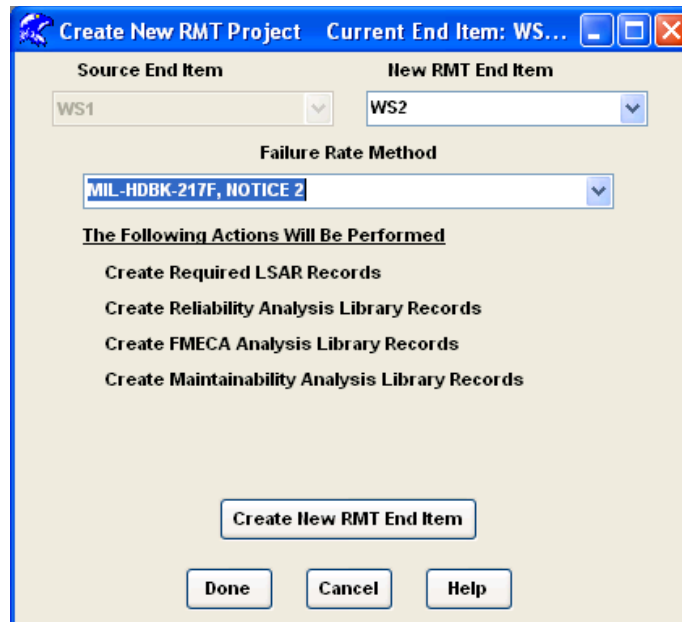


Figure 2-4. Create New RMT End Item

The Phase II data must conform to a certain set of assumptions for the RMT system to work properly:

- LCN Structure (XA.LCNSTRXA) must completely identify indenture within the project. LCNs assigned via the “Sequential” or “Modified Classical” methodologies may cause problems with reliability roll-up calculations.
- The RMT system only supports physical LCNs (XB.LCNTYPXB).
- The RMT system only supports a single, shared ALC (XB.ALTLCNXB, 00 is recommended).
- The RMT system requires a complete parts “tree” in order to function properly. That is, there can be only a single part application (HG record) that does not have a parent, and it should reside at the top level. This is because calculations are performed using a recursive “bottom-up” approach which stop when a part is encountered that has no parent.

SECTION 3



PHASE II PERFORM RMT ANALYSIS

SECTION 3 PHASE II PERFORM RMT ANALYSIS

3.0 INTRODUCTION

Selecting the RMT Management Finder from the Navigator will initialize the RMT Manager by displaying the part/application breakdown from Table HG from the end item selected during the login process. This window is where the user will select which analysis they wish to work on, i.e. Reliability Analysis, Failure Mode and Criticality Analysis, Testability Analysis, and/or Maintainability Analysis.

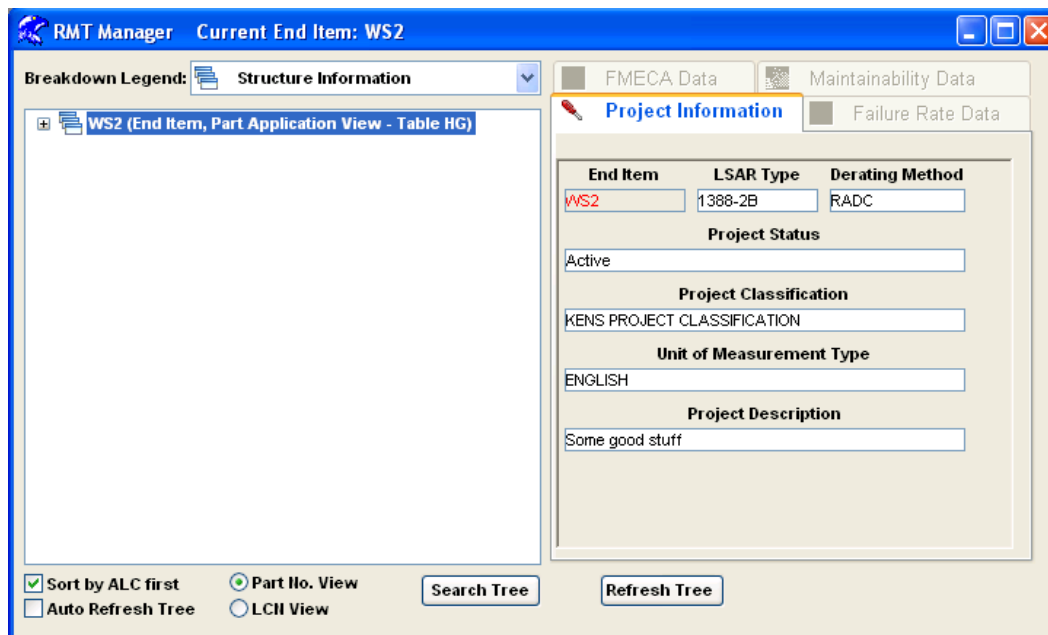


Figure 3-1. RMT Manager.

3.1 RMT MANAGER

STEP Navigating the RMT Manager

- 1) Click on the expand icon located to the left of the Project End Item (Figure 3-1.).

Note: The Tree Structure is displayed by Item Name and Reference Number. To display by LCN Nomenclature and LCN/ALC, click on the radio button to the left of LCN View at the bottom of the window.

- 2) Click on the expand icon, located to the left of the Item Name.

3) Continue in this manner to expand the entire tree.

ALSO/OR:

1) Click on the expand icon located to the left of the Project End Item (Figure 3-1.).

Note: Before performing the next step, click on the expand icon to the left of the Item Name/Ref Num or Lcn/Alc combination nearest to the indenture level of the search. If this is not done, the search may take an excessive amount of time.

- 2) Click on the Search Tree button.
- 3) Enter applicable search parameters.
- 4) Click on the OK button.

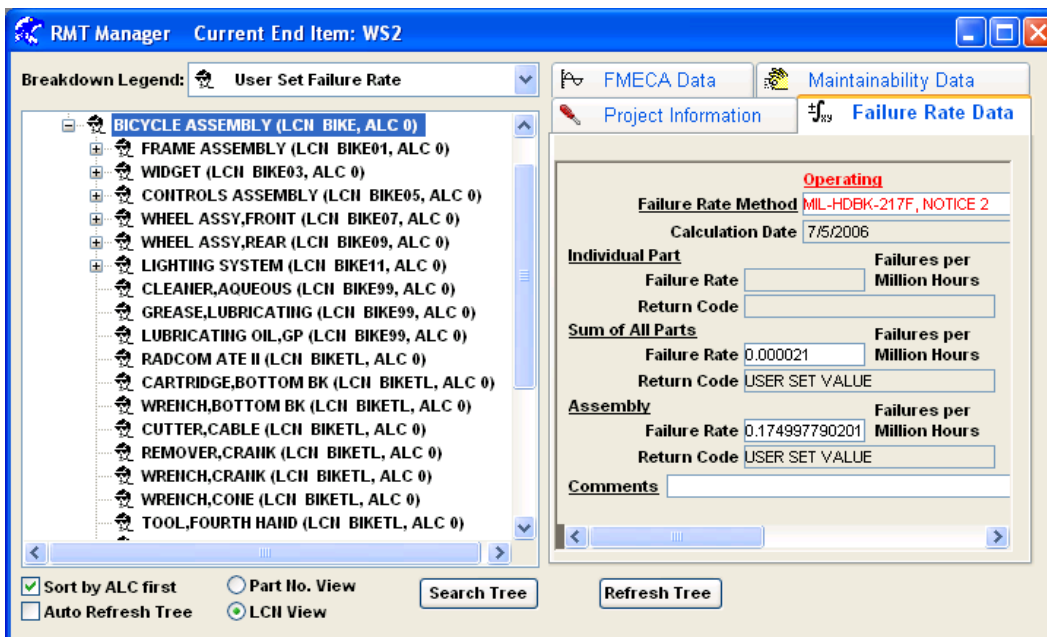


Figure 3-2. RMT Manager LCN View.

Figure 3-2 above shows the RMT Manager with the following conditions:

- Breakdown Legend drop down list box shows User Set Failure Rate. When this icon is next to a part or assembly, it indicates that the failure rate was provided by the user and not calculated by the system.
- Top Level Bicycle Assembly is highlighted with breakdown structure displayed.
- LCN View radio button is selected, which dictates breakdown structure by Item Name, LCN/ALC.

- Failure Rate Data Summary Tab is highlighted with **Operating** Failure Rate Data displayed.

Figure 3-3 below shows the RMT Manager with the following conditions:

- Part No. View Radio button is selected, dictating breakdown structure by Item Name, Part. No.
- Failure Rate Data Summary Tab is highlighted with **Nonoperating** Failure Rate Data Text Boxes displayed. This is achieved by moving the bottom slide bar to the right.

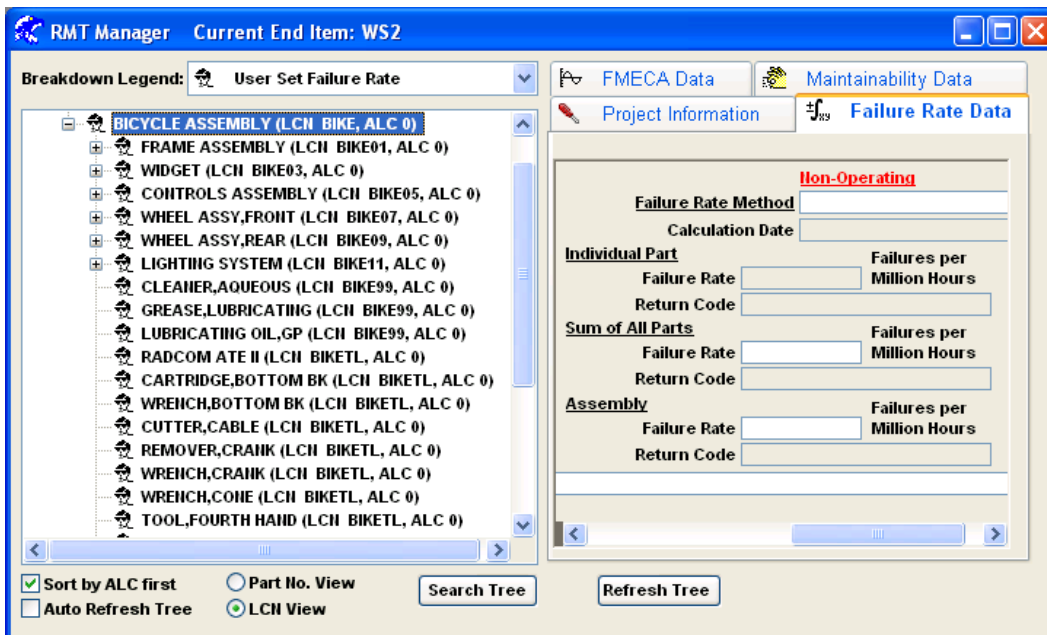


Figure 3-3. RMT Manager Part No. View.

3.2 PHASE II-RELIABILITY ANALYSIS

Reliability is defined as the ability of an item to perform its intended function for a specified interval under stated conditions. EAGLE RMT provides the capability to perform failure rate calculations, perform reliability modeling, and generate various reports associated with these analyses. The process for performing RMT Analysis begins with the generation of failure rates. Once Failure Rates have been calculated, then the remaining analysis methodologies can be utilized. Each method is discussed in the sub-sections below.

3.2.1 CREATE FAILURE RATE

There are three methods of creating failure rates in RMT. The first method is to calculate the failure rate using information and parametric data about the individual parts, sub-assemblies, and/or assemblies and then having the RMT system calculate the failure rate for that part, sub-assembly, and/or assembly. The RMT system can calculate operating failure rates with either MIL-HDBK-217F Notice 2 or the Telcordia SR-332 Black Box methodologies. Nonoperating failure rates are computed using a dormant conversion factor in accordance with the RAC Reliability Toolkit, Commercial Practices Edition.

The second method is to predict the reliability of a part via outside means (such as manufacturer data, existing failure rate data, or the like), and simply entering the value. The “Comments” field is available to record any information you would like to have about the part and/or failure rate, such as the source of failure rate information.

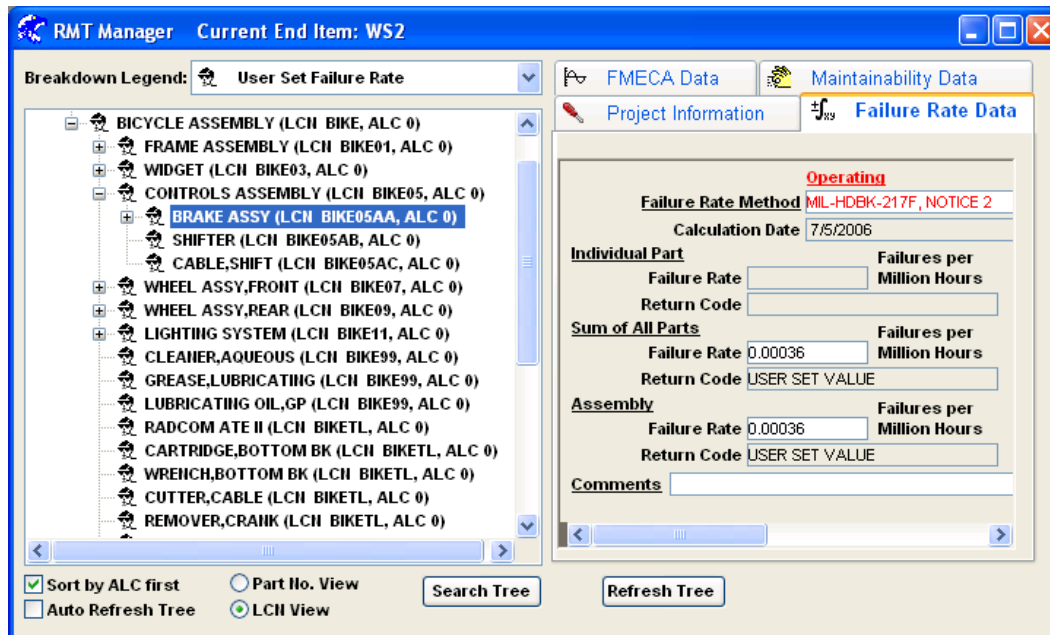


Figure 3-4. RMT Manager-Highlighted Item Name.

The third method is for those organizations that have preexisting and relevant failure data. If your organization is one that does have relevant failure data, then it may be possible to automatically import this data into the system. While this is documented as the importation of field data (IMPORT A RELIABILITY FILE), it could be data generated in a laboratory under simulated field conditions, or predictions considered relevant that come from an outside source.

3.2.1.1 CALCULATE A FAILURE RATE

STEP To enter Reliability (Failure Rate) Data:

- 1) Access the RMT Manager.
- 2) Click on the expand icon located to the left of the Project End Item.

Note: The Tree Structure is displayed by Item Name and Reference Number. To display by LCN Nomenclature and LCN/ALC, click on the radio button to the left of LCN View at the bottom of the window.

- 3) To locate a specific part, utilize the Search Tree button and enter search parameters, or click on the expand icon located to the left of the Item Name. Continue in this manner to locate the desired Item Name.
- 4) Click on the desired Item Name (Figure 3-4).
- 5) Choose Reports/Process>>RMT Reliability Data from the Main Toolbar or choose the Reliability icon from the Application Specific Toolbar.

RMT Reliability Information Current End Item: WS2

RMT Part Information | Part Classification | Static Part Information | Variable Part Information

Part Type: NOT DEFINED

CAGE	Reference Number	Item Name	End Item	LSA Control Number (LCN)	ALC	Type
99999	TL1001-1	TAILLIGHT ASSY	WS2	BIKE11BH	D	P

Assembly Flag: Assembly Duty Cycle: 1 Quantity: 1

Mission Time: 2 Unit of Measure: Hours

Failure Rate Information Operating

Failure Rate Method Mil-Hdbk-217F, Notice 2

Calculation Date: 7/5/2006 Environment: GM - Ground, Mobile

Individual Part Failure Rate: Failures per Million Hours

Return Code: Temperature: 35

Manual Entry (User Set): Failures per Million Hours

Sum of All Parts Failure Rate: 0.165622790201 Failures per Million Hours

Return Code: User Set Value

Manual Entry (User Set): No Failures per Million Hours

Assembly Failure Rate: 0.165622790201 Failures per Million Hours

Return Code: User Set Value

Manual Entry (User Set): No

Comments:

Records: 1

Figure 3-5. RMT Part Information.

- 6) Make sure the RMT Part Information Tab is selected (Figure 3-5).
- 7) Enter the mission time.
- 8) Enter the part's duty cycle (fraction of the Mission Time that the part will be in use).
- 9) Input quantity in Quantity box.

- 10) Select Environment data from the Environment drop down list box.
- 11) Enter value (Celsius) in Temperature text box.
- 12) Enter data in remaining two **Operating** text boxes if available.
- 13) Choose the save button from the Main Toolbar.

Note: Scroll to the right to enter Nonoperating data.

- 14) Click on the Part Classification Tab.
- 15) Select part type from the Part Type drop down list box.
- 16) Select part sub-type from the Part Sub-Type drop down list box.
- 17) Select part style from the Part Style drop down list box.
- 18) Enter data in remaining boxes as desired.

Note: If you wish to use a Telcordia SR-332 technique other than Black Box to calculate the failure rate, enter the Base Failure Rate in the Bellcore Modified Base Failure Rate Box.

- 19) Choose the Save button from the Main Toolbar.

Note: Depending on part classification, Static Part information may not be required.

- 20) If activated, click on the Static Part Information Tab.

Note: Common Part Data is provided to aid the user in calculations. To utilize this common part data perform steps 20 and 21.

- 21) Activate the View Common Part Data checkbox by clicking on it.
- 22) Click on the Use Common Data checkbox.
- 23) If Common Part Data was not utilized, enter data in the text boxes. Utilize the dropdown list where applicable.
- 24) Scroll down and select entry for Package Name from the drop down list box.
- 25) Choose the Save button from the Main toolbar.

Note: Depending on part classification, Variable Part information may not be required.

- 26) If activated, click on the Variable Part Information Tab. Enter data in the first four text boxes. Utilize the dropdown list where applicable.
- 27) Choose the Save button from the Main Toolbar. Return to the RMT Manager by closing the RMT Reliability Information window.

Note: The following steps are not necessary if Failure rate was entered in step 9. For individual parts, these steps are necessary to rollup failure rates.

- 28) Right Click on the highlighted Item Name.
- 29) Click on Reliability Checks And Calculations>>Check Reliability Data For Completeness. The Reliability Check Completed Window will be displayed. Click OK.
- 30) The RMT Failure Rate Calculation Messages Window will be displayed. At this time, NHA data may be present. Make sure no errors exist for your specific part/assembly. Click Done.
- 31) Right Click on the highlighted Item Name.
- 32) Click on Reliability Checks And Calculations>>Calculate Reliability Failure Rates.

Note: The system substitutes the default values of 1 (as a multiplicative identity) or 0 (as an additive identity) as appropriate when fields are left blank. If the calculation still cannot succeed with these assumptions, an error will be generated. See 3.2.2.1 below for details on error generation and handling.

- 33) Data in the Failure Rate and Return Code Text boxes to the right should reflect the correct information.

Note: The term “Sum of All Parts” refers to the sum of the failure rates of all the piece parts on the assembly, independent of the failure rates of the subassemblies.

3.2.1.2 HYBRID MICROCIRCUIT FAILURE RATES

Hybrid microcircuit failure rates can be calculated by the RMT system using either the Telcordia SR-332 or MIL-HDBK-217F, Notice 2 methodologies. The hybrid microcircuit (Part type “Hybrid”) may have any number of substrates (Part Type “Hybrid Substrate”) or various parts under it, but it may not contain another microcircuit. Furthermore, a microcircuit substrate cannot contain another microcircuit or another substrate. Finally, this representation must be present in Table ZRCM_PRJPRT to establish the structure of the microcircuit. See Figure 3-6 for a simple example.

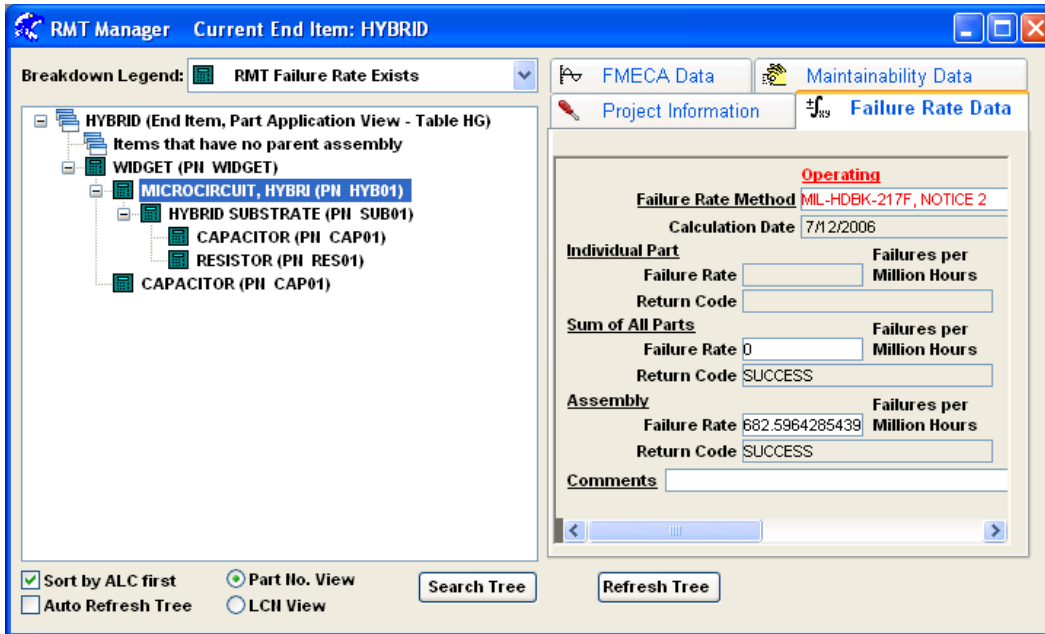


Figure 3-6. Hybrid Microcircuit Breakdown.

3.2.1.3 USER SET FAILURE RATES

STEP To enter User Set Failure Rate Data:

- 1) Follow procedures 1 through 7 in Paragraph 3.2.1.1.
- 2) Enter Individual Part or Assembly Failure Rate. (3.2.1.3). Note that the Return Code and User Set Flag are automatically set.

Note: If you have information about the failure rate that you would like to record (such as the data source), use the “Comments” field.

- 3) Enter failure rate in text box. Calculation date is set automatically.
- 4) Complete additional procedures 18 through 31 in Paragraph 3.2.1.1.

Note: If in the future you would like EAGLE to recalculate the failure rate for you, simply clear the failure rate data and follow procedures 1-31 in Paragraph 3.2.1.1.

STEP Alternate Method:

- 1) Enter the failure rate in the appropriate box on the Failure Rate Data Summary tab.

Note: If you are working with an assembly, the “Individual Part” fields will be disabled. For piece parts, the “Sum of All Parts” and “Assembly” fields will be disabled.

- 2) Choose the Save button from the main toolbar.

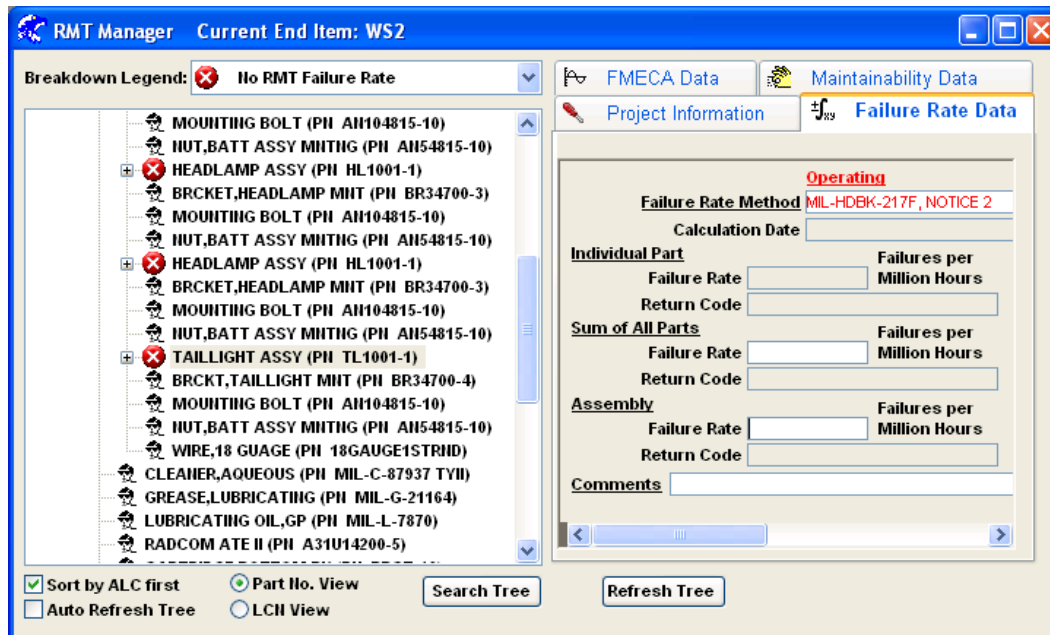


Figure 3-7. RMT Manager-Failure Rate Data Summary Tab (right hand pane).

3.2.1.4 IMPORT RELIABILITY FILE FORMAT

The following table (Table 2) describes each column or field defined in the Import Reliability File. The file type is MS Excel spreadsheet with 23 columns of data. Each description below contains information on the column the data must be in, the name of the column, the DEF STAN 00-60

Data Element Definition number³, whether or not the column data⁴ is mandatory or not, and any comments to help explain the data.

Column	Column Name	DED	Mandatory	Column Description
1	End Item	096	No	The End Item Name as defined for Phase II data in the meeting the EAGLE Security Administrator held with the lead individuals from the Logistics Team and the RMT Team to determine security requirements. If this data does not match the Current End Item displayed in the RMT Import Facility window it is ignored and the Current End Item displayed is used.
2	FMECA ID			
3	LSA Control Number	199		
4	Failure Mode Indicator	134		
5	Part Description	182		
6	Reference Number	089		
7	Item Function	180		
8	Failure Rate	140		
9	Failure Rate Method	141		
10	Mode	128		
11	Failure Mode Ratio	136		
12	Cause	124		
13	Failure Effect Probability	130		
14	Mission Phase	246		
15	Local Effect	126		
16	Next Effect	127		
17	End Effect	125		
18	Detection	129		
19	Compensating Provisions Design	049		
20	Compensating Provisions Operator	050		
21	Severity Class	362		
22	Severity Class 2		No	The Reliability Analysis Center document CRTA-FMECA makes allowances for additional severity levels (customized loss statements) beyond those defined by MIL-STD 882.
23	Remarks	137		

Table 2. Import Reliability File Format

³ Provided as reference to what the format and contents of the column contains.

⁴ All 23 columns in the spreadsheet are required in the order specified. The Mandatory information is provided to indicate whether or not data is required in that column.

3.2.1.5 IMPORT A RELIABILITY FILE

STEP To Import Custom RMT Data:

- 1) Access the RMT Manager.
- 2) Right click on the highlighted End Item.
- 3) Click on Import Reliability Failure Rates.
- 4) Click on the Select Import File button.

Note: Import File Format Window is displayed with specific File Format Information.

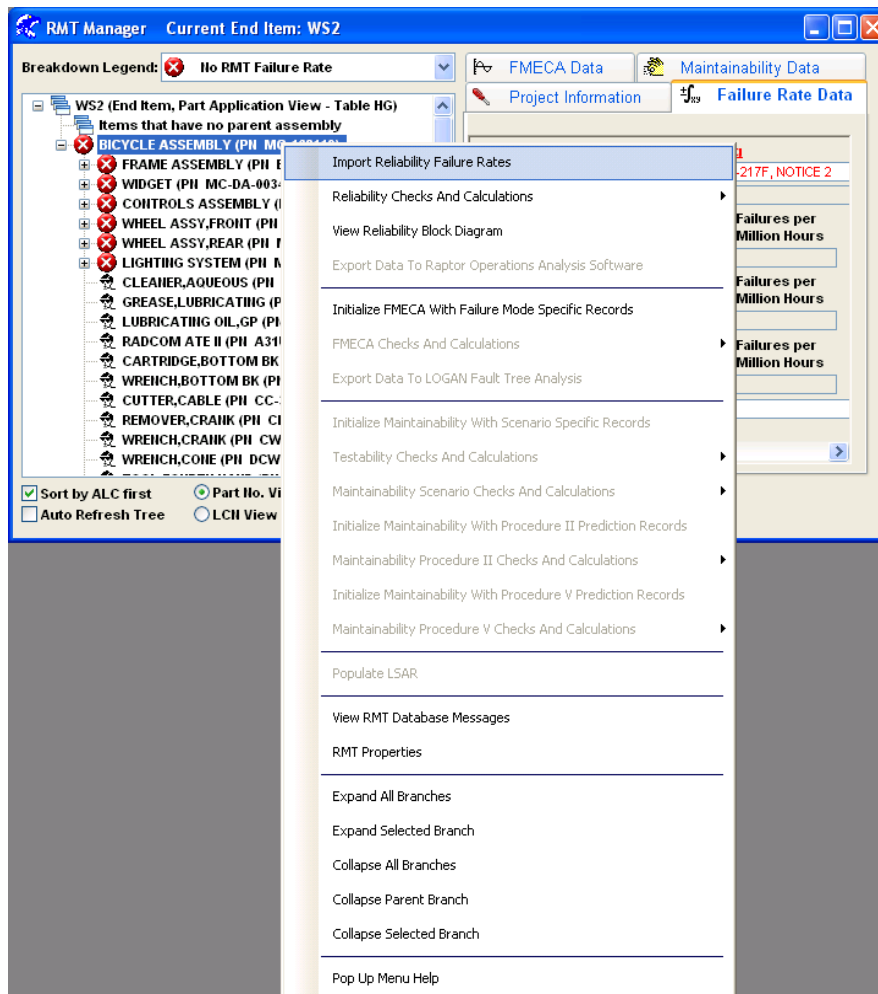


Figure 3-8. Import reliability Failure Rates.

- 5) Click the OK button.
- 6) Choose the correct File for import.
- 7) Click on the Open button.

Figure 3-9. RMT Import Facility

Note: At this point, a check is performed on the reference number of the first record in the import data with each record in table HA of the RMT Project End Item. If no match is found, the user is asked to continue with, or cancel the operation.

- 8) CAGE Code box is filled with current CAGE Code. Enter new CAGE Code if desired.
- 9) Click on the Import Data button to import the custom data.
- 10) When the Hourglass Icon changes to the arrow, indicating the import is completed, click Done. The User Set Flag is automatically turned on.

3.2.2 RELIABILITY CHECK UTILITY

The purpose of the Reliability Check Utility is ensure the data required for reliability calculations and subsequent rollout is available and within certain tolerances.

Currently the reliability checker performs the following tasks:

- Ensure that all part type, subtype, and style combinations are valid, and if not, that the user-set failure rate is set.
- Ensure all user set failure rates are valid (positive).
- Ensure all temperatures are valid (< -273 °C)

- Where possible, ensure that part data is meaningful (i.e. – a capacitor cannot have a negative capacitance). Note that this is what the second level procedures are for, so this may not be necessary or may be limited in function.
- Ensure all quantities are nonnegative.
- Ensure all environments are valid – again, this is what the second level procedures are for, so this criterion might be omitted.
- Ensure all duty cycles are between 0 and 1.
- Ensure mission time is nonnegative.
- Ensure the assembly flag is correct.

3.2.2.1 Z#RCM_CALCER

In most cases, if an error occurs while using EAGLE, a message box appears with the error details (Figure 3-10).

In the RMT system, there are cases where interrupting the program flow would be undesirable. For these cases, the Z#RCM_CALCER table was created. Z#RCM_CALCER allows EAGLE to log an error (or other informational message) to the table without interrupting the execution of the application running. For example, suppose we run the reliability checker, but have not established a part classification for a lower level part:

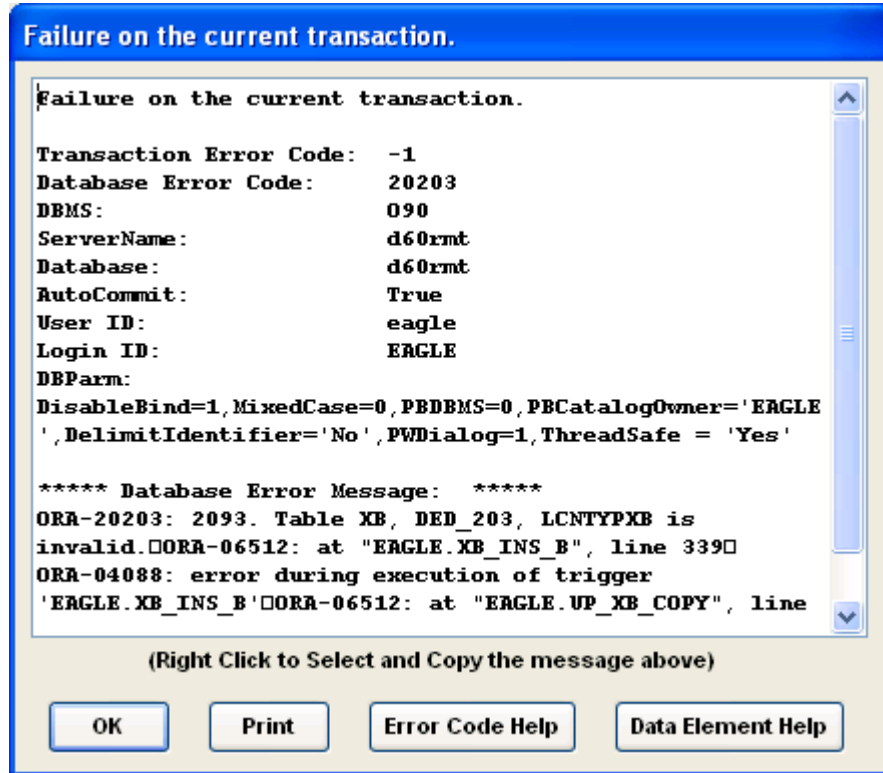


Figure 3-10. Error Message Box.

Without a user-set failure rate nor a part classification established, EAGLE will be unable to calculate the failure rate of this part. When we run the reliability checker, the checker goes through to completion. When finished, EAGLE notifies you that it has messages waiting for you in Z#RCM_CALCER (Figure 3-11):

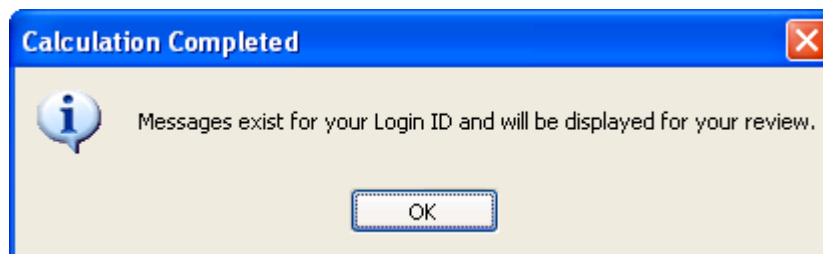


Figure 3-11. Message Window.

After clicking OK, EAGLE reports what it has in Z#RCM_CALCER for your review (Figure 3-12).

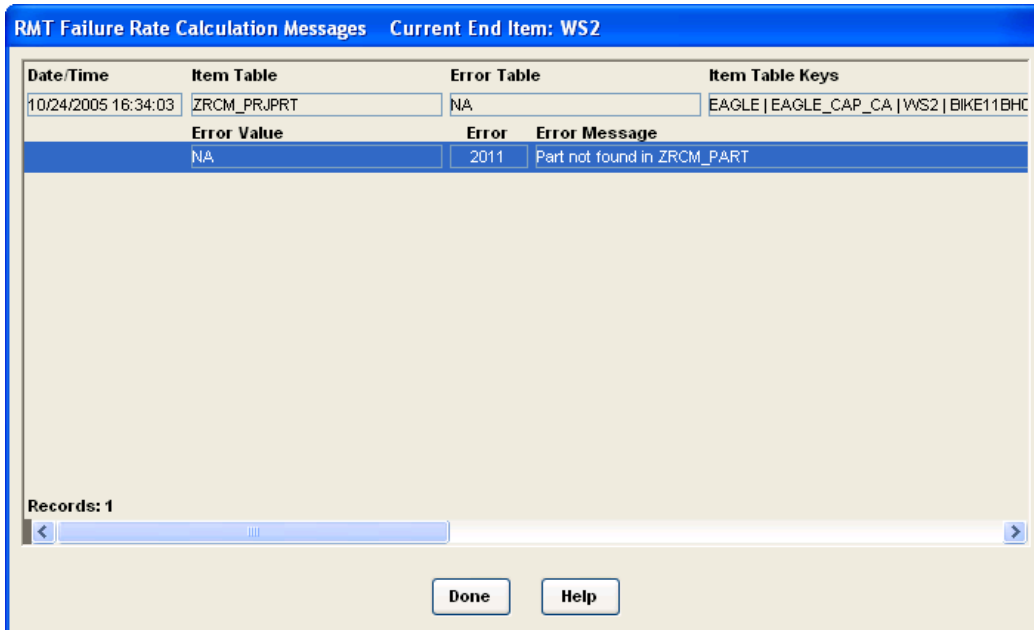


Figure 3-12. Calculation Message.

Note: To view Z#RCM_CALCER at any other time, simply right-click any part in the RMT Manager Window and select “View RMT Database Messages.”

3.2.3 RELIABILITY BLOCK DIAGRAMS

The purpose of the reliability block diagram is to show by concise visual shorthand the various series-parallel block combinations that result in item success. Reliability models are initially built the first time the RBD Analysis is displayed. The default (initial) model constructed is a simple series model. On larger systems or subassemblies which have a large number of lower level assemblies, the entire model may not be visible in the RBD Analysis Window without scrolling.

3.2.3.1 RMT RBD MATHEMATICAL MODEL SUPPORTED

Mil-Std-756B allows the contractor to select the appropriate modeling methods from a list of four defined methodologies. The standard provided these different methodologies because different

prediction methods may be applicable to different system components. The four available methods are:

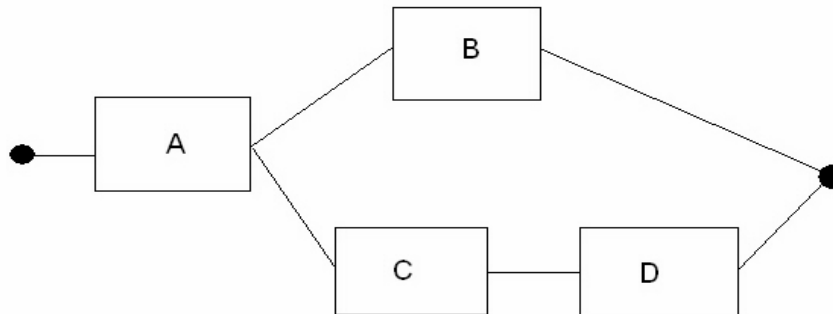
- Method 1001 Conventional Probability
- Method 1002 Boolean Truth Table
- Method 1003 Logic Diagram
- Method 1004 Monte Carlo Simulation

RMT has implemented Methods 1002 and 1004. Below, is an explanation of how the Method 1002 Boolean Truth Table is implemented in RMT. For details on the Monte Carlo method refer to Mil-std 756B.

3.2.3.2 RUNNING RELIABILITY MODELS VIA ENUMERATED STATES

Given a set of reliability blocks, each with a finite probability of success or failure, and a set of directed connections between these blocks, our task is to determine the probability of success of the entire set or “model”. We assume that the probabilities involved are independent. The best method of determining the probability of success for the model is to separate the probability space into a set of enumerated, independent sub-spaces, determine the probability of each sub-space, determine whether each sub-space represents a success or a failure of the model, and finally, sum across the sub-spaces that represent success.

For example, take the following model:



Assume that the probabilities of success for each block are: A 0.9, B 0.8, C 0.9, D 0.9. What is the probability of success for the entire model? First we break the probability space into 2^N subspaces where N is the number of blocks. Since there are 4 blocks in the model, the number of subspaces in this case is 2^4 or 16. Here are the Success (S) / Failure (F) enumerations of those subspaces (Table 3):

Subspace	S/F for A,B,C,D	Probability	Model S / F
0	FFFF	$.1 * .2 * .1 * .1 = 0.0002$	F
1	FFFS	$.1 * .2 * .1 * .9 = 0.0018$	F
2	FFSF	$.1 * .2 * .9 * .1 = 0.0018$	F
3	FFSS	$.1 * .2 * .9 * .9 = 0.0162$	F
4	FSFF	$.1 * .8 * .1 * .1 = 0.0008$	F
5	FSFS	$.1 * .8 * .1 * .9 = 0.0072$	F
6	FSSF	$.1 * .8 * .9 * .1 = 0.0072$	F
7	FSSS	$.1 * .8 * .9 * .9 = 0.0648$	F
8	SFFF	$.9 * .2 * .1 * .1 = 0.0018$	F
9	SFFS	$.9 * .2 * .1 * .9 = 0.0162$	F
10	SFSF	$.9 * .2 * .9 * .1 = 0.0162$	F
11	SFSS	$.9 * .2 * .9 * .9 = 0.1458$	S
12	SSFF	$.9 * .8 * .1 * .1 = 0.0072$	S
13	SSFS	$.9 * .8 * .1 * .9 = 0.0648$	S
14	SSSF	$.9 * .8 * .9 * .1 = 0.0648$	S
15	SSSS	$.9 * .8 * .9 * .9 = 0.5832$	S

Table 3. Success/Failure Enumerations

Subspaces 11 through 15 represent success for the model. If we add up the associated probabilities of subspaces 11 through 15, we get $.1458 + .0072 + .0648 + .0648 + .5832 = .8658$. As a check of the correctness of this method, note that the sum of probabilities of ALL of the subspaces should equal 1.0

From a computational standpoint, this method is simpler than generating equations and faster and more accurate than Monte Carlo simulation. In fact, given purely independent probabilities, it is perfectly accurate. Generating the subspaces is easy because the number of subspaces is $2^{**}N$ and the enumeration of the subspaces is simply a matter of counting from 0 to $2^{**}N-1$ and assigning the ordered blocks an S or an F depending on the binary digits of the current count. In the above example, if we count from 0 to 15, this is equivalent to counting from 0000 to 1111 in binary and assigning the blocks an S or an F where the binary count has a 1 or a 0. So subspace 13 will assign A = S, B = S, C = F and D = S because 13 = binary 1101.

3.2.3.3 CREATING A RELIABILITY BLOCK DIAGRAM

STEP To Create a Reliability Block Diagram:

- 1) Access the RMT Manager.
- 2) Right click on the desired Item Name.
- 3) Click on View Reliability Block Diagram. The Select/Enter RBM Model Information window is displayed (Figure 3-13).
- 4) Click OK to No Records Found.
- 5) Click the Insert Row button.

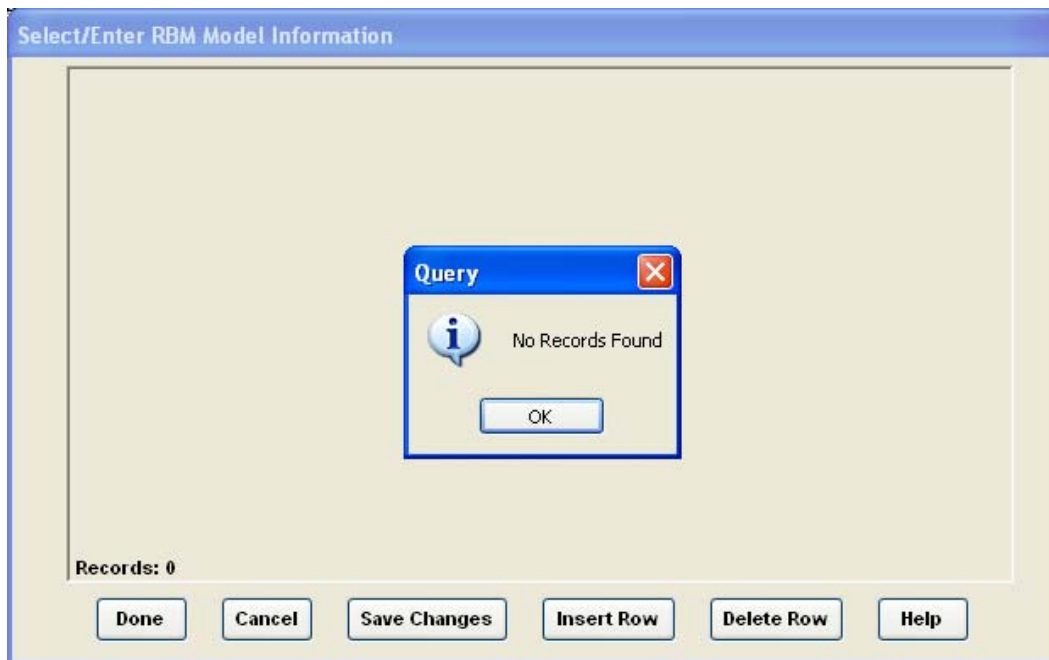


Figure 3-13. Select/Enter RBM Model Information.

- 6) Enter Model Identification and Model Description data in the appropriate text boxes (Figure 3-14)
- 7) Click Save Changes.
- 8) Click Done. The reliability block diagram defaults to a serial configuration (Figure 3-15).

Select/Enter RBM Model Information Current End Item: WS2

CAGE	Reference Number	End Item	LSA Control Number (LCN)	ALC	Type
99999	MC-CA-99036	WS2	BIKE05	0	P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2

Model Identification: TEST WS2 Model Description: VARIABLE

Failure Rate: 0.000564 Mission Time: 2

Reliability: 0.998872635952859

Records: 1

Done Cancel Save Changes Insert Row Delete Row Help

Figure 3-14. Enter Model Information.

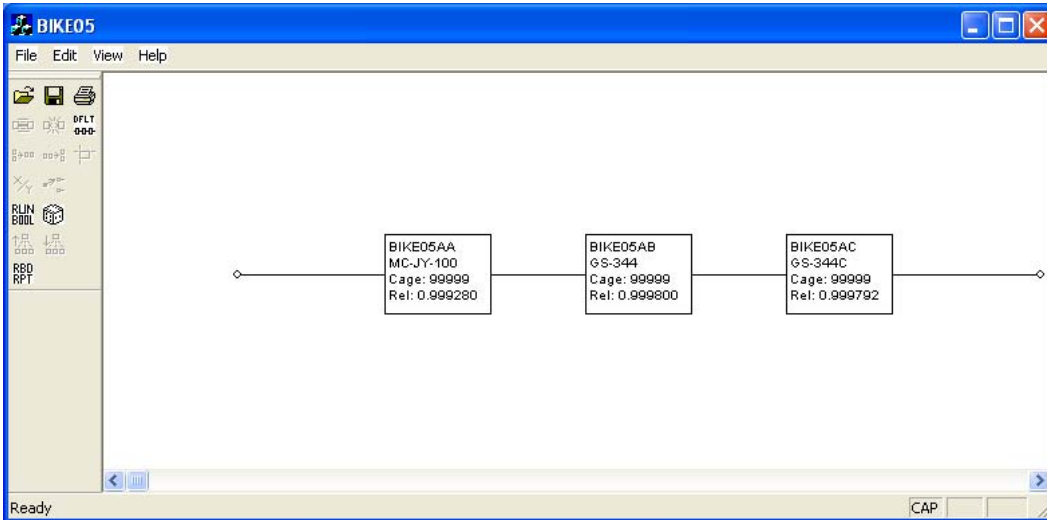


Figure 3-15. Serial RBD.

3.2.3.4 MANIPULATING A RELIABILITY BLOCK DIAGRAM

STEP To Manipulate a RBD:

- 1) Click in the white blank space and drag the rectangle over two nodes and select the parallel icon to create a parallel configuration.
- 2) Return to the initial serial configuration with the DFLT button.
- 3) The SNAP TO GRID button helps you organize the nodes into a visually appealing configuration.
- 4) Click and drag the rectangle over two parallel nodes and a serial node and click the switch button to create a switch configuration.
- 5) Click the RUN BOOL button to see the results of the boolean truth table.
- 6) Click the Die icon to run a Monte Carlo simulation.
- 7) Click the RBD RPT button to print the report of your RBD.

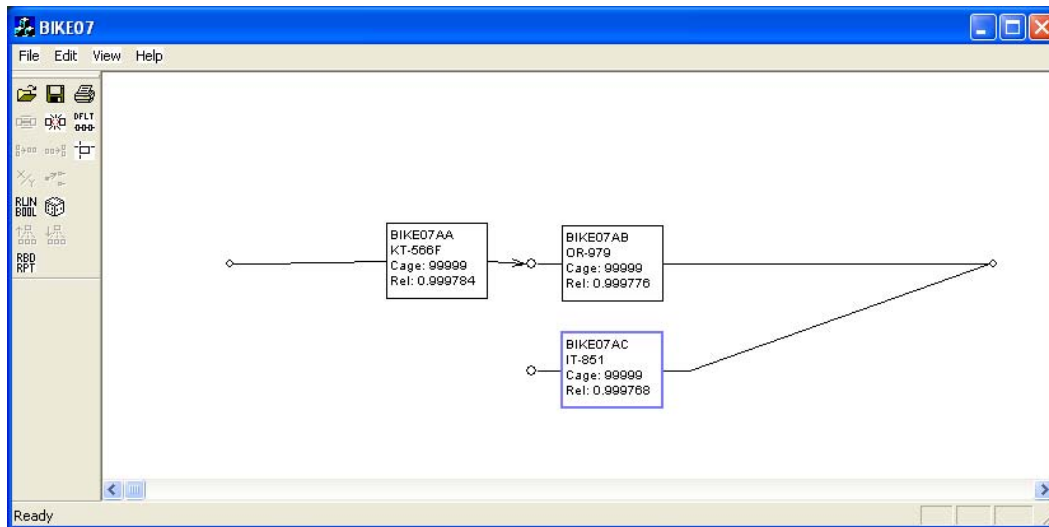


Figure 3-16. Switched/Parallel RBD.

3.2.4 RELIABILITY REPORTING

There are currently 9 reports than can be generated for Reliability information:

- **Failure Rate Report (4)**
This report has two options; Assembly Only, and Parts and Assemblies. The Operating Failure Rate Report shows an indented structure with reference designator, part number, description, quantity, and failure rate information by individual part. It can be produced either for Assemblies only or show Parts and Assemblies. The Nonoperating Failure Rate Report is exactly the same except displays nonoperating failure rates.
- **Part Type Summary Report**
This report will summarize the failure rate and quantity for each part type, subtype, style and quality level. It summarizes the parts on the selected assembly only.
- **Failure Rate Status Report**
Generate a summary report of the status of failure rates. This report shows a list of the status of the failure rate calculations.
- **Part Count Report**
This report summarizes the quantity of parts in the assembly. It has an option to display the quantities within the assembly only, or within all subassemblies.
- **Part Type Count Report**
This report summarizes the quantity of each type of part in the assembly. It has an option to display the quantities within the assembly only, or within all subassemblies.
- **Package Count Report**
This report summarizes the packages used for all microcircuits in the assembly.
- **RBD Analysis Report**
The RBD Analysis Report provides a graphic report of the Reliability Block Diagram Analysis with supporting tabular data for each model. For a given model a separate section is provided for each sub model, expanding the sub model block into its elemental blocks. This report can only be run from within the RBD Analysis System.

3.2.4.1 GENERATE RELIABILITY REPORTS

To Generate Reliability Reports:

- 1) Access the RMT Manager.
- 2) Click on the expand icon located to the left of the Project end item.

Note: The Tree Structure is displayed by Item Name and Reference Number. To display by LCN Nomenclature and LCN/ALC, click on the radio button to the left of LCN View at the bottom of the window.

- 3) To locate a specific part, utilize the Search Tree button and enter search parameters, or click on the expand icon located to the left of the Item Name. Continue in this manner to locate the desired Item Name.
- 4) Click on the desired Item Name.

- 5) Choose Reports/Process>>RMT Reports from the Main Toolbar or choose the Reports icon from the Application Specific Toolbar.

Note: The Adhoc Query Type: drop down list box will be used for Adhoc Reports.

- 6) Click on the expand icon to the left of Reliability Reports.
- 7) Double click on the desired report.
- 8) In the RMT Report Parameters window, fill in the text boxes as desired.
- 9) Click Done to run the report.
- 10) Click on the RMT Report Selection Tab to return to the Reliability Reports Folder.

3.3 PHASE II- FAILURE MODE AND CRITICALITY ANALYSIS

FMECA is the consequence of the mechanism through which the failure occurs and the consequence of a failure mode and its frequency of occurrences. EAGLE RMT provides the following capabilities within the FMECA discipline:

- Failure Mode, Effects, and Criticality Analysis (FMECA) as per MIL-STD-1629A and RAC-CRTA-FMECA.
- Reliability Centered Maintenance as per MIL-STD-2173(AS) and ATA MSG-3
- Failure rates associated with testability and detection.
- Reports associated with the above.

3.3.1 INITIALIZING FMECA

STEP To Initialize FMECA

Note: FMECA Data entry is begun after Reliability Data has been entered and before Maintainability Data is entered.

- 1) Access the RMT Manager.
- 2) Click on the expand icon located to the left of the Project End Item.

Note: The Tree Structure is displayed by Item Name and Reference Number. To display by LCN Nomenclature and LCN/ALC, click on the radio button to the left of LCN View at the bottom of the window.

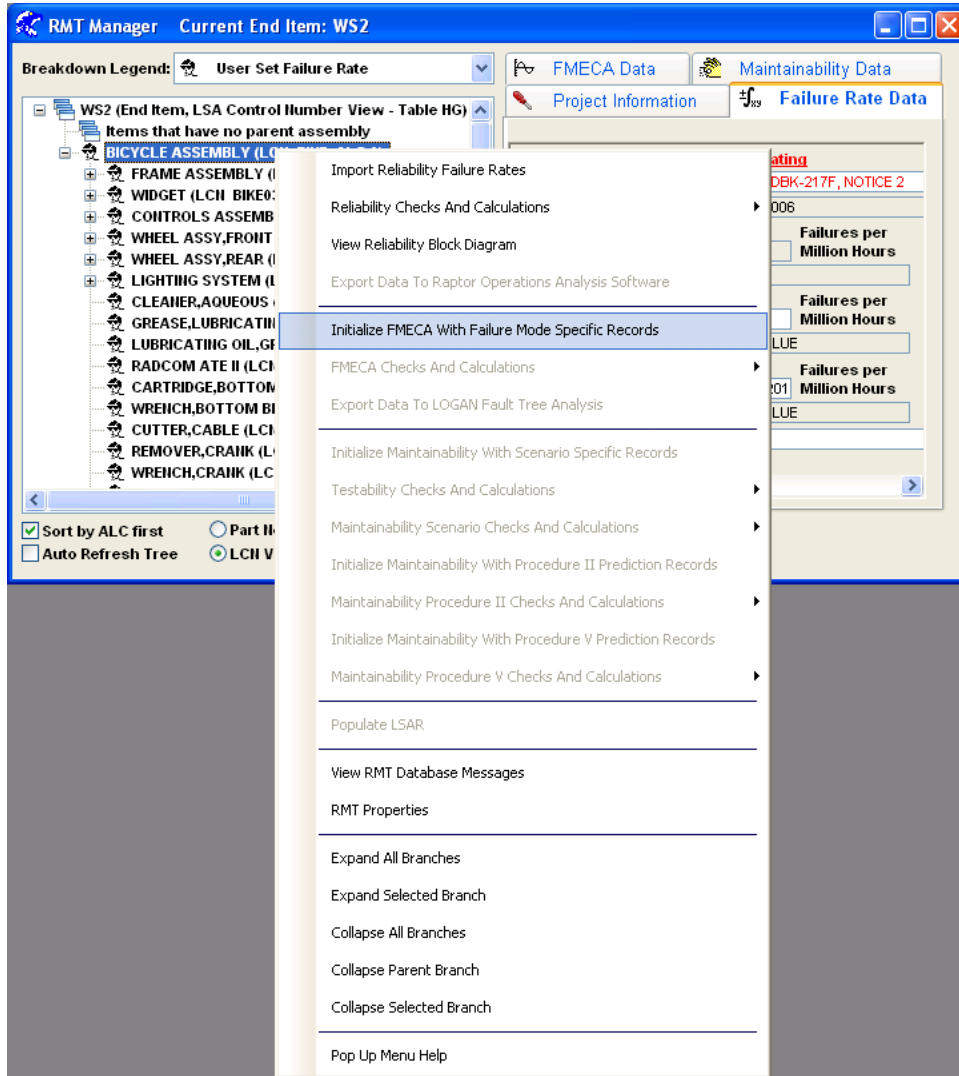


Figure 3-17. Initializing FMECA

- 3) To locate a specific part, utilize the Search Tree button and enter search parameters, or click on the expand icon located to the left of the Item Name. Continue in this manner to locate the desired Item Name.
- 4) Right click on the desired Item Name.
- 5) Click on Initialize FMECA With Failure Mode Specific Records.
- 6) Click OK

3.3.2 ENTERING FMECA PART INFORMATION AND FAILURE MODE DATA

STEP To Enter FMECA Part Information:

- 1) Make sure desired Item Name is highlighted.
- 2) Choose Reports/Process>>RMT FMECA Data from the Main Toolbar or choose the FMECA icon from the Application Specific Toolbar.
- 3) RMT FMECA Information window should be displayed with the FMECA Part Info. Tab activated.
- 4) Failure Rate Method text box should have data displayed. Failure Mode Function and Mission Phase Text Boxes may have data displayed. If data is not displayed, click on View FMECA Project Data checkbox.
- 5) Select desired row of data and click on the Use Project Data checkbox.
- 6) Enter data in remaining text boxes as desired. Duty Cycle entry is required.
- 7) Select Isolation Type data from the drop down list.
- 8) Click the Save button on the Main Toolbar.

RMT FMECA Information Current End Item: WS2

FMECA Part Info. Failure Modes RCM Analysis Next Effects Criticality Detection Signals

Part Type: NOT DEFINED View FMECA Project Data Use Project Data

CAGE	Reference Number	Item Name
99999	MC-RWA-7Y56T	WHEEL ASSY, REAR

End Item: WS2 LSA Control Number (LCN): BIKE09 ALC Type: 0 P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2

Failure Mode Function: RIDING Source = FMECA Project Data

Mission Phase: B Source = FMECA Project Data

Duty Cycle: 1

Functional Description: _____

Comments: _____

Minimum Equipment List: _____

Equipment List Comment: _____

Isolation Type: _____

Records: 1

Figure 3-18. Entering FMECA Part Information.

STEP To Enter Failure Mode Data:

- 9) Select the Failure Modes Tab.
- 10) To view data for existing records, click on Next Record button located to the right of LCN information text boxes.
- 11) To insert a new record, click on the Insert button located on the main toolbar.
- 12) Enter data in text boxes as necessary. Utilize the Source Data drop down list to access data from the Severity and Failure Mode libraries.
- 13) Click the Save button on the Main Toolbar.

Note: If this failure mode is a next effect for another failure mode, it is not necessary to enter the failure mode ratio – it will be computed automatically from the causing failure modes.

CAGE	Reference Number	Item Name
99999	MC-RWA-7Y56T	WHEEL ASSY, REAR

End Item	LSA Control Number (LCN)	ALC	Type
WS2	BIKE09	O	P

Failure Rate Method	MIL-HDBK-217F, NOTICE 2	
Failure Mode Function	RIDING	Mission Phase B
Failure Mode Data Source	EAGLE RMT APPLICATION	Source = Failure Mode Library
Failure Mode Identification	WHEEL FAILURE	Source = Failure Mode Library
Failure Mode Indicator	F001	
Local Effect Identification		Source = Failure Mode Library
Severity Level		
Severity Sub-Level Identification		Source = Severity Library
Failure Mode Ratio		
Compensating Provisions		
Detection Methods		
Failure Mode Remarks		
Maintenance Remarks		

Records: 1

Figure 3-19. Entering FMECA Failure Mode Data.

STEP To associate a signal with this failure mode:

- 14) Select the Signals Tab.
- 15) Click the Get From Signal Library button.
- 16) On the following screen, choose the appropriate signal from the signal library.

Note: To enter a new signal, first click in the library window and click the Insert button.

- 17) Click the Return button to populate the Signals tab.

- STEP To Enter Next Effects Data:
- 18) Select the Next Effects Tab.
 - 19) Click the View All Next Effects check box.
 - 20) Select desired Next Effect.
 - 21) Click the Use Selected Next Effect checkbox
 - 22) Enter data in Beta Percentage text box.
 - 23) Click the Save button on the Main Toolbar

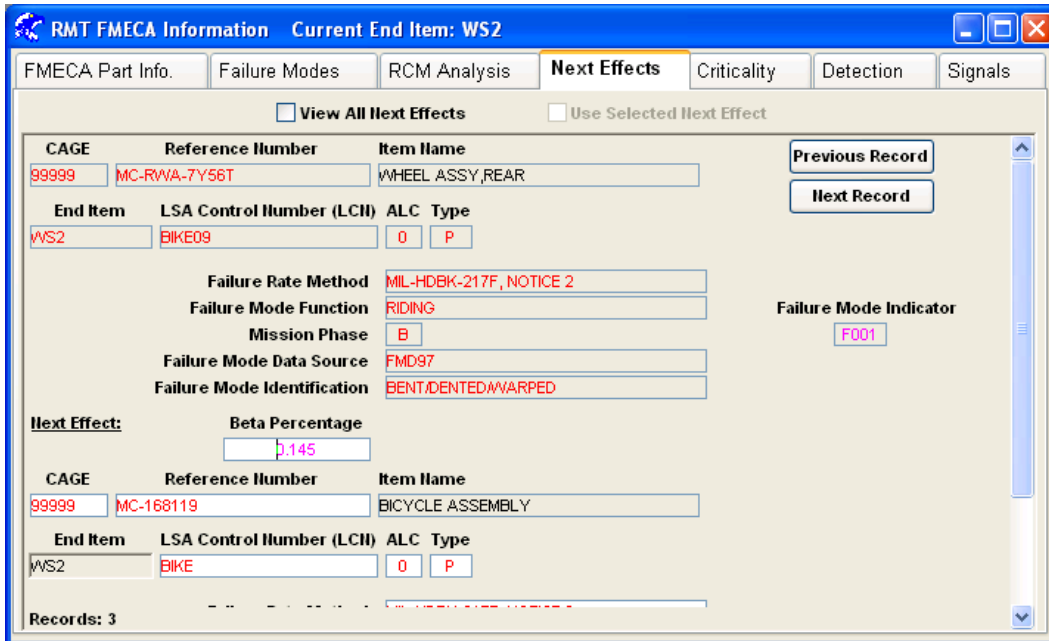


Figure 3-20. Entering FMECA Next Effects Data.

RMT FMECA Information Current End Item: WS2

FMECA Part Info. Failure Modes **RCM Analysis** Next Effects Criticality Detection Signals

Perform RCM Analysis

CAGE: 99999 Reference Number: MC-RWA-7Y56T Item Name: WHEEL ASSY, REAR

End Item	LSA Control Number (LCN)	ALC	Type	(RCM) Logic Results		RCM Disposition
WS2	BIKE09	0	P	01	14	
Failure Rate Method				02	15	A
MIL-HDBK-217F, NOTICE 2				03	16	B
Failure Mode Function				04	17	C
RIDING				05	18	D
Mission Phase				06	19	E
B				07	20	F
Failure Mode Data Source				08	21	G
FMD97				09	22	H
Failure Mode Identification				10	23	I
BENT/DENTED/WARPED				11	24	J
Failure Mode Indicator				12	25	
F001				13		

Records: 1

Figure 3-21. Entering RCM Analysis Data

STEP To Enter RCM Analysis Data:

- 24) Select the RCM Analysis Tab (Figure 3-21).
- 25) Click the Perform RCM Analysis check box.
- 26) Select the desired Logic Type from the RCM Logic Type dropdown list (Figure 3-22).
- 27) Select the desired Analysis Method from the RCM Analysis Method dropdown list.
- 28) Answer Yes or No to the RCM Statement by clicking on the correct Yes/No radio button, then click on the Accept Logic button. Do this until the 'RCM Logic is complete' window is displayed.
- 29) Click OK.
- 30) Click Done.

Reliability Centered Maintenance (RCM) Analysis Current End Item: WS2

CAGE	Reference Number	Item Name	End Item	LSA Control Number (LCII)	ALC	Type
99999	MC-RWA-7Y56T	WHEEL ASSY,REAR	WS2	BIKE09	00	P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2
Failure Mode Function: RIDING
Mission Phase: B

Failure Mode Data Source: FMD97
Failure Mode Identification: BENT,DENTED,WARPED

RCM Logic Type: Select an RCM Logic Type
RCM Analysis Method:

RCM Statement	RCM Logic
---------------	-----------

RCM Disposition

RCM Question	Reply	DB Column	Analysis
--------------	-------	-----------	----------

Done Save Changes Help

Figure 3-22. Select RCM Logic Type

STEP To Enter Criticality Data:

- 31) Click on the Criticality Tab.
- 32) Enter your own data for the Criticality and the end effect beta. Be aware however, that performing the automatic Criticality calculation will overwrite these values.

RMT FMECA Information Current End Item: WS2

FMECA Part Info. Failure Modes RCM Analysis Next Effects **Criticality** Detection Signals

View All Next Effects Use Selected Next Effect

CAGE	Reference Number	Item Name
99999	MC-RWA-7Y56T	WHEEL ASSY, REAR

Previous Record
Next Record

End Item	LSA Control Number (LCII)	ALC	Type
WWS2	BIKE09	0	P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2
 Failure Mode Function: RIDING
 Mission Phase: B
 Failure Mode Data Source: FMD97
 Failure Mode Identification: BENT, DENTED, & WARPED

Failure Mode Indicator: F001

End Effect:	Criticality	Conditional Probability	Mission Time
	0.00003654	0.145	2

CAGE	Reference Number	Item Name
99999	MC-168119	BICYCLE ASSEMBLY

End Item	LSA Control Number (LCII)	ALC	Type
WWS2	BIKE	0	P

Records: 10

Figure 3-23. Enter Criticality Data.

STEP To Enter Detection Data:

- 33) Click on the Detection Tab.
- 34) Fill in Detection Method Category and Detection Method Name Text Boxes by clicking on the Get From Detection Category Library button. Select the desired record and click on the <<<<RETURN button.
- 35) Fill in Detection Group Title Text Box by clicking on the Get From Group Library button. Select the desired record and click on the <<<<RETURN button.
- 36) Fill in Built-In-Test Identification Text Box.

Note: At this time disregard the Text Boxes titled Alternate.

- 37) Fill in remaining Text Boxes as desired (scroll down).
- 38) Click on the Save button located on the Main Toolbar.
- 39) Close the RMT FMECA Information window.

RMT FMECA Information Current End Item: WS2

FMECA Part Info. Failure Modes RCM Analysis Next Effects Criticality **Detection** Signals

Select ALT. Detection Method View All Parts

CAGE	Reference Number	Item Name
99999	MC-RWA-7Y56T	WHEEL ASSY_REAR

End Item	LSA Control Number (LCII)	ALC	Type
WS2	BIKE09	0	P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2

Failure Mode Function: RIDING

Mission Phase: B

Failure Mode Data Source: FMD97

Failure Mode Identification: BENT/DENTED/WARPED

Detection Method Category: TBD >>>>

Detection Method Name: TBD >>>>

Detection Group Title: VISUAL/OPERATOR-1 >>>>

Built-In-Test Identification: B1

Alternate CAGE Code:

Alternate Reference Number:

Alternate End Item Acronym Code:

Failure Mode Indicator: F001

Get From Detection Library

Get From Group Library

Records: 1

Figure 3-24. Enter Detection Data.

3.3.3 FMECA CHECK UTILITY

This utility is to check on the status of the Failure Mode and Effects Analysis and ensure that the data elements required for criticality calculations are valid.

EAGLE RMT uses this check as proof that FMEA was successfully completed and that rollups and criticality calculations are ready to be run. Once the criticality calculations have run successfully EAGLE RMT presumes that the FMECA has been completed. This section defines the items that the FMECA Check Utility is to check.

- Failure modes not assigned a severity classification.
- Failure modes without next effects Failure modes without causes
- Assemblies, and/or parts without reference designators
- Failure mode ratios not summed up the tree structure
- Failure modes with conditional probabilities not equal to 1.
- Assemblies, and/or parts, with failure modes less than or equal to zero.
- Assemblies, and/or parts, without failure modes
- Assemblies, and/or parts, with failure rates less than or equal to zero

- Assemblies, and/or parts, without failure rates
- Assemblies, and/or parts, without valid Duty Cycles ie they cannot be NULL or ≤ 0
- System level has failure modes defined (ie end effects)
- Assemblies, and/or parts failure mode ratios must sum up to 1.0 for that particular assembly or part.
- Probability Groups assigned to project.

STEP To Run FMECA Check Utility:

- 1) Make sure desired Item Name is highlighted.
- 2) Right click on the highlighted Item Name.
- 3) Click on FMECA Checks And Calculations>>Check FMECA Data For Completeness.

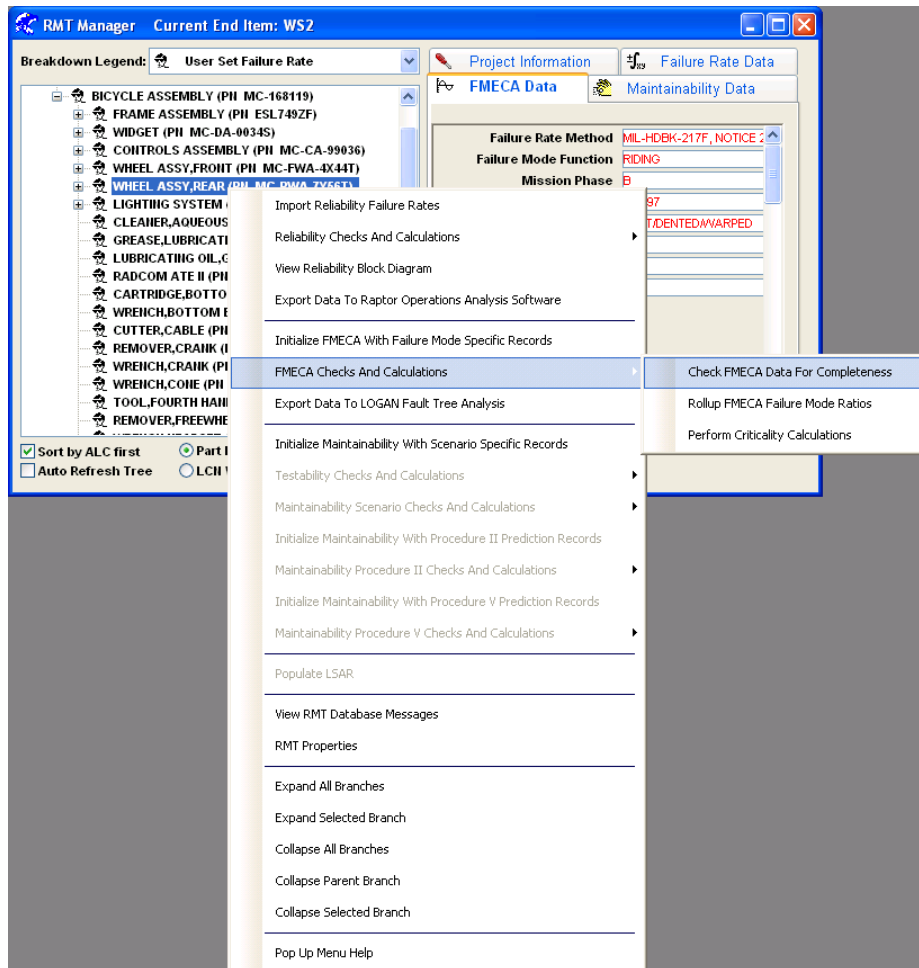


Figure 3-25. FMECA Check Utility.

3.3.4 ROLLUP FMECA FAILURE MODE RATIOS

The Roll-up Failure Mode Ratios is available from the project node and the Utilities submenu of the Main Menu. The tool works its way from the bottom of the product tree structure and recalculates all the failure mode ratios for the selected node and all its children nodes. This ensures that the ratios are consistent and correct throughout the product tree structure, which is crucial for correct calculation of the criticality numbers. Prior to doing the FMECA Roll-up, you should have successfully run the FMECA Check Utility to verify that failure rates are defined at the lowest level and that failure mode ratios are defined for failure nodes at the lowest level. Also, next higher effects should be defined for all of the failure modes in your project (except, of course, those at the end item level).

STEP To Roll-up FMECA Failure Mode Ratios:

Note: [Reference](#) (Figure 3-25).

- 1) Make sure desired Item Name is highlighted.
- 2) Right click on the highlighted Item Name.
- 3) Click on FMECA Checks And Calculations>>Rollup FMECA Failure Mode Ratios.

3.3.5 CRITICALITY CALCULATIONS

Calculating criticality is more of a process than a calculation per se. While there are several calculations to be performed, this section will deal with the process as well as those calculations. Criticality is only stored for failure modes below the system level. Prior to doing the FMECA Roll-up, you should have successfully run the FMECA Check Utility to verify that the required variables are available.

STEP To Perform Criticality Calculations:

Note: [Reference](#) (Figure 3-25). **This procedure will overwrite any criticality numbers or beta percentages already in place.**

- 1) Make sure desired Item Name is highlighted.
- 2) Right click on the highlighted Item Name.
- 3) Click on FMECA Checks And Calculations>>Perform Criticality Calculations.

3.4 PHASE II- TESTABILITY ANALYSIS

This is a design characteristic which allows the status (i.e. operable, inoperable, or degraded) of an item to be determined and the isolation of faults within the item to be performed in a timely manner. EAGLE RMT provides the capability to establish detection groups, establish built-in-test for failure modes, identify parts that a failure mode can be isolated to and calculate testability failure rates.

In order to calculate testability, all the lowest level failure modes for a BIT must have their excluded, detected, and false alarm failure rate fractions set. For isolation level failure rates, the isolation lists must be built. A failure mode is at the “lowest level” if it is not caused by another failure mode recorded in the FMEA or if it has a depth flag set by the user.

In the RMT Testability discipline, the Excluded Failure Rate Fraction refers to the fraction of the failure rate that is deliberately excluded from BIT. For example, suppose only the FM functions of an AM/FM radio were to be used. The analyst could exclude a portion of the failure rate he/she attributes to the AM functionality. The Detected Failure Rate Fraction is the fraction of the failure rate that is detectable. The False Alarm Failure Rate Fraction is the expected fraction of BIT failures reported that are not actually failures (i.e. false alarms).

3.4.1 ENTERING FAILURE RATE FRACTIONS

STEP To enter Failure Rate Fractions:

- 1) Make sure desired Item Name is highlighted in the RMT Manager.
- 2) Choose Reports/Process>>RMT FMECA Data from the Main Toolbar or choose the FMECA icon from the Application Specific Toolbar.
- 3) RMT FMECA Information window should be displayed with the FMECA Part Info. Tab activated (Figure 3-18).
- 4) Click the Failure Modes tab and choose a failure mode by clicking the ‘Next Record’ button or using the scroll bar.
- 5) Click the Detection tab. This tab shows all of the BITs related to this failure mode.
- 6) Insert a BIT by clicking the INSERT button.
- 7) Enter values for the Detection Method Category and Name by choosing the Get From Detection Library button. Choose an existing Detection Method Category or insert a new Detection Method Category and hit Return.
- 8) Enter values for the Detection Group Title in a similar fashion.
- 9) Enter a value for the Built-In Test Identification.
- 10) If nonzero, enter values for the Excluded, Detected, and False Alarm Failure Rate Fractions.
- 11) If you would like to include data for an alternate built-in-test, select the “Select Alt. Detection Method” checkbox. From the following screen, select or insert an Alternate BIT and choose Return.
- 12) If you wish to ignore testability analysis for children of this part, enter “Yes” for the User Set Depth Limit.
- 13) Click Save.

3.4.2 ADDING AN ISOLATION LIST ITEM

STEP To add an Isolation List Item

- 1) Click on the FMECA Icon.
 - 2) Click on the Testability tab.
 - 3) Choose a BIT using the Get From Bit Detection button.
-

- 4) Choose a part by checking the Bit Isolation Parts List check box.
- 5) The part shown is the part highlighted in the RMT manager. To choose another part, check the View All Parts checkbox.
- 6) Select the part and uncheck the Bit Isolation Parts List checkbox.
- 7) Click SAVE. This part has now been added to the isolation list for this BIT.

3.4.3 CHECK TESTABILITY

- 1) From the RMT Manager, right-click on the system level assembly and click on “Testability Checks and Calculations >>Check Testability Data for Completeness.”
- 2) The Testability Check Utility will inform you if detection groups have not been defined, detection codes have not been defined, if the lowest level failure modes are missing BIT data, and/or where depth flags have been set.

3.4.4 CALCULATING TESTABILITY

- 1) From the RMT Manager, right-click on the system level assembly and click on Testability Checks and Calculations >> Calculate Testability.
- 2) For the appropriate BITs, the Applicable, Detected, Analyzed, Excluded, False Alarm, Isolation Level 1, Isolation Level 2, and Isolation Level 3 failure rates will be calculated. In addition, for BITs corresponding to next effects, the excluded, detected, and false alarm fraction will be calculated.

3.5 PHASE II- MAINTAINABILITY ANALYSIS

Maintainability is the measure of the ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. EAGLE RMT provides capabilities to define various Scenarios and their corresponding tree structures, and perform analyses using Procedure 2 or Procedure 5 of Mil-Std-472. Several options are provided for calculating Availabilities, Mean Man Hours, Mean Time To Repair and Mean Maximum Maintenance Time for both Corrective and Preventative Maintenance.

3.5.1 ENTERING MAINTAINABILITY DATA

STEP To enter Maintainability Data:

Note: Maintainability Data entry is begun after Reliability and FMECA Data has been entered.

- 1) Access the RMT Manager
- 2) Click on the expand icon located to the left of the Project End Item.
- 3) Initialize the Maintainability scenario by right clicking on the system level assembly and clicking on “Initialize Maintainability Using Scenario Specific Records.”
- 4) In the window displayed, enter a name and description for the scenario:
 - The MMAX method is whether you wish to use MIL-HDBK-472 or NAVORD OD 39223.
 - Failure Rate Type is either OPERATING or NONOPERATING.

- The Procedure 5 Method Identification is either STANDARD (FDI time is calculated using the previous item's MCT) or ALTERNATE (FDI time is calculated using the previous item's MCT + the current item's FDI time).
- 5) From the RMT Manager Utilize the Search Tree button and enter search parameters, or click on the expand icon located to the left of the Item Name. Continue in this manner to locate the desired Item Name.
 - 6) Click on the desired Item Name.
 - 7) From the Application Specific Toolbar choose the Maintainability icon.
 - 8) The RMT Maintainability Information window should be displayed with the Part Info. Tab selected (Figure 3-26).
 - 9) The preventive maintenance, remove, repair, replace, disassembly, reassembly, fault detection/isolation, align/adjust, and verify times will be calculated. However, if you would like to set these values directly, enter the time in minutes and select the User Set Value checkbox for that value.

The screenshot shows the 'RMT Maintainability Information' window for 'Current End Item: WS2'. The 'Part Info.' tab is selected. The window displays the following information:

Part Type: NOT DEFINED View Scenario Definition Use Scenario

CAGE	Reference Number	Item Name
99999	MC-FWA-4X44T	WHEEL ASSY,FRONT

End Item	LSA Control Number (LCN)	ALC	Type
WS2	BIKE07	00	P

Failure Rate Method: MIL-HDBK-217F, NOTICE 2
Scenario: SCENARIO 1

Preventative Maintenance Interval	User Set Value	Man Hours
Preventive Maintenance Time	<input type="checkbox"/>	0
Remove Time	<input type="checkbox"/>	0.0216666
Repair Time	<input type="checkbox"/>	0
Replace Time	<input type="checkbox"/>	0.0483333
Disassembly Time	<input type="checkbox"/>	0.04
Reassembly Time	<input type="checkbox"/>	0.05
Fault Detection/Inspection Time	<input type="checkbox"/>	0.108333
Align and Adjust Time	<input type="checkbox"/>	0
Verify Time	<input type="checkbox"/>	0
Admin and Logistics Delay Time	<input type="checkbox"/>	
K Factor		1

Comments:

Records: 1

Figure 3-26. Maintainability Information.

- 10) Enter Preventive Maintenance Interval, Admin/Logistics Delay Time, K Factor and Comments as needed.
- 11) To see the details of this or other maintainability scenarios, click the View Scenario Definition check box. To use a different scenario, select that scenario in the screen shown after clicking the check box, then click the Use Scenario check box.
- 12) Choose the Tasks tab, and enter the task code, task type, task ID, and the man hours required to perform that task if desired (Figure 3-27).
- 13) Choose the Subtask tab.

Note: The task times can be different for the first and subsequent actions.

- 14) Enter the remove, replace, or judgment times as appropriate.

RMT Maintainability Information Current End Item: WS2

Part Info. Testability **Tasks** Subtasks Narrative Predictions Prediction Cases

Use Task Code Create/Modify Window

CAGE	Reference Number	Item Name
99999	MC-FWA-4X44T	WHEEL ASSY,FRONT
End Item	LSA Control Number (LCN)	ALC Type
WWS2	BIKE07	00 P
Failure Rate Method		MIL-HDBK-217F, NOTICE 2
Scenario		SCENARIO 1
Task Code	NGCOEAA	
Task Type	Corrective	
Task ID	INSTALL WHEEL ASSEMBLY	
Task Man Hours		
Task Code	NGCOEAA	
Task Type	Corrective	
Task ID	REMEDY PUNCTURE CAUSE	
Task Man Hours		
Task Code	RGCOEAA	
Task Type	Corrective	
Task ID	REMOVE WHEEL ASSEMBLY	
Task Man Hours		

Records: 5

Figure 3-27. Tasks Information.

Note: As a general rule, if the task function is a removal-type or replace-type task, it will require the remove time or replace time as appropriate. In these cases, the judgment time is also used to add time for these tasks if performing them required extra time due to any combination of factors

such as skill level, access, etc. For tasks that do not logically require remove and replace (e.g. “lubricate”), use the judgment time exclusively. These functions as well as further guidance for selecting which time to enter are found in Table 4.

The task times are related to the task function, not the subtask function. While this may seem counterintuitive, consider what happens when those subtasks have actual tasks created for them. Once the subtask is defined as a task, all of that task’s subtask remove/replace/judgment times add to that task function’s time.

- 15) If desired, you can view a library of remove/replace/judgment times by choosing the “View Standard Remove/Replace Times.” If one is suitable, choose it and click OK.
- 16) Enter the Artwork ID, Artwork Size, and Personnel Required if needed.
- 17) The Narrative Tab can be used to enter narrative for the subtasks.
- 18) After completing all tasks and subtasks in this manner, you are ready to check for completeness. Right click on the system level assembly and click on Maintainability Scenario Checks And Calculations>>Check Scenario Data For Completeness.
- 19) If you are satisfied with the results, then maintainability is ready to be calculated. Right click on the system level assembly and choose Maintainability Scenario Checks And Calculations>>Perform Scenario Calculations.
- 20) The rolled-up times should now be visible in the Part Info. Tab of the Maintainability tool.

Task Code Functions (2B)				
Code	Function	Used in	Columns used in TASKB	C/U/P
W	Access	Not used		
D	Adjust	Align/Adjust time	JUDTMEFT	C/U/P
E	Align	Align/Adjust time	JUDTMEFT	C/U/P
F	Calibrate	Not used		
9	Camouflage	Not used		
Q	Clean	PM Only	JUDTMEFT	U/P
2	Debug	Not used		
S	Disassemble/Assemble	Disassembly/Assembly time	RMVTMEFT for disassembly, RPLTMEFT for assembly	C/U/P
3	Dispose	Not used		
Z	End of Runway Inspection	Not used		
8	Evaluate	Not used		
N	Fault Location	FDI time	JUDTMEFT	C/U/P
A	Inspect	Not used		
G	Install	Replace time	RPLTMEFT, RPLTMEOT	C/U/P
4	Load/Unload	Not used		
P	Lubricate	PM Only	JUDTMEFT	U/P
M	Mission Profile Change	Not used		
6	Monitor	Not used		
O	Operate	Not used		
K	Overhaul	Not used		
U	Package/Unpackage	Not used		
V	Preserve	Not used		
7	Process	Not used		
L	Rebuild	Not used		
R	Remove	Remove time	RMVTMEFT, RMVTMEOT	C/U/P
H	Remove/Replace	Remove time/Replace time	RMVTMEFT, RMVTMEOT for remove, RPLTMEFT, RPLTMEOT for replace	C/U/P
J	Repair	Repair time	JUDTMEFT	C
C	Service	PM Only	JUDTMEFT	U/P
5	Set Up	Not used		
B	Test	Verify time	JUDTMEFT	C/U/P
Y	Transport	Not used		
T	Transportation Preparation	Not used		

Table 4. Task Code Functions.

3.5.2 PROCEDURE II PREDICTIONS

1. To make a Procedure II Prediction, first initialize the Procedure II prediction by right clicking on the system level assembly and clicking on Initialize Maintainability With Procedure II Prediction Records. You will then be presented with scenario choice box. Choose a scenario and click OK. You are then prompted to enter the Procedure II Prediction data, specifically the Prediction Name and the Prediction Date.
2. If desired, you can check the data for completeness. Right click on the system level assembly and click on Maintainability Procedure II Checks And Calculations>>Check Procedure II Data For Completeness.
3. If you are satisfied with the results, calculate the Procedure II prediction. Right click on the system level assembly and click on Maintainability Procedure II Checks And Calculations>>Perform Procedure II Prediction Calculations.
4. The results will be visible under the Predictions tab of the Maintainability Tool.

3.5.3 PROCEDURE V PREDICTIONS

1. To make a Procedure V Prediction, first initialize the Procedure V prediction by right clicking on the system level assembly and clicking on Initialize Maintainability With Procedure V Prediction Records. You will then be presented with scenario choice box. Choose a scenario and click OK, then choose a prediction and click OK. You are then prompted to enter the Procedure V Case data, specifically the Case Name and Case Description.
2. If desired, you can check the data for completeness. Right click on the system level assembly and click on Maintainability Procedure V Checks And Calculations>>Check Procedure V Data For Completeness.
3. If you are satisfied with the results, calculate the Procedure V prediction. Right click on the system level assembly and click on Maintainability Procedure V Checks And Calculations>>Perform Procedure V Prediction Calculations.
4. The results will be visible under the Prediction Cases tab of the Maintainability Tool.

SECTION 4



PHASE III CREATE NEW PRODUCTION LSAR

SECTION 4 PHASE III CREATE NEW PRODUCTION LSAR

4.0 INTRODUCTION

Briefly recall the three-stage process that the RMT data follows. Initially, the data comes from a standard LSAR (Phase I), from which a minimum of tables are removed to establish the product structure in Phase II. In Phase II, several supporting tables (Z-tables) are constructed and populated, enabling one to utilize the built-in toolkits to complete the reliability, FMECA, testability, and maintainability predictions. Once they are complete, they are ready for migration to Phase III, a new production LSAR. In Phase III, the supporting tables for toolkits are removed, and the data that comes from them are presented in the corresponding LSAR tables.

Some of the tables within the EAGLE LSAR are subject to automatic recalculation when a related item changes. For example, if a part failure rate were changed in Table BD, it would trigger an automatic update of the Engineering Failure Mode Mean Time Between Failure (Table BF). However, this would not be acceptable behavior for the LSAR population, since the data migrates record by record. Thus, the EAGLE automatic calculations are disabled while the new LSAR is populated, then reenabled.

Note: It is important to remember that once the LSAR is populated, any changes to the RAM data will trigger the EAGLE automatic calculations and change any related fields.

4.1 CREATE NEW LSAR

STEP To populate the LSAR:

Note: This function can only be performed by the Database Administrator.

- 1) Make sure correct End Item is selected. To view available End Items, click on the End Item icon located on the Main Toolbar. Select End Item and click OK.
- 2) Access the RMT Manager.
- 3) Click on the expand icon located to the left of the Project End Item.
- 4) Click on the desired Item Name.
- 5) Right click on the highlighted Item Name.
- 6) Click on Populate LSAR (Figure 4-1).
- 7) If new End Item has been established, select this End Item from the New LSAR End Item drop down list box; If not, enter End Item in the New LSAR End Item drop down list box.

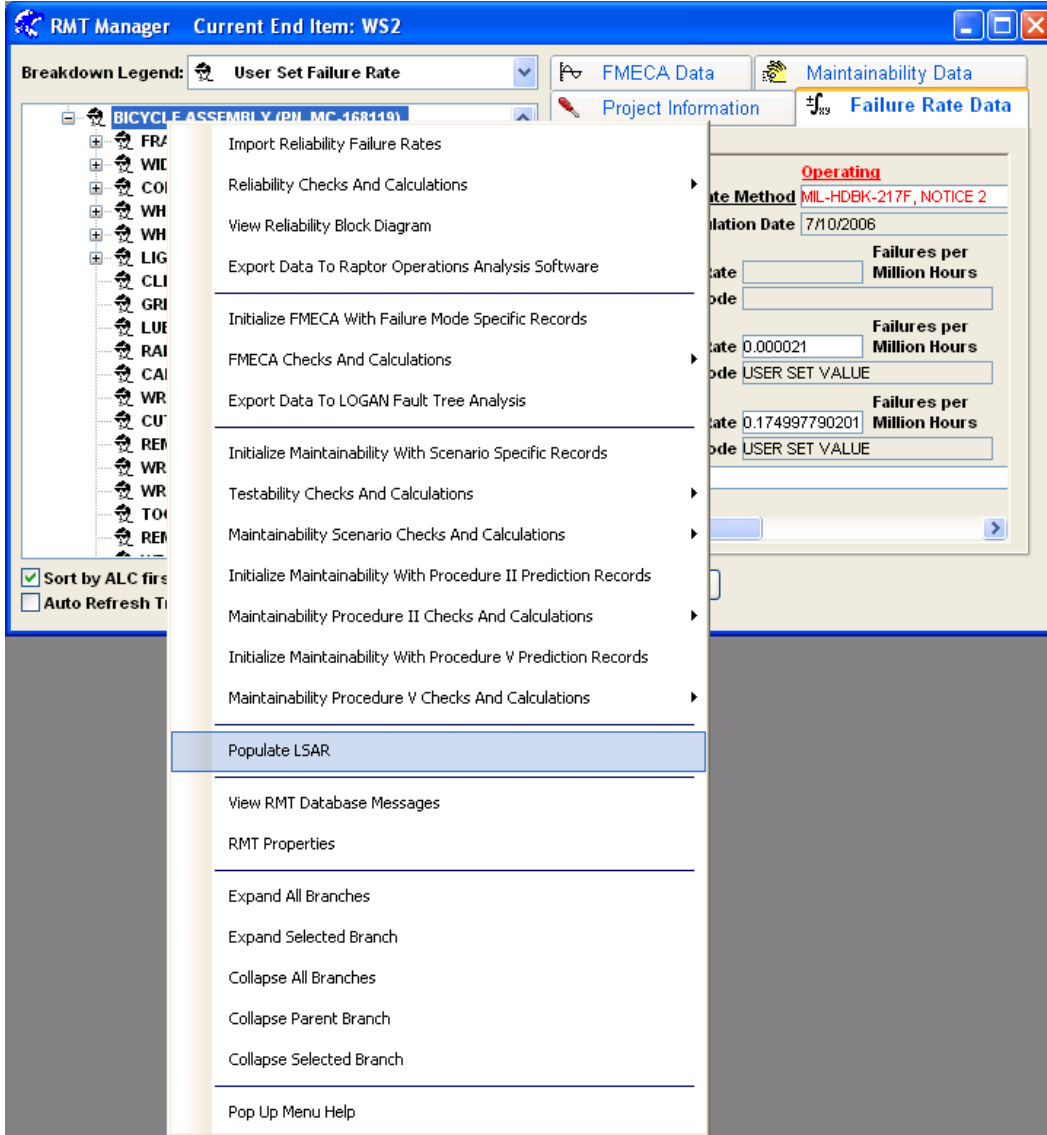


Figure 4-1. Populate LSAR

- 8) Utilize the Browse Button to select Parameter File.
- 9) Enter data in the eight (8) text boxes utilizing the drop down lists (Figure 4-2).
- 10) Click on the Populate LSAR Button.
- 11) Click Done.

Populate LSAR Current End Item: WS2

Source End Item	New LSAR End Item
WS2	
Parameter File: <input type="button" value="Browse"/>	C:\Program Files\RSC\EAGLE 2B Oracl
Service Designator Code:	
RCM Analysis Logic Used:	MIL-HDBK-217F, NOTICE 2
Operating Req. Indicator:	
Minimum Equipment List:	
Failure Rate Data Source:	
Failure Mode Function:	
Mission Phase:	
Maintainability Scenario:	
Scenario Prediction:	
Security Clearance Reqd:	

Figure 4-2. Parameter File

SECTION 5



PHASE IV ARCHIVAL AND DISPOSITION

SECTION 5 PHASE IV ARCHIVAL AND DISPOSITION

5.0 INTRODUCTION

After Phase III is complete, the data exists as a production LSAR. At this point, the RMT system no longer requires the use of the Phase II data, and it should be archived via the Full File utility with the "EAGLE Data Tables" option selected. In this manner, the data will be preserved for future use if it were required for future projects or to recover from data loss. If necessary, the data can then be removed from the server.



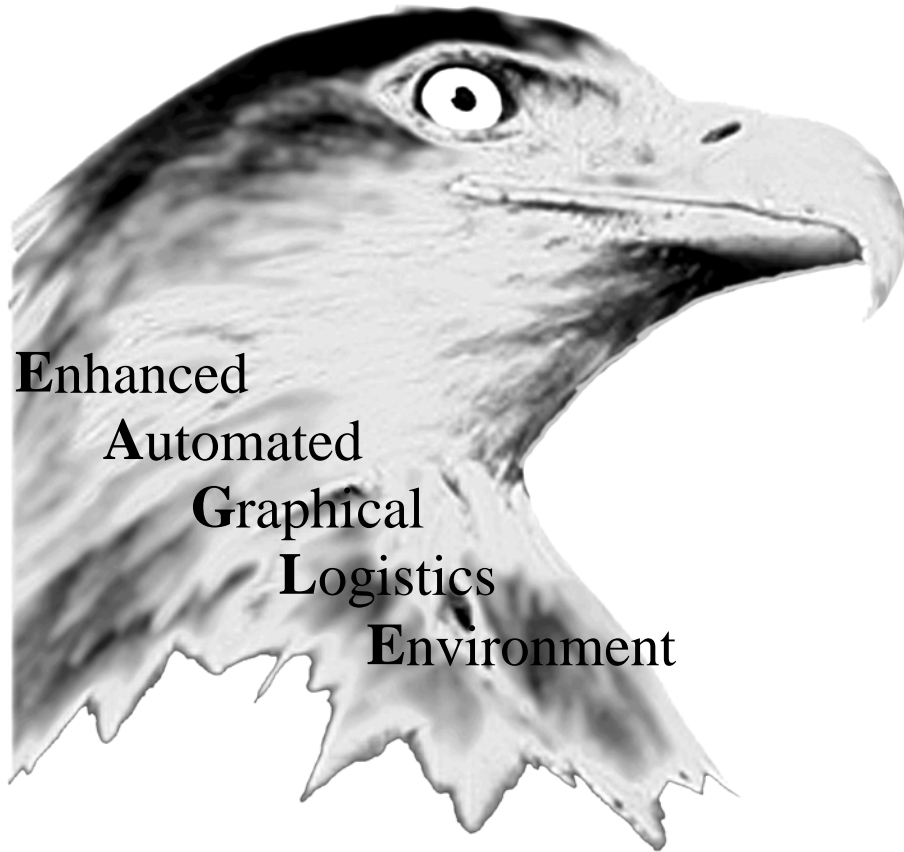
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NOTES



**Enhanced
Automated
Graphical
Logistics
Environment**

Technical support is provided by the EAGLE Team of Raytheon Company. Phone support is available Monday through Friday from 8:00 a.m. to 4:30 p.m. Mountain Standard Time. EAGLE technical support personnel can be reached at (520) 663-6673. Training on the EAGLE product is available.

Are you ready for EAGLE? Join Team EAGLE and find out what it's like to soar. Give your logistics software product the EAGLE advantage. For more information on becoming part of Team EAGLE, contact:

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