MIL-STD-1629A
Notice 1
7 June 1983

MILITARY STANDARD

PROCEDURES FOR PERFORMING
A FAILURE MODE
EFFECTS AND CRITICALITY ANALYSIS

To all holders of MIL-STD-1629A

1. The following pages of MIL-STD-1629A have been revised and supersede the pages listed:

New Page	Date	Superseded Page	Date
v	24 November 1980	v	Reprinted w/o change
vi	7 June 1983	vi	24 November 1980
1	24 November 1980	1	Reprinted w/o change
2	7 June 1983	2	24 November 1980
103-1 thru 103-3	7 June 1983	103-1 thru 103-3	24 November 1980
103-4	7 June 1983	New	
A-3	7 June 1983	A-3	24 November 1980
A-4	7 June 1983	A-4	24 November 1980

2. Make the following pen and ink changes:

a. Page 105-1, paragraph 2, change title of MIL-STD-2080 to "Maintenance Engineering Planning and Analysis for Aeronautical Systems, Subsystems, Equipment and Support Equipment."

b. Page 105-3, paragraph 3.6, line 2, change "PORGRAM" to "PROGRAM."

c. Page A-6, paragraph 50.7, line that starts with "For α_2: add parenthesis before β.

3. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

4. Holders of MIL-STD-1629A will verify that the page changes indicated herein have been entered. This notice will be retained as a check sheet. This issuance is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or canceled.

Custodians:
Army - CR
Air Force - 17

Review Activities:
Navy - SH, OS
Army - EA, AR

Preparing Activity:
Navy - AS
(Project No. RELI-0037)

CONTENTS (Continued)

FIGURES

CONTENTS (Continued)

1. SCOPE

1.1 Scope. This standard establishes requirements and procedures for performing a failure mode, effects, and criticality analysis (FMECA) to systematically evaluate and document, by item failure mode analysis, the potential impact of each functional or hardware failure on mission success, personnel and system safety, system performance, maintainability, and maintenance requirements. Each potential failure is ranked by the severity of its effect in order that appropriate corrective actions may be taken to eliminate or control the high risk items.

1.2 Application. This standard applies to the acquisition of all designated DoD systems and equipment. It primarily applies to the program activity phases of demonstration and validation and full-scale engineering development; e.g., design, research and development, and test and evaluation. This standard also can be used during production and deployment to analyze the final hardware design or any major modifications. The FMECA tasks contained in this standard apply to all items of equipment. This standard does not apply to software. Appendix A contains additional application and tailoring guidelines.

1.3 Numbering system. The tasks are numbered sequentially as they are introduced into this standard with the first task being number 101.

1.4 Revisions.

1.4.1 Standard. Any general revision of this standard which results in a revision of sections 1, 2, 3, or 4 will be indicated by revision letter after this standard number, together with date of revision.

1.4.2 Tasks. Any revisions of FMECA tasks are indicated by a letter following the task. For example, for task 101, the first revision is 101A, the second revision is 101B. When the basic document is revised, those requirements not affected by change retain their existing date.

1.5 Method of reference. The tasks contained herein shall be referenced by specifying:

a. This standard number.

b. Task number(s).

c. Other data as called for in individual task.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bid or request for proposal, are referenced in this standard for information and guidance.

SPECIFICATIONS

Military

MIL-M-24100	Manual, Technical; Functionally Oriented Maintenance Manuals for Systems and Equipment

STANDARDS

Military

MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models and Related Terms
MIL-STD-470	Maintainability Program Requirements (for Systems and Equipment)
MIL-STD-721	Definitions of Terms for Reliability and Maintainabilit
MIL-STD-756	Reliability Prediction
MIL-STD-780	Work Unit Codes for Aeronautical Equipment; Uniform Numbering System
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-882	System Safety Program Requirements
MIL-STD-1388	Logistics Support Analysis
MIL-STD-1591	On Aircraft, Fault Diagnosis, Subsystems, Analysis/Synthesis of
MIL-STD-2072	Survivability, Aircraft; Establishment and Conduct of Programs for
MIL-STD-2080	Maintenance Engineering, Planning, and Analysis the for Aeronautical Systems, Subsystems, Equipment and Support Equipment

HANDBOOKS

Military

MIL-HDBK-217	Reliability Prediction of Electronic EquipBent
MIL-HDBK-266	Application of Reliability Centered Maintenance to Naval Aircraft, Weapon Systems and Support Equipment

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

TASK 103

FMECA - MAINTAINABILITY INFORMATION

1. Purpose. FMECA-maintainability information supplies early criteria for Maintenance Planning Analysis (MPA), Logistic Support Analysis (LSA), test planning, inspection and checkout requirements, and identifies maintainability design features that require corrective action, and supplies information for the Reliability-Centered Maintenance (RCM) process required by MIL-HDBK-266(AS).

1.1 Application. The FMECA maintainability information requires data from the FMEA Task 101. Task 103 shall not be done without first doing Task 101.

1.2 Planning. Planning for the FMECA - maintainability information analysis includes the contractor's procedures for assuring the coincident use of this analysis when logistic support analysis in accordance with MIL-STD-1388, the maintenance planning analysis in accordance with MIL-STD-2080(AS), and maintainability analysis in accordance with MIL-STD-470 are required by contract.

2. Documents Referenced in Task 103:

STANDARDS

Military

MIL-STD-470	Maintainability program requirements (for systems and equipment)
MIL-STD-1388	Logistics Support Analysis
MIL-STD-2080(AS)	Maintenance Engineering, Planning and Analysis for Aeronautical Systems, Subsystems, Equipment and Support Equipment

HANDBOOKS

MIL-HDBK-266(AS)	Application of Reliability-Centered Maintenance in Naval Aircraft, Weapon Systems and Support Equipment

3. FMECA - Maintainability Information Worksheet. Maintainability information is documented on the approved FMECA - maintainability worksheet. Figure 103.1 is a sample worksheet. Complete worksheets will be included in the FMECA report, General Requirements, 4.5, following the FMEA worksheet for the same indenture level. The following information can be found and copied from the FMEA worksheet:

a. Item Identification Number

b. Item Nomenclature

c. Function

d. Functional Failure (Failure Mode (Task 101))

e. Engineering Failure Mode (Failure Causes (Task 101))

f. Failure Effects (local, next higher level, end)

g. Severity Class

h. Mission Phase

3.1 System/Subsystem Description. Provide a concise description of the sytem or subsystem in terms of its general function and major assemblies or components.

3.2 Compensating provisions. This entry shall specifically address redundancies and protective features in relation to functions and functional failures. An item is considered redundant if its purpose is to duplicate the function of another item. Also list the protective or warning devices, or fail-safe design, that act to mitigate serious consequences upon failure of a critical item.

3.3 Functions. Functions and subfunctions should be transferred from Task 101 worksheets. A number shall be placed in the small column next to each function. The first function will be numbered 1, the second 2, and so on.

3.4 Functional Failures. Record the functional failure (failure mode from Task 101). Functional failures shall be lettered alphabetically beginning with "A". Note that a function may have more than one functional failure (failure mode, Task 101).

3.5 Engineering Failure Mode. Record the engineering failure modes (failure causes from Task 101). Engineering failure modes shall be numbered beginning with "1". Note that a functional failure may have more than one engineering failure mode (failure cause, Task 101).

3.6 Minimum Equipment List. Specify if the aircraft or end item of equipment can be dispatched on its assigned mission with the analysis item inoperative. If the answer is "yes", specify any limitation.

3.7 Failure Detection Method. A description of the methods by which occurrence of a specific functional failure (failure mode) is detected and localized by the operator or maintainance technician shall be recorded. Describe the warning devices, if applicable, and other indications which make evident to the operator or technician that an item has malfunctioned or failed. If no indication exists, state whether or not the undetected failure will jeopardize the mission objectives or personnel safety, and if the undetected failure allows the item to remain operational in a safe state, a second failure situation shall be explored to determine whether or not an indication will be evident to the operator or maintenance technician. Proper correlation of an item malfunction or failure may require identification of normal, abnormal and incorrect indications. Normal indications are those that are evident to an operator or maintenance technician when the item is operating normally. Incorrect indications are those that are evident to the operator or maintenance technician when the item has malfunctioned or failed.

3.8 Engineering Failure Mode MTBF and Remarks. Calculate and provide MTBF data for each engineering failure mode (failure cause) developed as part of Task 101. Also include any remarks pertaining to and clarifying any other columns. Notes regarding recommendations for design improvements shall be recorded and further amplified in the FMECA report, General Requirements, 4.5.

3.9 Ordering Data. The following details shall be specified in the appropriate contractual documents:

a. Task 101 (see 1.1 of Task 103)

b. DI-R-7085

c. DI-R-7086

d. The Statement of Work

e. Other requirements as necessary for tailoring.

FAILURE MODE EFFECTS AND CRITICALITY ANALYSIS - MAINTAINABILITY INFORMATION

SYSTEM/SUBSYSTEM NOMENCLATURE		SYSTEM IDENTIFICATION NUMBER	DATE:	PREPARED BY:
INDENTURE LEVEL	REFERENCE DRAWING	MISSION	SHEET ___ OF ___	APPROVED BY:
SYSTEM/SUBSYSTEM DESCRIPTION			COMPENSATING PROVISIONS	

ITEM IDENT NO.	ITEM NOMENCLATURE	FUNCTION NO.	FUNCTIONAL FAILURE LTR	ENGINEERING FAILURE MODE NO.	MISSION PHASE	FAILURE EFFECTS: LOCAL EFFECTS	FAILURE EFFECTS: NEXT HIGHER LEVEL	FAILURE EFFECTS: END EFFECTS	FAILURE DETECTION METHOD	SEVERITY CLASS	MINIMUM EQUIPMENT LIST	ENGINEERING FAILURE MODE MTBF AND REMARKS

FIGURE 103.1 Example of FMECA - maintainability information worksheet format.

50.1.3 Intended use. The FMECA is potentially one of the most beneficial and productive tasks in a well structured reliability program. Since individual failure modes are listed in an orderly, organized fashion and evaluated, the FMECA serves to verify design integrity, identify and quantify sources of undesirable failure modes, and document the reliability risks. FMECA results can be used to provide the rationale for changes in operating procedures for ameliorating the effects or for detecting the incipience of the undesirable failure modes. Although the FMECA is an essential reliability task, it supplements and supports other engineering tasks through identification of areas in which effort should be concentrated. The FMECA results are not only used to provide design guidance, but they are used advantageously in and for maintenance planning analysis, logistics support analysis, survivability and vulnerability assessments, safety and hazards analyses, and for fault detection and isolation design. This coincident use of the FMECA must be considered in FMECA planning and every endeavor made to prevent duplication of effort by the program elements which utilize FMECA results.

50.2 FMEA (Task 101). The FMEA is an essential design evaluation procedure which should not be limited to the phase traditionally thought of as the design phase. The initial FMEA should be done early in the conceptual phase when design criteria, mission requirements, and conceptual designs are being developed to evaluate the design approach and to compare the benefits of competing design configurations. The FMEA will provide quick visibility of the more obvious failure modes and identify potential single failure points, some of which can be eliminated with minimal design effort. As the mission and design definitions become more refined, the FMEA can be expanded to successively more detailed levels. When changes are made in system design to remove or reduce the impact of the identified failure modes, the FMEA must be repeated for the redesigned portions to ensure that all predictable failure modes in the new design are considered.

50.3 CA (Task 102). The CA is a procedure for associating failure probabilities with each failure mode. Since the CA supplements the FMEA and is dependent upon information developed in that analysis, it should not be imposed without imposition of the FMEA. The CA is probably most valuable for maintenance and logistics support oriented analyses since failure modes which have a high probability of occurrence (high criticality numbers) require investigation to identify changes which will reduce the potential impact on the maintenance and logistic support requirements for the system. Since the criticality numbers are established based upon subjective judgments, they should only be used as indicators of relative priorities.

50.4 FMECA-maintainability information (Task 103). This analysis is an extension of the FMECA and is dependent upon FMEA generated information; therefore, the FMECA- maintainability information analyses should not be imposed without imposition of the FMEA. The identification of how each failure will be detected and localized will provide information for evaluating item testability. The failure mode listing which is included on the completed worksheet should be utilized to provide this required data for logistics support analyses (LSA), maintenance plan analysis (MPA), and reliability centered maintenance (RCM).

50.5 DMEA (Task 104). The DMEA provides essential inputs for the vulnerability assessment of a weapon system to aid in the identification of deficiencies and the evaluation of designs for enhancing survivability. Since the DMEA utilizes the failure mode information from the FMEA, it should not be imposed without imposition of the FMEA. The DMEA, like the initial FMEA, should be done early in the conceptual phase to provide data related to the capability of the conceptual weapon system design to survive the effects of the specified hostile threats. Development of this data before weapon system design configuration is finalized will provide significant survivability benefits with minimal impact on cost and schedule.

50.6 FMECA plan (Task 105). The FMECA plan provides the contractor's plans and activities for implementing the FMECA tasks. The plan is used by the procuring activity to evaluate the planned FMECA task efforts, and when approved, is used for monitoring contractor implementation of the tasks. The plan can be required as a separate document submittal or it can be included as part of the Reliability Program Plan. The FMECA plan includes a description of the contractor's procedures for implementing the tasks and provides a cross index showing the relationship of coincident performance and use of the FMEA tasks to preclude duplication of effort. Sample contractor formats used in performance of each FMECA task are included as a part of each task specified in the contract statement of work.

50.7 Criticality number (C_r) calculation example. Calculation of meaningful criticality numbers requires the use of specific failure rate and part configuration data. When part configurations are known, failure rate data can be obtained from the appropriate reliability prediction, field data from past systems of similar design and environmental use, or failure rate data sources such as MIL-HDBK-217. With known failure rates, the criticality number for an item is the number of failures of a specific type expected per million hours due to the item's failure modes under a particular severity classification as discussed in Task 101. A failure mode criticality number, C_m, for a particular severity classification is given by the expression:

$$C_m = \beta\alpha\lambda_p t \qquad (1)$$

The item criticality number, C_r, under a particular severity classification, is then calculated by summing the Cm for each failure mode under that severity classification. This summation is given by the expressions:

$$C_r = \sum_{n=1}^{j} (C_m)_n \quad \text{or}$$

$$C_r = \sum_{n=1}^{j} (\beta\alpha\lambda_p t \times 10^6)_n \qquad (2)$$