

1.0 INTRODUCTION

The Failure Mode, Effects and Criticality Analysis (FMECA) is a reliability evaluation/design technique which examines the potential failure modes within a system and its equipment, in order to determine the effects on equipment and system performance. Each potential failure mode is classified according to its impact on mission success and personnel/equipment safety. The FMECA is composed of two separate analyses, the Failure Mode and Effects Analysis (FMEA) and the Criticality Analysis (CA). The FMECA:

- Determines the effects of each failure mode on system performance
- Provides data for developing fault tree analysis and reliability block diagram models
- Provides a basis for identifying root failure causes and developing corrective actions
- Facilitates investigation of design alternatives to consider high reliability at the conceptual stages of the design
- Aids in developing test methods and troubleshooting techniques
- Provides a foundation for qualitative reliability, maintainability, safety and logistics analyses

The results of the FMECA:

- Highlight single point failures requiring corrective action
- Rank each failure according to the severity classification of the failure effect on mission success and personnel/equipment safety
- Provide estimates of system critical failure rates
- Provide a quantitative ranking of system and/or subsystem failure modes
- Identify reliability/safety critical components

1.1 FMECA Benefits

The FMECA facilitates identification of potential design reliability problem areas which must be eliminated or their effect minimized, by design modification or tradeoffs. Specific defects identified can include:

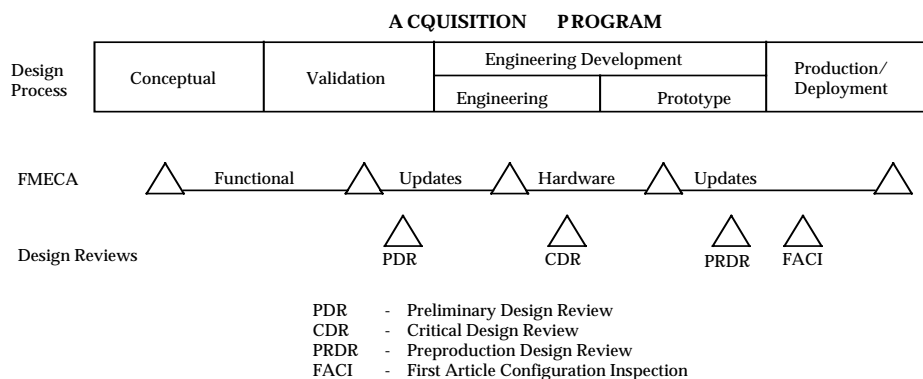
- Circuit failures that may cause the failure of a related critical circuit
- Areas where fail safe or fail soft features are required
- Primary failures which may cause costly secondary failures

Information and knowledge gained by performing the FMECA can also be used as a basis for trouble shooting activities, maintenance manual development and design of effective built-in test techniques.

The FMECA provides valuable information for maintainability, safety and logistic analysis.

1.2 FMECA Characteristics

The FMECA should be scheduled and completed concurrently as an integral part of the design process. This analysis should begin early in the conceptual phase of a design, when the design criteria, mission requirements and performance parameters are being developed. To be effective, the final design should reflect and incorporate the analysis results and recommendations. The following diagram depicts how the FMECA process should coincide with a typical acquisition program.



The results of both the functional and hardware FMECA's must be presented at each of the design reviews. The design reviews then serve as a forum to modify, correct, or update the system design.

Since the FMECA is used to support maintainability, safety and logistics analyses, it is important to coordinate the analysis to prevent duplication of effort within the same program. FMECA is an iterative process. As the design becomes mature, the FMECA must reflect the additional detail. When changes are made to the design, FMECA must be performed on the redesigned sections. This ensures that the potential failure modes of the revised hardware will be addressed. If the FMECA is performed correctly, it becomes an important tool for making program decisions regarding trade-offs affecting design integrity.

The FMECA can be performed by a cognizant design engineer, reliability engineer, independent evaluator, or combination of the above, having a thorough understanding of the operation and application of the system being analyzed. The analysts then feed back appropriate data gained from the FMECA into the design process to drive effective and timely corrective action implementation.

1.3 FMECA Guidelines

A number of government standards require the performance of a FMEA or FMECA. These include:

MIL-STD-785, "Reliability Program for Systems and Equipment Development and Production," This standard imposes the requirement to perform Task 204, "Failure Mode, Effects and Criticality Analysis." It gives guidance as to when the task is to be performed and to what depth it should be done. It does not dictate how the analysis is to be performed.

MIL-STD-1543, "Reliability Program Requirements for Space and Launch Vehicles," This document is similar in many respects to MIL-STD-785. It also imposes the requirement to perform Task 204, "Failure Mode, Effects and Criticality Analysis." It gives guidance as to when the task is to be performed and to what depth it should be done but does not dictate how the analysis is to be performed.

NASA NHB 5300.4, "Reliability Program Provisions for Aeronautical and Space Contractors," This document is similar in some respects to MIL-STD-785. It imposes the requirement to perform an FMECA and gives guidance as to when the task is to be performed and to what depth it should be done but it does not dictate how the analysis is to be performed.

There are many published papers, especially those found in the Annual Reliability and Maintainability Symposium Proceedings, suggesting various unique approaches to FMECA. A comprehensive bibliographic listing of such papers may be found in Appendix B. The vast majority of FMEAs and FMECAs performed today are generally performed in accordance with MIL-STD-1629, "Procedure for Performing a Failure Mode, Effects and Criticality Analysis." Nevertheless, there are currently two other generally recognized FMEA/FMECA guideline documents which may be of interest to the reader. They are:

- 1) **IEEE Std 352-1975/ANSI N411.4 1976, "IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems,"** provides a detailed example of an FMEA is given in Section 8 of this document.
- 2) **SAE G-11, "Reliability, Maintainability and Supportability Guidebook,"** closely parallels the techniques found in MIL-STD-1629.

1.4 Scope

The procedures called out in MIL-STD-1629A are the most widely accepted methods throughout the military and commercial industry. The primary objective of this document is to educate the reader on the analytical techniques and guidelines for performing a FMECA according to the methods described in MIL-STD-1629. These guidelines may be tailored to meet specific customer needs.