DATA ITEM DESCRIPTION

Title: FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS REPORT

Number: DI-SESS-81495A
AMSC Number: 9507
DTIC Applicable: Yes
http://www.dtic.mil/dtic/submit
Preparing Activity: AS
Applicable Forms: N/A

Approval Date: 20141219
Limitation: No
GIDEP Applicable: Yes
http://www.gidep.org/data/submit.htm

Use/relationship:

The Failure Modes, Effects, and Criticality Analysis (FMECA) Report provides an analysis of independent single item failures and the resulting potential impact on mission success, performance, safety, and maintainability. This analysis is intended to promote design corrective actions by identifying potential failure risk and maintainability issues in order that appropriate corrective actions may be taken early to eliminate or control high risk items to improve operational readiness and reduce life cycle cost.

This Data Item Description (DID) contains the format, intended use information, and content preparation instructions for the data product generated by the specific and discrete task described in the solicitation, and should be tailored appropriately.

This DID supersedes DI-ILSS-81495.

Requirements:

1. Format. The Failure Modes, Effects, and Criticality Analysis (FMECA) Report shall be in contractor's format.

2. Content. This report shall document the results of the FMECA, as required by the contract statement of work, and shall include:

   a. Identification of the system overview, scope, level of analysis, assumptions, summary of results, documentation of the data sources and techniques used in performing the analysis, and worksheets used during the analysis. The worksheets shall be organized to first display the highest indenture levels of the system. Sample worksheets for Failure Modes Effect Analysis (FMEA) and Criticality Analysis (CA) are shown in Figures 1 and 2, respectively.
   b. Analysis performed for all mission profile(s), under worst-case conditions, which shall document and relate all associated failure modes from the piece part (or lowest indenture level specified) through all indenture levels through the subsystem and system levels, as well as identifying severity levels (categories I through IV) for each indenture level. All single-point failure modes shall be identified, evaluated and design mitigation documented.

c. Identification of those failure modes which are detectable by Built-In-Test (BIT) and to what level they will be isolated. If failures are identified as undetectable but the failure has no effect on the mission, the consequences of a second, separate item failure shall be analyzed. For those cases in which the mission would be jeopardized by the second failure, it shall be determined whether or not a failure indication would now be evident to the operator, maintainer, or detectable by BIT. The report shall also identify failure modes that result in an out-of-tolerance condition or loss of functionality rather than a "hard" failure. The report shall identify the extent to which system monitoring and warning features will provide warning of impending failure, to facilitate corrective action during a preventive maintenance period.
d. Identification of both the preventive maintenance provisions which would minimize the probability of occurrence and the corrective maintenance features which would minimize downtime in the event of occurrence, and a description of the methodology and controls used to ensure the preventive and corrective actions are adequate.
e. Identification and description of the hardware and software design provisions for maintenance by modular replacement, indication probable adjustment requirements following repair, and identification of the first point at which the post-repair checkout can be made to verify that the maintenance action is complete.
f. A description of the impact of the FMECA analysis on design, maintenance planning/supportability, and diagnostics. Major problems detected by the analysis shall be detailed, including how the problems were resolved (e.g. design changes, etc), including impacts on safety, supportability, and diagnostics. Contractor interpretations and comments concerning the analysis and identification of the critical items list and initiated or recommended actions for control of failure risk shall be included.
g. A summary which shall include contractor conclusions and recommendations based on the analysis results and problem information included in the report.

FMEA																
Identification Number	Item/Functional Identification Nomenclature	Function Number	Function	Functional Failure Letter	Functional Failure Description	Failure Mode & Causes	Mission Phase/ Operational Mode	Failure Effects			Failure Detection Method	Isolation	Compensating Provisions (Design/Operator)	Severity Classification	Basic Maintenance Actions	Remarks
								Local Effects	Next Higher Effect	End Effect						
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q

Figure 1 – Sample FMEA Worksheet

A - A serial number or other reference designation identification number is assigned for traceability purposes.

B - The name or nomenclature of the item or system function being analyzed for failure mode and effects.

C – The first function shall be numbered 01, the second 02, and so on.

D - A concise statement of the function performed by the item including any performance standards.

E – The first functional failure shall be numbered A, the second B, and so on.

F – Ways an item can either partially (with upper and/or lower performance limits) or totally fail to perform its functions.

G - All predictable failure modes along with their most probable causes for each indenture level analyzed shall be identified and described.

H - A concise statement of the mission phase and operational mode in which the failure occurs.

I - Local effects identify the impact a failure mode has on the operation and function of the item in listed in block A.

J - Next higher level effects identify the impact an assumed failure has on the operation and function of the items in the next higher indenture level above the indenture level under consideration.

K - End effects evaluate and identify the total effect a failure has on the operation, function, or status of the uppermost system or end item and the surrounding environment.

L - A description of the methods by which occurrence of the failure mode is detected by the operator and by the maintainer at the unit level and to what indenture level they will be isolated. Describe the method by which ambiguities are resolved when more than one failure mode causes the same failure indication. Identify to what indenture level failures can be isolated by the use of BIT features and indicate when ancillary test equipment will be required for fault isolation.

M - Describe the most direct procedure that allows an operator to isolate the malfunction or failure.

N - The compensating provisions, either design provisions or operator actions, which circumvent or mitigate the effect of the failure.

O - Severity classification categories (I-IV) assigned to each failure mode, without considering compensating provisions, according to the failure effect at the uppermost system. The severity classification categories are:

Category I - Catastrophic - A failure which may cause death or system loss (i.e., aircraft, tank, missile, ship)

Category II - Critical - A failure which may cause severe injury, major property damage, or major system damage which will result in mission loss.

Category III - Marginal - A failure which may cause minor injury, minor property damage, or minor system damage which will result in delay or loss of availability or mission degradation.

Category IV - Minor - A failure not serious enough to cause injury, property, or system damage, but which results in unscheduled maintenance or repair.

P - Describe the basic actions taken by the maintainer to correct the failure.

Q - Any pertinent remarks pertaining to and clarifying any other columns or recommendations for design improvements.

Criticality Analysis													
Identification Number	Item/Functional Identification Nomenclature	Function	Failure Mode & Causes	Mission Phase/ Operational Mode	Severity Classification	Failure Probability OR Failure Rate Data Source	Failure Effect Probability (β)	Failure Mode Ratio (α)	Failure Rate (λ)	Operating Time (t)	Failure Mode Crit # $C_m = \beta\alpha\lambda t$	Item Crit # $C_r = \sum_{m=1}^{j} (\beta\alpha\lambda t)_m$	Remarks
A	B	D	G	H	O	R	S	T	U	V	W	X	Q

Figure 2 – Sample Criticality Analysis Worksheet

Columns A, B, D, G, H, O, & Q on the Criticality Analysis worksheet are copied from the FMEA worksheet.

R – Failure probability or Failure rate data source - When failure modes are assessed in terms of probability of occurrence (Levels A-E):

Level A – Frequent: High probability of occurrence that may be defined as a single failure mode probability greater than or equal to 10^{-1} of the overall probability of failure during the operating time interval.

Level B – Reasonably probable: Reasonable probability of occurrence that may be defined as a single failure mode probability of occurrence which is more than 10^{-2} but less than 10^{-1} of the overall probability of failure during the item operating time.

Level C – Occasional: Occasional probability of occurrence that may be defined as a single failure mode probability of occurrence which is more than 10^{-3} but less than 10^{-2} of the overall probability of failure during the item operating time.

Level D – Remote: Remote probability of occurrence that may be defined as a single failure mode probability of occurrence which is more than 10^{-6} but less than 10^{-3} of the overall probability of failure during the item operating time.

Level E – Extremely unlikely: Extremely unlikely may be defined as a single failure mode probability of occurrence which is less than 10^{-6} of the overall probability of failure during the item operating time.

When failure rate data are to be used in the calculation of criticality numbers (column W), the data source of the failure rates used in each calculation shall be listed. When a failure probability is listed, the remaining columns S-V are not required.

S - The conditional probability that the failure effect will result in the identified criticality classification, given that the failure mode occurs. The values represent the analyst's judgment as to the conditional probability the loss will occur and should be quantified in general accordance with the following:

Actual loss 1.0
Probable Loss > 0.10 to <1.0
Possible Loss >0 to = 0.10
No Effect = 0

T - The fraction of the part failure rate related to the particular failure mode under consideration.

U - The failure rate from the appropriate reliability prediction.

V - The operating time of the item per mission shall be derived from the system definition.

W – A relative measure of consequence of a failure mode and its frequency of occurrence.

X – A relative measure of consequence of an item failure and its frequency of occurrence.

End of DI-SESS-81495A.