FME(C)A Handout

What is FME(C)A and what are the benefits?

- Failure Mode and Effects Analysis (FMEA) and Failure Mode, Effects and Critically Analysis (FMECA)
- Methodologies which are designed to help you systematically and rigorously study your system and the environment it is interacting with.
- Helps you to recognize and address vulnerabilities in your system.
- Helps you to identify potential failures in your system, causes and effects of these failures and the actions you possibly can take to mitigate these risks...
- Helps you to improve product/process reliability and quality
- Helps you to early identification and elimination of potential product/process failure modes
- Helps you to prioritize product/process deficiencies

When to do FME(C)A?

- Before the design has been complete, both design of the product and design of the process

FMEA Procedure

The process for conducting an FMEA is straightforward. The basic steps are outlined below.

1. Review documents of your system (requirements, goals, system description, etc). A clear understanding of the system under consideration is important.
2. Identify your system, sub-systems, components and etc. You can use Functional Block Diagram for this purpose. The diagram shows the logical relationships of components and establishes a structure around which the FMEA can be developed.
3. Begin listing items or functions in the FMEA worksheet as described:

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) Of Failure	Occur	Current Design Controls		Detec	RPN	Recommended Actions	Response & Target Complete Date	Action Results				
							Prevent	Detect					Action Taken	SEV	OCC	DET	RPN

(1) Function: Function should be written clearly and must be precise so there is no change of misinterpretation.

EXAMPLES
– HVAC system must defog windows and heat or cool cabin to 70 degrees in all operating conditions (-40 degrees to 100 degrees)

(2) Failure Mode: Failure modes be written clearly and must be precise so there is no change of misinterpretation.

There are 5 types of failure modes:
– complete failure,
– partial failure,
– intermittent failure,
– function out of specification
– unintended function

EXAMPLES
– HVAC system does not heat vehicle or defog windows
– HVAC system takes more than 5 minutes to heat vehicle
– HVAC system does heat cabin to 70 degrees in below zero temperatures
– HVAC system cools cabin to 50 degrees
– HVAC system activates rear window defogger

(3) Effect(s) of Failure: Describe the effects of those failure modes. For each failure mode identified the engineer should determine what the ultimate effect will be. A failure effect is defined as the effect of a failure mode on the product/process function as perceived by the customer.

EXAMPLES
– Cannot see out of front window
– Air conditioner makes cab too cold
– Does not get warm enough
– Takes too long to heat up

(4) Sev: Establish a numerical ranking for the severity of the effect. A common industry standard scale uses 1 to represent no effect and 10 to indicate very severe with failure affecting system operation and safety without warning.

If severity is based upon internally defined criteria or is based upon standard with specification modifications, a reference to rating tables with explanation for use must be included in FMEA

EXAMPLES
– Cannot see out of front window – severity 9
– Air conditioner makes cab too cold – severity 5
– Does not get warm enough – severity 5
– Takes too long to heat up – severity 4

(5) Class:

Classification of Failures According To Occurrence (MIL-STD 1629A)

Level	Occurrence	Probability
A	Frequent	p>0.2
B	Reasonable Probable	0.10>p>0.2
C	Occasional Probability	0.01>p>0.10
D	Remote Probability	0.001>p>0.1
E	Extremely unlikely Probability	P<0.001

(6) Cause(s) of Failure: Identify the causes for each failure mode. A failure cause is defined as a design weakness that may result in a failure.

EXAMPLES
– Incorrect location of vents
– Incorrect routing of vent hoses (too close to heat source)
– Inadequate coolant capacity for application

(7) Occur:

Occur	Description
10	>=50% (1 in two)
9	>=25% (1 in four)
8	>=10% (1 in ten)
7	>=5% (1 in twenty)
6	>=2% (1 in fifty)
5	>=1% (1 in hundred)
4	>=0.1% (1 in thousand)
3	>=0.01% (1 in ten thousand)

2	>=0.001% (1 in four)
1	Almost Never

EXAMPLES
– Incorrect location of vents – occurrence 3
– Incorrect routing of vent hoses (too close to heat source) – occurrence 6
– Inadequate coolant capacity for application – occurrence 2

(8) Current Design Control: Identify Current Controls (design or process). Current Controls (design or process) are the mechanisms that prevent the cause of the failure mode from occurring or which detect the failure before it reaches the Customer.

EXAMPLES
– Engineering specifications (P) – preventive control
– Historical data (P) – preventive control
– Functional testing (D) – detective control
– General vehicle durability (D) – detective control

(9) Detect: Determine the likelihood of Detection. It is rated relatively scaled from 1-10.

EXAMPLE:
– Engineering specifications – no detection value
– Historical data – no detection value
– Functional testing – detection 3
– General vehicle durability – detection 5

(10) RPN: RPN = Severity rating X Occurrence rating X Detection rating
–The RPN can range from a low of 1 to a high of 1,000 (Higher RPN higher priority to be improved.)

EXAMPLE
– Cannot see out of front window – severity 9,
– incorrect vent location – occurrence 2,
– Functional testing – detection 3,
– RPN – 54

(11) Recommended Action: All critical or significant characteristics must have recommended actions associated with them.

(12) Responsibility & Target Completion Date: All recommended actions must have a person assigned responsibility for completion of the action.

(13) Action Results: Action taken must detail what actions occurred, and the results of those Actions.