Available Online http://www.ijncse.com

ISSN Online: 2395-7018
Special issue ,March, 1-9

INTERNATIONAL JOURNAL OF NANO CORROSION SCIENCE AND ENGINEERING

FAILURE MODE AND EFFECT ANALYSIS IN HEAVY EQUIPMENT MANAGEMANT

S.Ananda murugan
M.E II[nd] Year Construction engineering & Management
Guide: Miss.S.Shaya leji
Assistant Professor
Dept. of Civil Engineering
Christian College of Engineering and Technology
Dindigul
sanandamurugan@gmail.com

Abstract

Failure Mode and Effects Analysis (FMEA) are designed to identify potential failure modes for a product or process, to assess the risk associated with those failure modes. The Failure Modes, Effects and Criticality Analysis (FMEA) procedure is a tool that has been adapted in many different ways for many different purposes. It can contribute to improved designs for products and processes, resulting in higher reliability, better quality, increased safety, enhanced customer satisfaction and reduced costs. The RPN is an optional step that can be used to help priorities failure modes for action. It is calculated for each failure mode by multiplying the numerical ratings of the severity, probability and occurrence and the probability of detection. The failure modes that have the greatest RPN receive priority for corrective action. The RPN should not firmly dictate priority as some failure modes may warrant immediate action although their RPN may not rank among the highest. Actions to resolve failures may take the form of design improvements, changes in component selection, the inclusion of redundancy in the design, or incorporation design for safety aspects. In this project the potential failure mode, potential effect of failure , potential cause of failure for the equipment are to be identified using RPN method of FMEA and ranking of them are to be done.

1.INTRODUCTION

Proceedings of the "International Conference on Recent Trends in Mechanical and Civil Engineering", Christian College of Engineering and Technology, Oddanchatram, India, 17-19, March, 2016.
Editors: Dr S Rajendran and Dr S Karthikeyan

1.1 GENERAL

Failure Mode and Effects Analysis (**FMEA**) was one of the first systematic techniques for failure analysis. It was developed by reliability engineers in the 1950s to study problems that might arise from malfunctions of military systems. An FMEA is often the first step of a system reliability study. It involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes, and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded in a specific FMEA worksheet.

FMEA is an essential function in design, from concept through development. Quality and reliability of products and manufacturing processes are critical to the performance of the final products. They are also important indices for meeting customer satisfaction. In order to fulfill customer requirement for quality and reliability, some actions for assuring the quality and reliability of products or processes should be taken by all engineers involved. One of the most powerful methods available for measuring the reliability of products or process is FMEA. Customers are placing increased demands on companies for high quality, reliable products. The increasing capabilities and functionality of many products are making it more difficult for manufacturers to maintain the quality and reliability. Traditionally, reliability has been achieved through extensive testing and use of techniques such as probabilistic reliability modeling. These are techniques done in the late stages of development. The challenge is to design in quality and reliability early in the development cycle.

The cause and effect diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). Causes are arranged according to their level of importance, resulting in a depiction of relationships and hierarchy of events. This can help you search for root causes, identify areas where there may be problems, and compare the relative importance of different causes.

1.2 AIM

FMEA aims to identify and prioritize possible imperfections in products and processes.

FMEA analyses :

- Potential failure modes of product or machine,
- Potential effects of failure,
- Potential causes for failure (like Material defects, Design deficiencies, Processing and manufacturing deficiencies, and Service condition etc.)
- Assesses current process controls, and
- Determines a risk priority factor.

1.3 OBJECTIVES OF FMEA

The main objectives of FMEA are to:

✓ identify the equipment or subsystem and mode of operation

- ✓ recognize potential failure modes and their causes
- ✓ evaluate the effects of each failure mode on the system
- ✓ identify measures for eliminating or reducing the risks associated with each failure mode.

REVIEW OF LITERATURE

[1] Arun Chauhan, et al., "Performance Evaluation of Casting Industry by FMEA", Vol 02, Issue 02; August-December 2011 International Journal of Mechanical Engineering Applications Research ISSN: 2249 – 6564.

Using the Failure Mode and Effect Analysis (FMEA) technique, the manufacturing technique and analyze it .Thus the various possible causes of failure and their effects along with the prevention are discussed in this work. Severity values, Occurrence number, Detection and Risk Priority Number (RPN) are some parameters, which need to be determined. The FMEA technique is applied on two products i.e. flywheel and flywheel housing of one casting industry situated in north India. For each specific product, the preventions suggested in the paper can considerably decrease the loss to the industry in terms of both money and time. Suggestions can easily help to improve the efficiency of the manufacturing processes and can also increase the productivity the casting industry.

[2] Vivek Shrouty, et al ., "Implementation of Failure Mode and Effect Analysis", Vol 2, Issue 8, February 2013 International Journal of Engineering and Innovative Technology (IJEIT).

A failure modes and effects analysis (FMEA) is a procedure in product development and operations management for analysis of potential failure modes within a system for classification by the severity and likelihood of the failures. A successful FMEA activity helps a team to identify potential failure modes based on past experience with similar products or processes, enabling the team to design those failures out of the system with the minimum of effort and resource expenditure, thereby reducing development time and costs.

[3] R.Srinivasa Moorthy, et al., "Implementation of Machinery Failure Mode and Effect Analysis in Amhara Pipe Factory", Volume-03, Issue-01, pp-57-63 American Journal of Engineering Research (AJER).

Failure Mode and Effect Analysis (FMEA) is a pro-active quality tool for evaluating potential failure modes and their causes. It helps in prioritizing the failure modes and recommends corrective measures for the avoidance of catastrophic failures and improvement of quality. In this work, an attempt has been made to implement Machinery FMEA in UPVC pipe production unit of Amhara Pipe Factory, P.L.C., Bahir Dar, Ethiopia. The failure modes and their causes were identified for each machine, the three key indices (Severity, Occurrence and Detection) we reassessed and the analysis was carried out with the help of MFMEA Worksheet. Finally, the necessary corrective actions were recommended.

[4] George Mathew, "FMEA Analysis for Reducing Breakdowns of a Sub System in the Life Care Product Manufacturing Industry", Volume 2, Issue 2, March 2013 International Journal of Engineering Science and Innovative Technology (IJESIT).

Use of Failure Mode and Effects Analysis (FMEA) for improving the reliability of sub systems in order to ensure the productivity which in turn improves the bottom line of a manufacturing industry. Thus the various possible causes of failure and their effects along with the prevention are discussed in this work. Severity values, Occurrence number, Detection and Risk Priority Number (RPN) are some parameters, which need to be determined. These are the steps taken during the design phase of the equipment life cycle to ensure that reliability requirements have been properly allocated and that a process for continuous improvement exists. The FMEA technique is applied on an automatic plastic welding machine used for the production of blood bags in a life care manufacturing company in south India. The preventions suggested in this paper can considerably decrease the loss of production hours in the industry due to the breakdown of the machine.

METHODOLOGY

3.1 FMEA PROCEDURE

The process for conducting FMEA can be divided into following steps. These steps are briefly explained as follows.

Step 1 Collect the functions of system and build a hierarchical structure. Divide the system into several subsystems, having number of components.

Step 2 Determine the failure modes of each component and its effects. Assign the severity rating (S) of each failure mode according to the respective effects on the system.

Step 3 Determine the causes of failure modes and estimate the likelihood of each failure occurring. Assign the occurrence rating (O) of each failure mode according to its likelihood of occurrence.

Step 4 List the approaches to detect the failures and evaluate the ability of system to detect the failures prior to the failures occurring. Assign the detection rating (D) of each failure mode.

Step 5 Calculate the risk priority number (RPN) and establish the priorities for attention.

Step 6 Take recommended actions to enhance the performance of system.

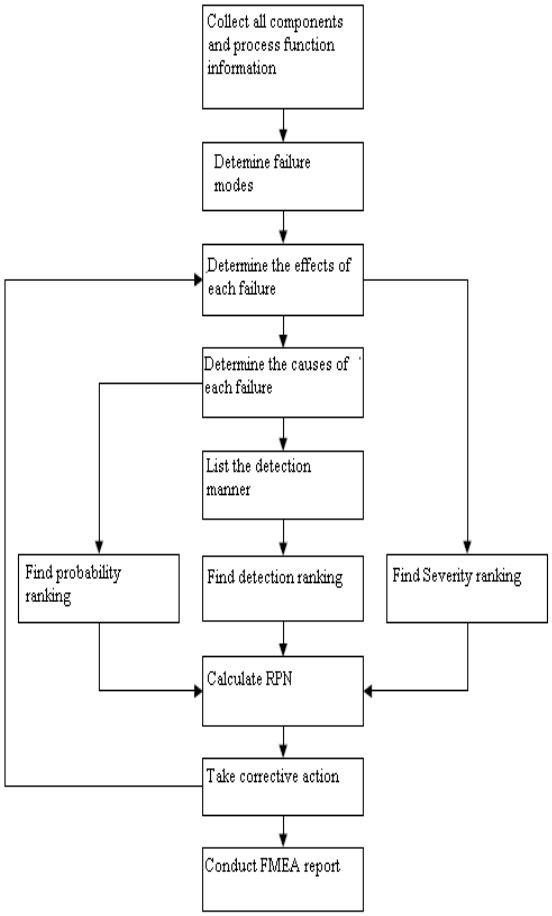
Step 7 Conduct FMEA report in a tabular form.

Figure 3.1: FMEA Procedure

3.2 SEVERITY

Determine all failure modes based on the functional requirements and their effects. Examples of failure modes are: Electrical short-circuiting, corrosion or deformation. It is important to note that

a failure mode in one component can lead to a failure mode in another component. Therefore each failure mode should be listed in technical terms and for function. After that the ultimate effect of each failure mode needs to be considered. The severity codes along with example are given in Table 3.1.



Code	Classification	Example
10	Dangerously High	Injury or Death
9	Extremely High	Regulatory non-compliance
8	Very High	In-effective service or treatment
7	High	High Customer Dissatisfaction
6	Moderate	Potential in-effectiveness
5	Low	Customer Complaints
4	Very Low	Lowered effectiveness
3	Minor	A nuisance to the customer
2	Very Minor	Not apparent, minor effect
1	None	Not apparent, no effect

Table 3.1: Severity Codes

A failure effect is defined as the result of a failure mode on the function of the system as perceived by the user. In this way, it is convenient to write these effects down in terms of what the user might see or experience. Examples of failure effects are: degraded performance, noise or even injury to a user. Each effect is given a *severity number (S)* from 1 (no danger) to 10 (dangerously high). These numbers help an engineer to prioritize the failure modes and their effects.

If the severity of an effect has a number 9 or 10, actions are considered to change the design by eliminating the failure mode, if possible, or protecting the user from the effect. A severity rating of 9 or 10 is generally reserved for those effects which would cause injury to a user or otherwise result in litigation.

3.3 OCCURRENCE

Code	Classification	Example
10 9	Very High	Inevitable Failure
8 7	High	Repeated Failures
6 5	Moderate	Occasional Failures
3 2	Low	Few Failures
1	Remote	Failure Unlikely

Table 3.2: Occurrence Code

Occurrence is the chance that one of the specific cause/mechanism will occur. In this step, it is necessary to look at the cause of a failure and how many times it occurs. Looking at similar products or processes and the failures that have been documented for them can do this .In this step, it is necessary to look at the cause of a failure and how many times it occurs. Looking at similar products or processes and the failures that have been documented for them can do this. A failure cause is looked upon as a design weakness.

All the potential causes for a failure mode should be identified and documented. Again this should be in technical terms. Examples of causes are: erroneous algorithms, excessive voltage or improper operating conditions. The occurrence codes (O) along with example are shown in Table 3.2.

3.4 DETECTION

Detection is an assessment of the probability that the current process control will detect a potential weakness or subsequent failure mode before failure mode the part or component laves the manufacturing operation or assembly location. Assume the failure has occurred and then asses the capabilities of the current process control to prevent shipment of the part having this nonconformity (defect).in simple words it can said that detection ranking is done based on prevention failure modes from occurring or which detect the failure before it reaches to the customer An example for ranking of the detection table 3.3 is shown below

Code	Classification
10	Absolute Uncertainty
9	Very Remote
8	Remote
7	Very Low
6	Low
5	Moderate
4	Moderate High
3	High

2	Very High
1	Almost Certain

Table 3.3: Detection Codes

3.5 RISK PRIORITY NUMBERS (RPN)

After deciding the severity, occurrence and detection numbers, the RPN can be easily calculated by multiplying these 3 numbers:

$$RPN = S \times O \times D$$

The RPN can be computed for the entire process and/or for the design process only. Once it is calculated, it is easy to determine the areas of greatest concern. The failure modes that have the highest RPN should be given the highest priority for corrective action. But sometimes, it may not always appropriate to treat first with the highest severity numbers. There could be less severe failures, but which occur more often and are less detectable may be given more priority than others.

After these values are allocated, recommended actions with targets, responsibility and dates of implementation are noted. These actions can include specific inspection, testing or quality procedures, redesign (such as selection of new components), adding more redundancy and limiting environmental stresses or operating range. Once the actions have been implemented in the design/process, the new RPN should be checked, to confirm the improvements. These tests should be put in graphs for easy visualization. Whenever a design or a process changes, the FMEA score should be updated. The process for conducting FMEA is discussed in the following section.

Potential failure mode

In what ways can the process step or input fail?

Potential failure effect

What is the impact on the key output variables once it fails (customer or internal requirements)?

Potential causes

What causes the key input to go wrong?

Current controls

What are the existing controls and procedures that prevent either the cause or the failure mode?

Recommended action

What are the actions for reducing the occurrence of the cause of improving detection?

Responsible

Who is responsible for the recommend action?

Actions taken

Note the actions taken include dates of completion.

4.DATA COLLECTION

4.1 GENERAL

In this the samples data's for FMEA is mentioned in the Table 4.1. Here the

functions, potential failure mode, potential effect of failure, severity, potential cause of failure, occurrence, machine control, detection, risk priority numbers (RPN) and Recommended actions are mentioned for the sub-system like mixer and helical spring conveyor.

The data's of functions, potential failure mode, potential effect of failure, potential cause of failure were collected. The various sub-systems are,

1. Bull Dozer
2. Crane
3. Belt Conveyor
4. DumpTruck

5.CONCLUSION

Failure Mode and Effect Analysis (FMEA) is a pro-active quality tool for evaluating potential failure modes and their causes. It helps in prioritizing the failure modes and recommends corrective measures for the avoidance of failures and improvement of quality. An FMEA is a reliability tool that helps avoid costs incurred from product failure and liability. The main advantage of FMEA is to improve the quality and safety of a product/process, Increase user satisfaction, Reduce system development time and cost. The data can be collected regarding to the project. Then find out the Potential failure mode, potential effect failure and potential cause of failure. Using FMEA we can easily find out the failures by applying the Risk Priority Number (RPN) .RPN is calculated by severity, occurrence and detection. The small RPN is always better than the high RPN. By using QUANTUM XL Software the data can be implemented. The initial output of an FMEA is the prioritization of failure modes based on their risk priority numbers and this alone does not eliminate the failure mode.

REFERENCES

1) Narayanagounder, S. and Gurusami, K. (2009), "A New Approach for Prioritization of Failure Modes in Design FMEA using ANOVA", Journal of World Academy of Science (Engineering and Technology), Vol. 49, 2009, pp. 524-53.

2) Janakiram, M. and Keats, J. B. (1995), "The use of FMEA in process quality improvement", International Journal of Reliability, Quality and Safety Engineering, Volume 2, Issue 1, pp. 103-115.

3) Dr. D. R. Prajapati, (July 2012), "Implementation of Failure Mode and Effect Analysis: A Literature Review", International Journal of Management, IT and Engineering, Volume 2, Issue 7.

4) Segismundo, A. and Miguel, A. C. P. (2008), "Failure mode and effects analysis (FMEA) in the context of risk management in new product development: A case study in an automotive company",

International Journal of Quality & Reliability Management, Volume 25, Issue 9, pp. 899 - 912.

5) Guidance of Failures Modes and Effects Analysis, International Marine Contractors Association, April 2002.

6) Veeranna D. Kenchakkanavar and Co., Failure Mode and Effects Analysis: A Tool to Enhance Quality in Engineering Education, International Journal of Engineering (IJE), Vol. 4: Issue 1.

7) B.G. Dale and P. Shaw, ―Failure Mode and Effects Analysis in the U.K. Motor Industry: A State-of-Art Study,‖ Quality and Reliability Engineering International, Vol. 6, 184, 1990.

8) A. A. Nannikar, D. N. Raut,R. M. Chanmanwar,S. B. Kamble , D. B. Patil, March (26-28 2012), "FMEA for Manufacturing and Assembly Process", International Conference on Technology and Business Management

9) Jakuba, S.R., "Failure Mode and Effect Analysis for Reliability Planning and Risk Evaluation", Engineering Digest, Vol. 33, No. 6, June 1987.

10) Bradley, J.R. and Guerrero, H.H., 2011, "An Alternative FMEA Method for Simple and Accurate Ranking of Failure Modes," Decision Sciences, Vol. 42, pp. 743-771.