

# RISKS PRIORITIZATION USING FMEA METHOD -A CASE STUDY

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**Abstract** - The electricity power generation plays the important role of every business or industrial, since it must be supplied to cope with the full consumption on demand sites. A survey has been conducted to identify the chances of failures of various machinery/ equipment which may occur in thermal Power Plant at Jaiswal Neco Industries Limited, Raipur. Many factors for failure are come to be known, out of which some major critical factors are identified for which FMEA is conducted. Failure Modes and Effects Analysis (FMEA) is methodology for analyzing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. Failure mode, effects and criticality analysis (FMECA) is the also most popular systematic assessment of a process (product) that enables us to determine the location and the mechanism of potential failures, with the aim of preventing process (product) failures. FMEA is precisely an analytical methodology used to ensure that potential problems have been considered and addressed throughout the product and process development cycle. A process or a design should be analyzed first before it is implemented and also before operating a machine the failure modes and effect must be analyzed critically. A comparative analysis of various risks factors reduces the chance of its occurrence. The main motive of this paper is risk Prioritization using FMEA method, which are more severe for the Company. Finally the most risky failure according to the RPN numbers is found and the cause and effects along with the preventive measures are tabulated.

**Key Words:** FMEA, RPN, FMECA,

## 1. INTRODUCTION

Risk management is a critical component of strategy development and execution, and a driver of firm success. Maintenance is the crucial issue for the plant with highly complexity and a variety of machines such as thermal power plant, cement plant, oil refining plant and so on. The main of maintenance propose is to suppress the risky of plant suddenly shutdown with uncontrollable system. A thousand of equipments at each plant unit must be take care depending on maintenance policy such time based

maintenance, break down maintenance etc. All equipments are mostly importance to be maintained in order to keep them working stability supposed with ill-conditioning operation.

Failure mode, effects and criticality analysis (FMECA) is the also most popular systematic assessment of a process (product) that enables us to determine the location and the mechanism of potential failures, with the aim of preventing process (product) failures. FMECA is characterized by a bottom-up approach by which any complex production system is decomposed into its constituent parts, which are successively analysed to find all the potential failure causes and their effects.

Failure Modes and Effects Analysis (FMEA) is a technique for evaluate possible reliability troubles in the early hours at the progress cycle where it is simpler to acquire actions to overcome these matters, thereby improving consistency through design.

Failure mode, effects and criticality analysis (FMECA) is the most popular systematic assessment of a process (product) that enables us to determine the location and the mechanism of potential failures, with the aim of preventing process (product) failures. FMECA is characterized by a bottom-up approach by which any complex production system is decomposed into its constituent parts, which are successively analyzed to find all the potential failure causes and their effects.

FMEA can be apply to recognize probable failure modes, conclude their effect on the process of the product, and categorize actions to diminish the failures. A vital step is anticipating what might go incorrect with a product. Whereas anticipating each failure mode is not possible, the improvement squad ought to invent as extensive a record of likely failure modes as probable.

## Case study

This paper is based on process FMEA which analyses the failure of Turbine auxiliaries and its effect on power generation of Power Plant. In this research the thermal power plant of Jaiswal Neco Industries Limited, Raipur is selected to analyse the failure mode. The developed method can help the maintenance team for making decision in spare

part management and it is friendly-user to pursuit the maintenance policy focused on critical maintaining equipments in overall systems. Some of the problem arised are:

**1. Problem in Heat Exchanger of Oil System of Turbine.**

- a. Remains high Thrust Pad temperature of Turbine Shaft.
- b. High Axial and differential expansion of turbine.

**2. Found high vibration in Turbine body.**

- a. Problem in Recirculation cooling water pump.
- b. Auxiliary power consumption of plant become high due to running of stand by pump.
- c. Increase in Steam consumption of turbine due to decrease in condenser vacuum.
- d. Exerts high pressure, due to running of standby pump, on oil cooler fins and reduce life of oil cooler.

**Major Equipment in which problem has arised are:**

**OIL COOLERS**

Normally two oil coolers of 100% capacity each are provided to cool entire oil supplied to turbine bearings, gearbox, and generator bearings for lubrication. Governing oil is not cooled at oil cooler. This oil is taken out before oil cooler. One cooler is put on line and another one is kept as standby. Online changeover facility is provided to take the standby cooler in to service while turbine is running without interruption of oil supply. Before changeover, it is to be ensured that the standby cooler is filled with oil and air is vented out properly. Otherwise there will be air lock and oil supply to bearings may interrupt.

**SHAFT VIBRATION:**

Vibration of the turbine indicates condition of turbine in running condition. Rotor rotates at high speed through set of journal bearings. There is little clearance in between rotating and stationary parts. Due to misalignment, disturbance in balancing, rubbing of moving part etc., rotor tends to vibrate. This vibration is supposed to be within permissible limit. Excessive vibration may damage turbine and lead to extensive maintenance.

**THRUST PAD/ BEARING TEMPERATURE:**

Journal bearings are used to take radial load of the shaft. But it can't axial load. Shaft is permitted to float to both axial float is restricted to certain limit. Excessive axial shift may damage rotating and fixed parts. For this thrust bearing are provided. Particularly in turbine, fluid film tilting pad type thrust bearing is used.

Due to friction heat is generated in journal bearing which is cooled by help of lubricating oil. At higher temperature, babbating material of the bearing can damage. So it is required to keep the bearing temperature within safe limit. For this, temperature of bearing is monitored continuously.

**TURBINE BEARING TEMPERATURE:**

Journal bearing is a cylinder which surrounds the shaft and is filled with lubricating oil. It consists of a split outer shell of hard metal and a soft metal at the inner cylindrical part. In this bearing a shaft or journal rotates inside the bearing over a layer of lubricating oil, separating the shaft and bearing due to fluid dynamics principle. This lubricating oil layer supports the shaft preventing metal to metal contact. Oil is pumped into the bearing through oil pump. When rotor rotates lubricating oil is drawn up around the journal due to hydro dynamic effect of lubrication. When lubrication is introduced between two surfaces of rolling contact, it creates a large increase in pressure. Some of the failure mechanisms are

- 1-Overload
- 2-Overheating
- 3-Fatigue
- 4-Erosion

**COOLING WATER SYSTEM:**

In a condenser cooling water is circulated to condense exhaust steam of turbine. Exhaust steam is having considerable amount of heat energy. This heat energy is required to be transferred to cooling water to condense steam. So the cooling water temperature rises. This cooling water is required to be cool down, again use it in condenser. This cooling is done at cooling tower. From cooling tower, cooling water is circulated through condenser by help of cooling water pumps. This exhaust steam is to be cool down to 41.2°C. There are two types of cooling water circulation system. These are:

- 1-Open or once through System
- 2-Closed system

## COOLING TOWER:

Cooling tower is a structure in which hot water is made droplets with the help of nozzle to increase contact surface of water and allowed to come in contact with atmospheric air. Atmospheric air is having certain capacity to absorb water vapors at a given temperature. Water vapors is created due to evaporation of water heat is required. This heat is obtained from remaining water. So this remaining water is cooled as heat is removed from it for evaporation. Rate of evaporation and hence drop in cooling water temperature depends upon following factors.

## INDUCED DRAFT COUNTER FLOW COOLING TOWER:

A mechanical fan is located at top of the tower. Water is distributed throughout the area of tower and made droplets with the help of spray nozzles. Mist eliminators are placed above distributed pipe line and nozzle to restrict escape of vapor mist to atmosphere. Hot water is allowed to flow down to the basin by gravity. When fan is started atmospheric air is sucked and enters through the louvers. This air moves up and comes in contact with downward droplets. It carries the heat of water and discharge to atmosphere through the fan. Flow of air and water is in counter direction. SO the temperature between the hot water and cool air is almost same throughout the mixing area. So this type of tower is thermodynamically most suitable. Cold water is collected in a basin from where water is drawn out for further use in condenser. This complete arrangement is called as a cell. Cells are connected side by side in parallel to meet the requirement of plant.

## 2. METHOD AND PROCEDURE

The FMEA is a powerful design tool that provides a mean to compare, from a risk point of view, alternative machine system configurations. The FMEA is a formalized but subjective analysis for the systematic identification of possible Root Causes and Failure Modes and the estimation of their relative risks. The main goal is to identify and then limit or avoid risk within a design. Hence the FMEA drives towards higher reliability, higher quality, and enhanced safety. It can also be used to assess and optimize maintenance plans.

An FMEA is usually carried out by a team consisting of design and maintenance personnel whose experience includes all the factors to be considered in the analysis. The causes of failure are said to be Root Causes, and may be defined as mechanisms that lead to the occurrence of a failure. While the term failure has been defined, it does not describe the mechanism by which the component has failed. Failure Modes are the different ways in which a component may fail. It is vitally important to realize that a Failure Mode

is not the cause of a failure, but the way in which a failure has occurred. The effects of one failure can frequently be linked to the Root Causes of another failure.

The FMEA procedure assigns a numerical value to each risk associated with causing a failure, using Severity, Occurrence and Detection as metrics. As the risk increases, the values of the ranking rise. These are then combined into a risk priority number (RPN), which can be used to analyze the system. By targeting high value RPNs the most risky elements of the design can be addressed. RPN is calculated by multiplying the Severity by the Occurrence by the Detection of the risk. Severity refers to the magnitude of the End Effect of a system failure. The more severe the consequence, the higher the value of severity will be assigned to the effect. Occurrence refers to the frequency that a Root Cause is likely to occur, described in a qualitative way. That is not in the form of a period of time but rather in terms such as remote or occasional.

FMEA is the methodology designed to identify potential failure modes for a product or process before the problems occur, to assess the risk. Ideally, FMEA's are conducted in the product design or process development stages, although conducting an FMEA on existing products or processes may also yield benefits.

For calculating the risk Prioritization in FMEA method, Risks have been evaluated by set of Questionnaire respond from SME (Table 1). Risks have been evaluated in three components which are multiplied to produce a Risk Priority Number (RPN):

- 1) Severity (*S*): Severity is described on a 10-point scale where 10 is highest.
  - 2) Occurrence (*O*): Occurrence is described on a 10-point scale where 10 is highest.
  - 3) Detection (*D*): Detection is described on a 10-point scale where 10 is highest.
- $$RPN = S * O * D.$$

**Note:** Table 2 is below in Appendix

## 3. RESULT ANALYSIS

The FMEA method in this study is formed to prioritize the various risks within the organization. As per this method first priority considers the severity of risk and then Occurrence of those risks comes in precedence, last but not least is Detection of risk. Higher the RPN value, higher the priority of risk. Thus the firm has Risk Priority by the use of FMEA method Here the most critical risks is shown according to their RPN value (see in table 1) that require optimization at maximum level.

Table 1. Prioritizing risk on the basis of RPN value.

Process Input	RPN value on the basis of Process Input
Turbine Bearing Temperature	84
Shaft Vibration	75
Cooling Tower	72
Thrust Pad Temperature	60
Oil Cooler	40
LP Dosing	18
RCW	16
QC NRV	12

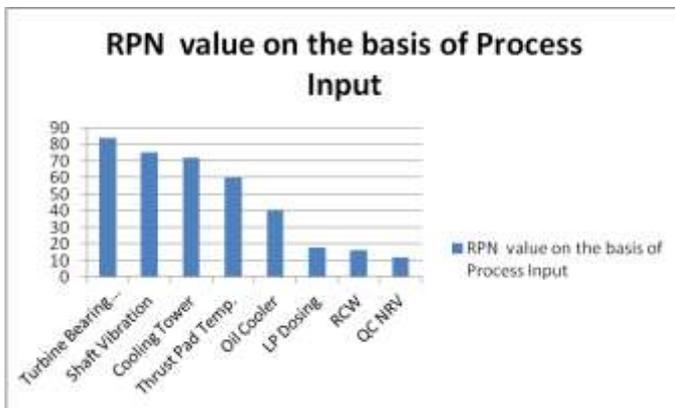


Fig. 2. Critical risk factors on the basis of RPN value

Note: There is no threshold value for RPNs. In other words, there is no value above which it is mandatory to take a recommended action or below which the team is automatically excused from an action.

#### 4. CONCLUSIONS

A survey has been conducted to identify the chances of failures of various machinery/ equipment which may occur in thermal Power Plant at Jaiswal Neco Industries Limited, Raipur. Many factors for failure are come to be known, out of which some major critical factors are identified for which FMEA is conducted.

From the survey conducted is it is found that Turbine Bearing Temperature, shaft vibration, problem in Cooling Tower are major concern which are to be taken in account.

Once FMEA data was produced, it was ranked in assembly order giving a clear picture of the unreliability of assemblies, subassemblies and parts. This could be a useful tool for designers to identify weak points in the plant design.

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#### Appendix

- Step 1: Structuring the Questionnaire for risk factor in the thermal power plant.
- Step 2: Identifying the critical risk factors and calculating RPN values for each.

**Table 2: Calculation of Risk Priority Number(RPN)**

Step/ Process Input	Potential Failure Mode	Potential Failure Effects	Severity	Potential Causes	Occurrence	Current Control	Detection	RPN	Action Recommended
Oil Cooler	Improper Heat Exchange, Standby Oil Cooler in damaged condition	Vibration, High Thrust Pad Temp., High Bearing Temp.	4	Lack of Strainer In Cooling Water Line, Overload in Fins Due To Extra Pump	5	Controlled by Operating in Reduced Turbine Load	2	40	Required strainer, Replace mat of Fins
Shaft Vibration	Shaft Vibration is Increased	Reduces Power Generation & reduces the Life of Turbine	5	Due to High Oil Temp.	5	Controlled by Operating in Reduced Turbine Load	3	75	Sudden Variation of Load Should be Prevented
Thrust Pad Temperature	Running in unsafe Temp. zone	High shaft Axial Displacement, Reduces Power Generation	6	Low material quality of Turst Pad, Due to High Oil Temp.	5	High Auxiliary Power Consumption, Controlled by Operating in Reduced Turbine Load	2	60	Throttling of cooling Valve
Turbine Bearing Temperature	High Bearing Temperature	Effects the Turbine rolling	7	High Moisture Content in oil	3	By Frequent Use of centrifuge	4	84	Proper oil topup in main oil tank
RCW	Cavitation Problem	Reduces Condenser Efficiency	4	Due to Lack of air Vent	2	Using extra RCW	2	16	Air Vent required
Cooling Tower	Improper cooling	Reduces Condenser Efficiency, High Cooling water temp.	3	Improper functioning of Drift eliminator	4	Operating CT fan in full RPM	6	72	To Prepare proper section for drift eliminator
QC NRV	Oil Inlet Line leakage	Jammed operation of QCNRV	2	Flange bolting problem	3	Unnecessary Closing of PDCS	2	12	Changing Flange Bolt
LP Dosing	Aqitation Shaft Damaged	Improper removal of dissolved Gases	3	Improper Chemical Dosing in Degrator	3	Using more Chemical for dosing	2	18	Replacement of shaft