Failure Mode and Effect Analysis (FMEA) – A Case Study in Manufacturing Facility

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Abstract – Failure Modes and Effects Analysis (FMEA) has been appeared to be a viable method for enhancing apparatus structure dependability. This paper applies the FMEA to the plan for accessibility of a 2.3MW, wind turbine configuration. The procedure will be utilized to look at the forthcoming reliabilities of the equipped turbine. Arrangements have been proposed to diminish generally wind turbine failure rate and raise its accessibility. The paper proposes changes to the FMEA technique to investigations accessibility.

Keywords: Failure Modes and Effect Analysis (FMEA), Wind turbine, High Speed Gear Box

1. INTRODUCTION

Wind control is the quickest developing sustainable power source asset and wind control entrance in power frameworks increments at a huge rate as illustrates. The high infiltration of wind control into power frameworks in the present and not so distant future will affect their arranging and task. One of these effects the impact of wind control on power frameworks unwavering quality, underscored claiming wind control is discontinuous. So, the dependability of the Wind turbines (WT) conveying this power will turn into a basic thought throughout the following couple of years.

Failure Modes and Effects Analysis (FMEA), the best possibility for unwavering quality examination at the structure arrange, is very much characterized and has been utilized effectively in many power generation systems. This strategy has been utilized independently by WT producers and their providers

The principle target of this paper will be to do a FMEA on a total 2.3 MW, variable speed, adapted drive WT, considering all the assemblies in the drive train and the impacts of their failure on the general turbine execution, to exhibit the appropriateness of this strategy to WT frameworks.

2. Types of FMEA

2.1 System –

Focuses on global system functions.

2.2 Design –

Focuses on components and subsystems.

2.3 Process –

Focuses on manufacturing and assembly processes.

2.4 Service –

Focuses on service functions.

2.5 Software –

Focuses on software functions.

3. Steps to Conduct FMEA

There are 10 steps to conduct a FMEA

3.1 Review the process

Utilize a procedure flowchart to recognize each procedure part.

Rundown each procedure part in the FMEA table.

If it begins feeling like the extension is too huge, it presumably is. This is a decent time to break the Process Failure Mode and Effects Analysis into more reasonable pieces.

3.2 Brainstorm potential failure modes

Audit existing documentation and information for intimations pretty much most of the manners in which every segment can fail.

The rundown ought to be thorough – it very well may be matched down, and things can be joined after this underlying rundown is created.

There will probably be a few potential failures for every part.

3.3 List potential effects of each failure

The impact is the effect the failure has on the finished result or on ensuing strides all the while.

There will probably be more than one impact for every failure.

3.4 Assign Severity rankings

Considering the seriousness of the outcomes of failure.

3.5 Assign Occurrence rankings

Rate the seriousness of each impact utilizing tweaked positioning scales as a guide.

3.6 Assign Detection rankings

What are the odds the failure will be identified before it happens.

3.7 Calculate the RPN

Severity X Occurrence X Detection

3.8 Develop the action plan

Choose which failures will be chipped away at dependent on the Risk Priority Numbers. Spotlight on the most elevated RPNs.

Characterize who will do what by when.

3.9 Take action

Implement the improvements identified by your Process Failure Mode and Effects Analysis team.

3.10 Calculate the resulting RPN

Reconsider every one of the potential failures once upgrades have been had and decide the effect of the enhancements.

4. FMEA for Wind Turbine

SAE J 1739 was produced as an automotive design tool, SMC REGULATION 800-31 was created for aviation yet the most generally utilized standard is MIL-STD-1629A (1980), drafted by The United States Department of Defense. With more than 30 years use and improvement, it has been utilized in a wide range of enterprises for general failure examination. Because of the intricacy and criticality of military systems, it gives a solid establishment on which to perform FMEAs on an assortment of frameworks. It likewise contains formulae for foreseeing the failure rates of electrical and electronic systems, whose coefficients depend on quickened life tests.

In traditional FMEA the Severity, Occurrence and Detection factors are independently evaluated utilizing a numerical scale, ordinarily extending from 1 to 10. These scales, in any case, can differ in range contingent upon the FMEA standard being connected. Notwithstanding, for all principles, a high esteem speaks to a poor score (for instance calamitously extreme, exceptionally customary event or difficult to recognize). When a standard is chosen it must be utilized all through the FMEA.

In this paper was utilized however with some correction, primarily to change the Severity, Occurrence and Detection criteria by which the RPN is figured. These alterations were important to make the FMEA strategy more proper to WT systems.

The adjusted Severity scale and criteria are appeared in Table 1. The first size of 1-4 was kept up however changes were made to the classification criteria definitions to accentuation their suggestions for a WT.

Table.1

SCALE	PORTRAYAL	CRITERIA
1	ClassificationIV (Minor)	Electricity can be produced yet critical fix is required.
2	Classification III (Marginal)	Reduction in capacity to produce power.
3	Classification II (Critical)	Loss of capacity to produce power.
4	Classification I (Crucial)	Real harm to the Turbine as a capital establishment

The adjusted Occurrence scale and criteria are classified in Table 2.

Table. 2

SCALE	PORTRAYAL	CRITERIA
1	Level E (Greatly Unlikely)	For single Failure Mode probability of occurrence is less than 0.001
2	Level D(Remote)	For single Failure Mode probability of occurrence is less than 0.01
3	Level C(Occasional)	For single Failure Mode probability of occurrence is less than 0.1
5	Level A (Frequent)	For single Failure Mode probability of occurrence is more than 0.1.

The Level B of standard was evacuated as the nearness of Level an and C were viewed as sufficient for the WT as it was initially hard to make an unmistakable refinement between Levels A, B and C.

The quantity of Detection levels was diminished by evacuating 2, 3, 5, 6 and 8 as the nearness of the staying four dimensions was sufficient for this examination. The altered Detection scale and criteria are organized in Table 3.

Table.3

SCALE	PORTRAYAL	CRITERIA
1	Always possible	Current checking strategies quite often will identify the disappointment
4	High	Great probability current checking strategies will identify the disappointment.
7	Low	Low probability current observing techniques will identify the disappointment.
10	Almost Impossible	No known checking strategies accessible to recognize the disappointment.

It tends to be presumed that the base RPN for any Root Cause is 1 and the greatest is 200. For whatever length of time that the rating sizes of a chosen FMEA method stay settled, it tends to be utilized for the correlation of elective structures and recognizable proof of basic gatherings.

Characterizing these three criteria tables dependent on MIL-STD-1629A is the initial phase in playing out a FMEA. As referred to before the fundamental standards of a FMEA utilizing distinctive norms are comparable and basic;

• The framework to be contemplated must be separated into its gatherings

• Then for every get together all conceivable Failure Modes must be resolved

• The Root Causes of every Failure Mode must be resolved for every get together.

• The End Effects of every Failure Modes must be doled out a dimension of Severity, and each Root Cause must be appointed a dimension of Occurrence and Detection

• Levels of Severity, Occurrence and Detection are increased to deliver the RPN

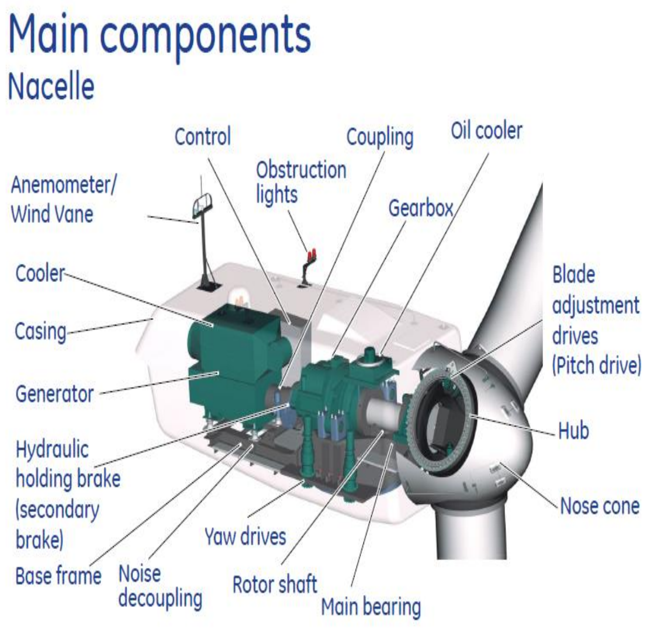
In this manner the principal organize in the FMEA strategy is getting a far reaching comprehension of the WT systems and its fundamental congregations.

5. WT SYSTEMS CONSIDERED IN THIS PAPER

This paper centers around an adapted drive WT with a 2.3 MW, 80m measurement rotor, a model arrangement for the aberrant drive idea, with a variable speed framework fusing a LV DFIG and dynamic sharp edge pitch control. This equipped drive WT at that point will be contrasted and novel WT frameworks fusing either a LV BDFIG or a water driven converter coupled to a MV synchronous generator, which has been fitted in various 2.3 MW WTs. The gearbox utilized in the regular R80 has three phases comprising of one planetary and two parallel stages while the BDFIG works at a lower speed what's more, utilizes a comparable two-phase gearbox while the water powered converter utilizes an indistinguishable two-phase gearbox however joins its own gearbox to modify speed.

To accomplish consistency in the FMEA it is basic to think about the dimension of detail required for a genuine portrayal of the framework without confusing the examination. On the off chance that, the framework is separated to singular parts it would wind up complex, requiring itemized framework information. For WTs, where a wide range of setups and structures are comparable, with complex congregations lacking open detail on all parts, it is worthy to do the FMEA down to get together dimension, for instance to the grease oil arrangement of the gearbox as opposed to singular siphons, funnels and valves.

In this paper eleven fundamental gatherings are considered for the WT in the FMEA examine,



6. WT FMEA PROCEDURE

After subdivision of the chose WT system the possible Failure Modes are produced. The normal Failure Modes were considered for each of the 107 sections in the R80 and many were observed to be normal between different parts. Table 4 demonstrates the normal failure Modes for the WT.

Table 4.

FAILURE MODE	DESCRIPTION
STRUCTURAL FAILURE	Failure of any part or assembly that frames some portion of a supporting structure
ELECTRICAL FAILURE	Failure of a part or assembly because of an electrical imperfection
MECHANICAL FAILURE	Failure of a part or assembly because of a pressure related deformity
OUTPUT INACCURACY	Failure of a part or assembly because of a flag yield error
MISALIGNMENT	Failure of a part or assembly because of an accidental change in the parts position or introduction, with specific reference to parts pivoting about incidental hub
THERMAL FAILURE	Failure of a part or assembly because of an inadequacy to endure any uncovered high temperatures, bringing about a decrease in inflexibility

For the above possible failure modes, we also need to predict the relatable root causes.

The root causes found out are enlisted below:

Electrical Overload

Lightning Strike

Presence of Conducting Debris

Excessive Brush Wear

Loss of Power Input

Presence of Debris

External Accidental Damage

Calibration Error

High Cycle Fatigue

Maintenance Fault

Connection failure

Installation Defect

Manufacturing Defect

Corrosion

Insufficient Lubrication

Mechanical Overload

The last steps in the FMEA are:

• Adjusting the severity of each Failure Mode to an appropriate level due to its effect.

• Assigning occurrence and detection figures for the related Root Causes.

7. FMEA RESULTS FOR THE 2.3 MW TURBINE

The Result from the FMEA performed on the 2.3 MW WT system are as follows.

Table 5.

Sub Assembly	RPN
Drive Train	100
Generator	17.5
Gearbox	30.4
Converter	21.7
Transformer	3.3

8. DISCUSSION

The outcomes demonstrate that the traditional 2.3 MW has the elevated RPN for this FMEA method. At last the advantage of the Hydraulic Converter R80.3 is extremely considerable, proposing this can possibly accomplish high unwavering quality dependent on the utilization of a high dependability synchronous generator, the end of the transformer and of the Electrical Converter. Besides this setups utilization of two separate gearboxes signals a possibility to enhance the dependability still further by killing one and coordinating it into the water driven torque converter.

Such outcomes could be improved by nittier gritty investigation of the deliberate failure rates in individual subassemblies

9. CONCLUSIONS

A FMEA method has been chosen and applied to a 2.3 MW wind turbine to check its reliability,

It has been demonstrated that the technique can fill in as a primer disappointment rate expectation instrument

This is an empowering result which shows that the FMEA could be produced further for this reason.

The RPN information figured from the FMEA ought to be contrasted and field disappointment rate information for congregations, to locate any possible similarities between them. Further examination has demonstrated that correlation between the result of event and identification and field failure rates gives the closer examination, giving trust in the FMEA procedure. The result of event and discovery under-gauges field failure rates, anyway this could be a helpful device for foreseeing failure rates in new turbine structures. When FMEA information was created, it was positioned in assembly order giving an unmistakable image of the untrustworthiness of congregations, subassemblies and parts. This could be a helpful apparatus for planners to recognize fragile focuses in the WT structure.

The FMEA can possibly enhance the dependability of WT systems particularly for the seaward condition, where unwavering quality will have a lot more grounded impact in planned cost-adequacy. Moreover, it is trusted that in time, it will assume a noteworthy job in the advancement of WTs, which require practically no support, making wind a more financially savvy and reasonable vitality asset.

10. ACKNOWLEDGEMENT

Special thanks for his valuable Guidance to **Mr. N.C. Mundhada**, HOD Mechanical Engineering Department, Institute of Knowledge, college of Engineering, PimpaleJagtap.

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