

Failure Mode and Effect Analysis on Base Frame – Case Study

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Abstract— Failure mode and effect analysis (FMEA) is systematic, proactive method for evaluating the process to identify where and it might be fail to assist the relevant impact of different failures in order to identify the part of processes that are most needed of the change. The FMEA process consist of step wise process starting from potential failure causes ,study existing and complete the working of mechanism , calculate the risk priority number (RPN)of existing and modified. The presented paper deals with the review of various industrial case studies and their implementation of FMEA. This project discusses and implementation of Process Failure mode and effect analysis for improvement in welding process. This work is performed in the “LEMKEN India Agro Equipment Private Limited.” MIDC Buttibori Nagpur. We consider various parameters and examine them. The parameters which we focused ranked them according to the Ford Motor Company Reference Manual of Fourth Edition. Severity, Occurrence and Detection are ranked to calculate the Risk Priority Number (RPN). The Risk Priority Number (RPN) is the product of Severity, Occurrence and Detection which gives the idea about the most affecting parameter in the existing welding process. Studying that parameter we take the corrective action and calculate the RPN again so those to confirm the affecting parameter are minimized or not. In this way we can eliminate the failure

Keywords- Severity, Occurrence, Detection and RPN, DFMEA, PFMEA, MIG welding and risk evaluation

1. INTRODUCTION

An FMEA (Failure Mode and Effect Analysis) is a systematic method of identifying and preventing product and process problems before they occur. FMEAs are focused on preventing defects, enhancing safety, and increasing customer satisfaction. Ideally, FMEAs are conducted in the product design or process development stages, although conducting an FMEA on existing products and processes can also yield substantial benefits. Preventing process and product problems before they occur is the purpose of Failure Mode and Effect Analysis (FMEA). Used in both the design and manufacturing processes, they substantially reduce costs by identifying product and process improvements early in the develop process when changes are relatively easy and inexpensive to make. The result is a more robust process because the need for after-the-fact corrective action and late change crises are reduced or eliminated. This project discusses and implementation of Process Failure mode and effect analysis for improvement in welding process. This work is performed in the “LEMKEN India Agro Equipment Private Limited.” MIDC Buttibori Nagpur. We consider various parameters and examine them. [1,2,3]

2. FMEA Types

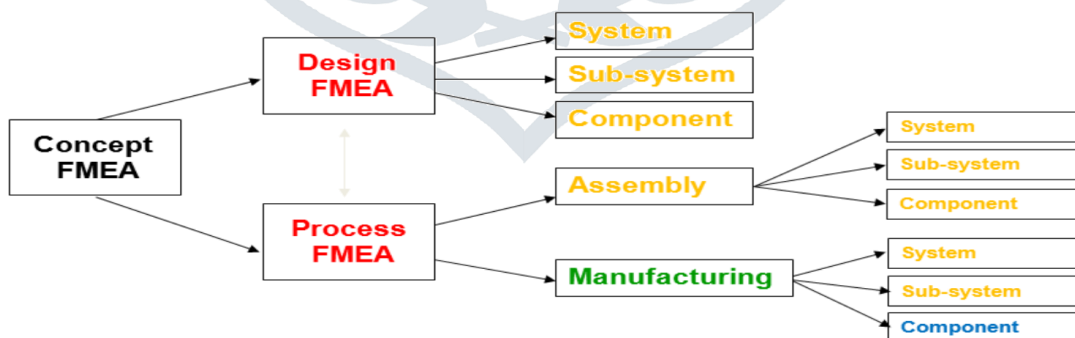


Fig. 1 Types of FMEA.

Design FMEA (DFMEA):- This type of FMEA has the purpose of identification and prevention of failure modes of products, which are related to their design, in order to validate the established design parameters for a specific functional performance level, at system, subsystem or component level. The most important function of this type of FMEA is the identification in the early stages of design development of the potential failure modes in order to eliminate or mitigate their effects, select the optimal design variant and develop a documentary base to support future designs in order to minimize the risks that faulty products reach the customers.[4,5]

Process FMEA (PFMEA):- The purpose of this variant of FMEA is to determine the potential failure modes of manufacturing/assembly processes at operation, subsystem or system level and to eliminate as early as possible the process deficiencies that could lead to the apparition of defective products as well as to avoid using inadequate methods as part of the processes. Besides offering solutions for the improvement of the process design, PFMEA also provides solutions for the development of future processes and process validation programs.[6,7]

3. Parameters Consider for Case Study are Shown in Fish Bone Diagram

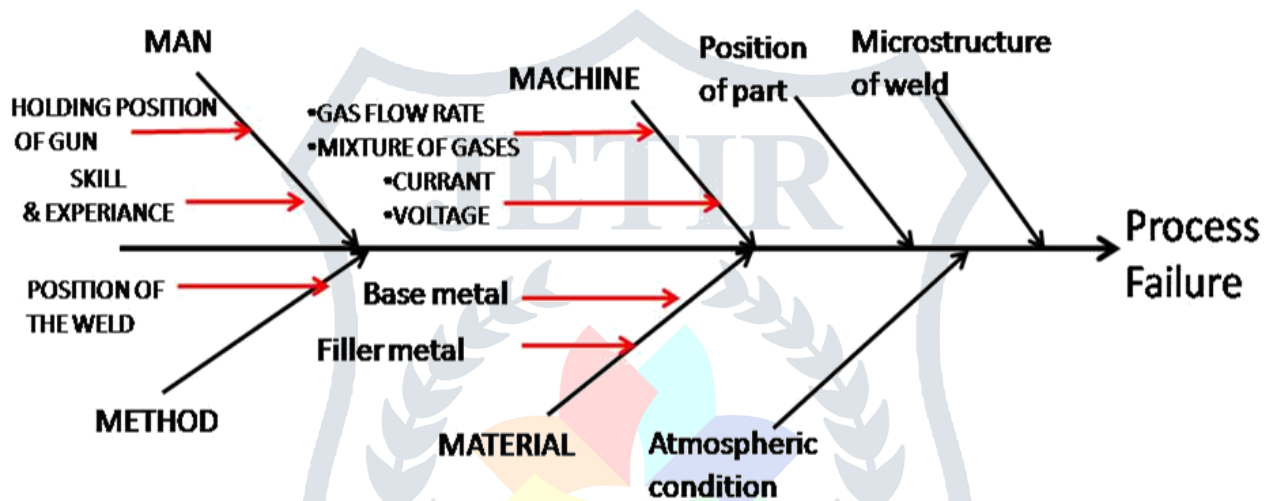


Fig. 2 Fish Bone diagram for Process Failure

4. Voltage

The maximum and minimum of the voltage range for the machine were defined in SOP (Standard Operating Procedure) to performed welding operation. This creates the problem of

- 1) Inconsistent penetration
- 2) Turbulent weld pool
- 3) Undercut
- 4) Spatter generation
- 5) Pin hole formation
- 6) Stubbing.

The voltage fluctuations are recorded by the Data Logger and the voltage range is revised maximum.

5. Gun Traveling Speed

The gun travelling speed is totally depends on the operator skill following are the causes of High or low gun traveling speed

- 1) Insufficient Penetration
- 2) Weld Bead Smaller
- 3) Weld Bead Larger

By providing proper training to the worker it can help to minimized failure.

6. Current and Feed Rate

The maximum and minimum of the current range for the machine were defined in SOP (Standard Operating Procedure) to performed welding operation and the feed rate is kept accordingly. This creates the problem of

- 1) Slag inclusions
- 2) Metal Piling-up instead penetrating into base metal
- 3) Weld Bead Sags
- 4) Spatter generation

The Current fluctuations are recorded by the Data Logger and the current range is revised.

7. Shielding Gas

The Argon and Carbon dioxide mixture gas were used with the Standardized ratio. The gas flow rate is in 15-20 lit/min. The following potential causes are occurred

- 1) Surface Porosity
- 2) Ripples are disrupted
- 3) Spatter generation

8. Environment

It is one of the important parameter which are generally avoided to consider is environmental air. The Argon and Carbon dioxide mixture gas is lighter. When the surrounding air velocity is more it's difficult to provide proper shielding to the weld bead

9. Filler Metal

Now copper Coated wire of classification AWS A5.18:ER 70S-6 is used for industry. The results are satisfactory with the same filler material and other suggesting material has high cost so we kept it as it is.

10. Implementation of FMEA Sheet

Table 1 FMEA Worksheet with RPN No. before and after implementation.



System	Agro Equipment	FMEA Number	Opt-01
Subsystem	Base Frame	Page	1 of 1
Component	Leg Holding Plate	Prepared By	Manoj Barik Kushal Gawnade Jitnas C
Model Year(s)/Vehicle(s)	2013 Opnal 090	FMEA Date(Orig.)	02-Mar-15
Core Team	Manoj Barik Kushal Gawnade J	Revised	*****

Process Failure Mode And Effect Analysis	Base Frame
02-Mar-15	*****
FMEA Date(Orig.)	Revised
*****	*****

Sr. No.	Process Function (Step)	Potential Failure Modes (process defects)	Potential Effect(s) of Failure	Severity	Potential Cause(s) of Failure	Current Process		D E T	R P N	Recommend Actions	Taken Actions	S O D R E C E P V C T N
						Control Prevention	Control Detection					
1	W E L D I N G	Voltage	High Voltage (greater than 30 V) OR Low Voltage (less than 25 V)	6	1) Inconsistent penetration 2) Turbulent weld pool 3) Undercut 4) Spatter generation 5) Pin hole formation 6) Stubbing	1) Automatic setting in machine 2) Parameter Chart 3) SOP	1) Digital Display of machine 2) Visual Inspection of weld area 3) SOP	7	294	Voltage Fluctuation record manually data logger. It help in understanding as how it affects the severity and RPN of study.	Voltage Fluctuation recorder using data logger and voltage range is revised	5 5 5 125
2		Gun Travelling Speed	High/Low Travelling Speed	6	1) Insufficient Penetration 2) Weld Bead Smaller 3) Weld Bead Larger	1) Provide Training to workers 2) Proper Gun holding position 3) Gun travelling angle 4) Contact tip-to-work distance	1) Check welding area visually 2) Uneven sound during welding 3) Thickness Gauge	7	294	Training needed to the welder for gun travelling and distance of gun holding	Standardised the welding position by expert as well as training is provided to welder.	4 5 5 100
3	P R O C E S S	Current and Feed Rate	Low Current (less than 250 amp) OR High Current (greater than 300 amp)	8	1) Sag inclusions 2) Metal Piling-up instead penetrating into base metal 3) Weld Bead Sags 4) Spatter generation	1) Automatic setting in machine 2) Parameter Chart 3) SOP 4) Clean welding gun 5) Check damage in the wire bundle 6) Wire feeder drive rolls	1) Digital Display of machine 2) Visual Inspection of weld area 3) Formation of small holes in welding	8	448	Current Fluctuation record manually data logger. It help in understanding as how it affects the severity and RPN of study.	Current Fluctuation recorder using data logger and current range is revised.	6 6 5 180
4		Shielding Gas	Insufficient Shielding Gas (less than 15-20 l/min)	8	1) Surface Porosity 2) Pipples are disrupted 3) Spatter generation	1) Set the flow meter of gas 2) Clean gas flow holes in the gun 3) Condition of gas flow tube 4) Opening Valve condition	1) Visual Inspection of the flow regulator 2) Generation of spatters around the part is more 3) Visual Inspection of weld bead 4) Peak/valley welding surface	9	504	Vary the gas combination % and Replace the existing gas with the helium gas	Vary the gas combination %	7 7 7 343
5	S	Environment	High velocity of Atmospheric air	7	1) Porosity and blow holes	1) Close all door and windows	1) Visual Inspection of the weld bead	5	175	Provide proper shielding seal-up	Shielding is provided at work place	5 5 5 125
6		Filler Material	1) Strength of material 2) Chemical composition 3) Electrical conductivity	8	1) Generation of cracks 2) Provide insufficient strength 3) Undercut 4) Variation in welding bead 5) Spatter Generation	1) Proper storage Area 2) Term and condition conforming to Chemical, mechanical grade and conductivity as per Baton Test Certificate	1) As Per SOP	8	384	Change the existing filler material with ASNI/SAP 5.28 ER 90s_02_ER 100S_G	Not possible to replace the filler material	8 6 8 384

11. RESULTS

Improvement Trend in RPN No. "Before and After"

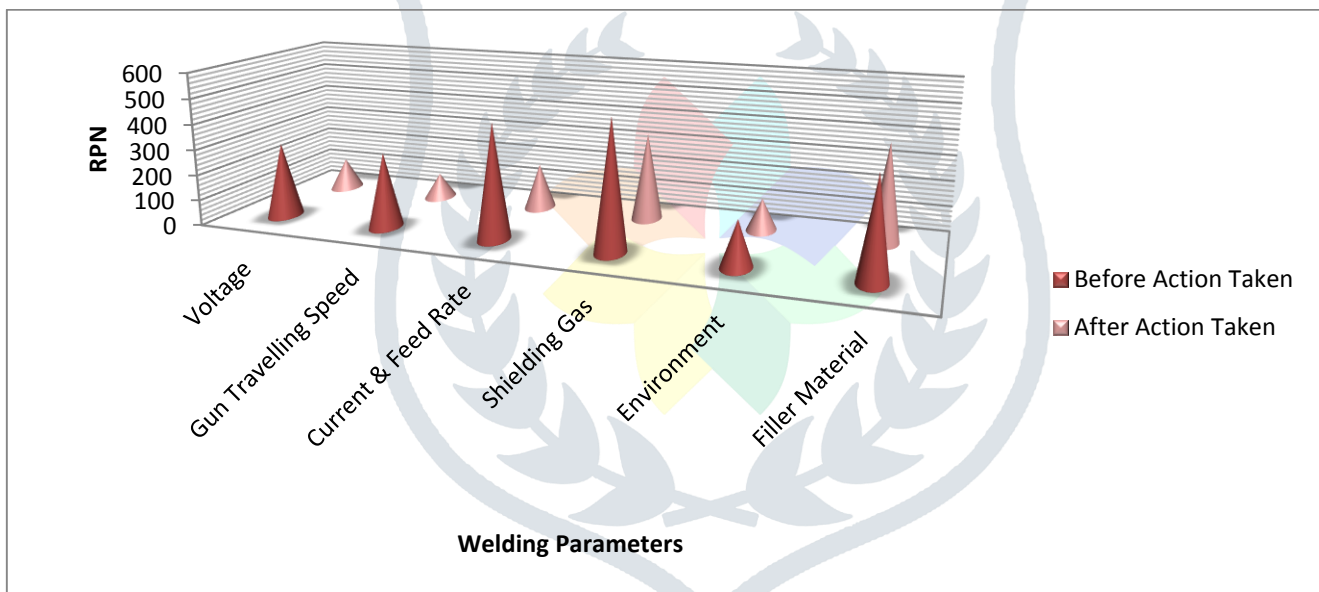
After the implementing all the possible suggestion the RPN values for each parameter are increase. From Table 2 we can say that the maximum % improvement is done in the Gun Travelling Speed. There is no possibility to increase the RPN of

filler material because the change of filler material is not allowed as per company policy as well as cost of the filler material which suggested for replace.

Table 2 Improvement Trend in RPN No. before and after implementation.

Sr No.	RPN (Risk Priority No.)	Before Action Taken	After Action Taken	% Improvement
1	Voltage	294	125	57.49%
2	Gun Travelling Speed	294	100	65.98%
3	Current & Feed Rate	448	180	63.11%
4	Shielding Gas	504	343	31.94%
5	Environment	175	125	28.57%
6	Filler Material	384	384	No. Improvement

Chart 4.1 Shows the Improvement Trend in RPN No. before and after implementation for each parameter.



12. CONCLUSION

The whole welding process is to minimise the failure by controlling the parameters affecting on it. A specialised method like failure mode and effect analysis is very effective to critically examine all the possible cause. A systematic analysis of FMEA has provided large improvement in efficiency.

In this project the Failure Mode and Effect Analysis is implemented in LEMKEN INDIA AGRO EQUIPMENT PVT. LTD. Buttibori, Nagpur.on welding process.to reduced the failure in the base frame. The failure mode and effect analysis tool plays a key role for the improvement in the production rate and reduced in the failure.

From the results analysis the Risk Priority Number (RPN) before and after implementation shows the improvement and reduction in the failure rate. The maximum improvement is done in the Gun travelling speed.

13. FUTURE SCOPE

- There is scope to invent such stabilizer which provides constant current and voltage from starting to end of the welding process.
- The suggested filler material provides better result.
- Change of Shielding gas also gives better results.

14. ACKNOWLEDGMENT

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