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Failure Mode and Effect Analysis on Welding Aseembly Process

G.S.Sawadadkar[1], H.K.Dhage[2], R.R.Thorat[3], D.B.Rankhambe[4]

[1] *(Professor Department of Mechanical Engineering, JSPM Narhe Technical Campus, Pune, Maharashtra, India)*

[2,3,4] *(BE Student Department of Mechanical Engineering, JSPM Narhe Technical Campus, Pune, Maharashtra, India)*

Abstract: *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. 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. In this work, process failure mode and effect analysis is done on general welding process*

Keywords: *FMEA-Failure mode effect analysis, effective weld, risk priority numbers.*

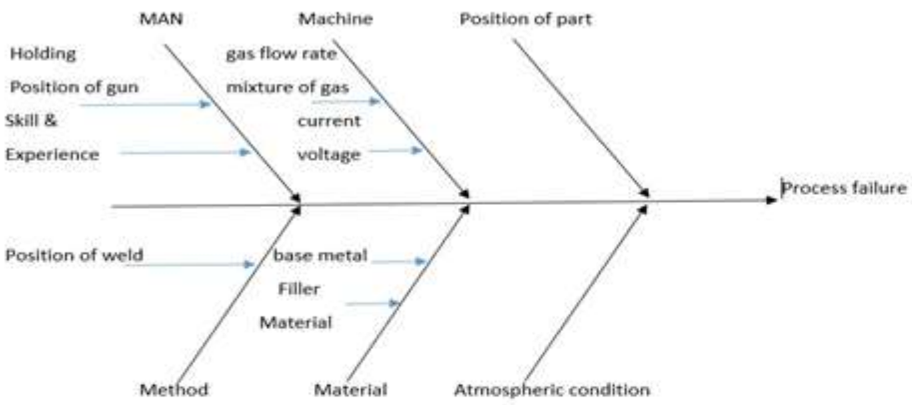
I. Introduction

The purpose of FMEA is to analyze the design characteristics relative to the planned manufacturingprocesstoensurethattheresultantproductmeetscustomerneedsandexpectations. When modes of failure are identified, improvement can be done by reducing the chances for occurrence by taking some correctactions. FMEA provides an organized analysis of failure modes of the system being defined and identifies related causes. Corrective action considerations. 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 obtained found robust, as the need for post corrective action and problems are reduced completely. This project discuses and implementation of Process Failure mode and effect analysis for improvement in all sub-processes involved till the completion of welding process.

II. Fmea Procedure

1. For each process input(start with high value inputs),determine the ways in which the input can go wrong (failure mode).
2. For each failure mode, determine effects.
- Select a severity level for each effect.
3. Identify potential causes of each failure mode.
- Select an occurrence level for each cause.
4. List current controls for each cause.
- Select a detection level for each cause.
5. Calculate the Risk Priority Number (RPN).
6. Develop recommended actions, assign responsible persons, and take actions.
- Give priority to high RPNs.

2.1 Fish Bone/ Cause and effect diagram of welding defects



III. Welding Defects modes

The weld defects such as Lack of Penetration, Porosity, Slag Inclusion, Burn Through, Oxide Inclusion, Lack of Fusion, Crack, Cluster Porosity, Internal Concavity, Offset, Tungsten Inclusion etc., deteriorate the mechanical properties of the welded structures thereby increasing the risks of fatigue, failure and disaster. Lack of Penetration is one of the weld defects that occur as a result incomplete penetration of the weld defect through a joint. This is one of the most unpleasant weld defects because this acts as a cause for Natural stress. When this defect is pressurized, it may result in the failure of the entire weld metal. So this should be avoided to the maximum possible extent. It usually appears as a dark straight line of medium width. Internal Concavity defect arises due to the contraction of the weld metal as it cools. This defect resembles Lack of Penetration but has irregular edges and is broader in the middle.

Cluster porosity and Porosity weld defect occur due to the presence of moisture, which turns into gas that will be further trapped in the weld when heated. Lack of fusion weld defect occurs when the filler metal doesn't fuse correctly with the base metal. In a radiographic image these defects appear as straight lines between the seam of the metal and they orient themselves in only one direction, along the weld seam in the metal. Oxide Inclusion occurs as irregularities dark in color since they are less intense than the adjoining materials.

Fig: Porosity & Weld Bed

IV. Fmea Procedure & Chart

Step 1: Occurrence

In this step it is necessary to look at the cause of a failure mode and the number of times it occurs. This can be done by looking at similar products or processes and the failure modes that have been documented for them in the past. 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. A failure mode is given an occurrence ranking (O), again 1–10. Actions need to be determined if the occurrence is high (meaning > 4 for non-safety failure modes and > 1 when the severity-number from step 1 is 1 or 0). This step is called the detailed development section of the FMEA process. Occurrence also can be defined as %. If a non-safety issue happened less than 1%, we can give 1 to it. It is based on product and customer specification.

Step 2: Severity

Determining all failure modes based on the functional requirements and their effects. Examples of failure modes are: Electrical short-circuiting, corrosion or deformation.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. Hereafter the ultimate effect of each failure mode needs to be considered. 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 (critical). These numbers help an engineer to prioritize the failure modes and their effects. If the sensitivity 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

Step 3: Detection

When appropriate actions are determined, it is necessary to test their efficiency. In addition, design verification is needed. The proper inspection methods need to be chosen. First, we should look at the current controls of the system, that prevent failure modes from occurring or which detect the failure before it reaches the customer. Hereafter one should identify testing, analysis, monitoring and other techniques that can be or have been used on similar systems to detect failures. From these controls an engineer can learn how likely it is for a failure to be identified or detected. Each combination from the previous 2 steps receives a detection number (D).This ranks the ability of planned tests and inspections to remove defects or detect failure modes in time. The assigned detection number measures the risk that the failure will escape detection. A high detection number indicates that the chances are high that the failure will escape detection, or in other words, that the chances of detection are low.

SR. No	Problem	Potential Effects	Severity Rating	Occurrence Rating	Detection Rating	Cause	Solution	RPN
1	EXCESSIVE ELECTRODE CONSUMTION	Improper weld	5	5	4	Inadequate gas flow.	Increase gas flow.	100
				9	1	Improper size electrode for current required.	Use larger electrode.	45
				6	3	Operating of reverse polarity.	Use larger electrode or change polarity.	90
				5	3	Electrode contamination.	Remove contaminated portion, then prepare again.	75
				4	5	Excessive heating inside torch.	Replace collect, try wedgecollect orreverse collet.	100
				9	4	Electrode oxidizing during cooling.	Increase gas post flow time to 1 sec. per 10 amps.	180
				1	7	Shield gas incorrect.	Change to proper gas (no oxygen orCo2).	35

2	ERRATICAR C	Defected job	7	5	6	Incorrect voltage(arc toolong).	Maintain short arc length.	210
				3	5	Current too low for electrode size.	Use smaller electrode or increase current.	105
				9	1	Electrode contaminated.	Remove contaminate d portion, then prepare again.	63
				7	2	Joint too narrow.	Open joint groove.	98
				6	3	Contaminated shield gas, dark stains on the electrode or weld bead indicate contamination .	The most common cause is moisture or aspirated air in gas stream. Use welding grade gas only. Find the source of the contaminate and eliminate it promptly.	126
3	INCLUSION OF TUNGSTEN OR OXIDES IN WELD	Irregular weld	7	5	2	Poor scratch starting technique.	Many codes do not allow scratch starts. Use copper strike plate. Use high frequency arc starter.	70
				5	5	Excessive current for tungsten size used.	Reduce the current or use larger electrode.	175
				3	4	Accidental contact of electrode with puddle.	Maintain proper arc length.	84
				4	4	Accidental contact of electrode to filler rod.	Maintain a distance between electrode and filler metal.	112
				6	5	Using excessive electrode extension.	Reduce the electrode extensionto recommende d limits.	210
				6	5	Inadequate shielding or excessive drafts.	Increase gas flow, shield arcfrom wind, or use gaslens.	210

				4	5	Wrong gas.	Do not use Ar-02 or Ar-Co2GMA (MIG) gases forTIG welding.	140
				6	4	Heavy surface oxides not beingremoved	Use ACHF, adjust balance control for maximum cleaning, or wire brush and clean the weld joint prior to welding.	168
4	POROSITY IN WELD DEPOSIT	Weld strength reduces	7	5	7	Entrapped impurities, hydrogen, air, nitrogen, water vapor.	Do not weld on wet material. Remove condensation from line with adequategas pre-flow time.	245
				4	8	Defective gas	Check hoses	224

V. Conclusion And Results

- Proper early failure detection methods and potential failure prediction or detection is fundamental for effective maintenance management. This reduces the probability of failure which leads to plant shut down and thus improving OEE. To reduce the adverse effects of breakdown and to increase the equipment availability at a low cost, FMEA Is a key reliability analysis tool that needs to be instituted in industrial set-ups.

The FMEA benefits:

- prevention planning,
- identifies change requirements,
- cost reduction,
- decreased waste and warranty costs,
- reduce non-value added operations,
- systematic procedure,
- acknowledged procedure,
- knowledge transfer through departments,
- risk management instead of crisis management,
- Determination of failure modes.

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