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Implementation of TFMEA in Automatic High Pressure Line Casting Unit

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Abstract:- Total Quality Management practices are beneficial in achieving continuous quality improvement in manufacturing industries. An attempt is made to find out the potential failures in the automatic high-pressure line of a casting industry. Implementation of TFMEA on automatic high-pressure lines of casting industry is seen to bring down the number of rejections per batch.

Keywords:- *QM; TQM; TFMEA; HP Line; FMEA.*

I. INTRODUCTION

Total failure mode and effect analysis namely TFMEA comes under quality management techniques to determine the chances of failures in a system. QM and TQM are widely used in industries for continuous quality improvement. The United States, Japan and The European Union have been implementing total quality management since the end of the twentieth century as a preferred technique to improve quality. MEA is an approach for identifying all possible failures in a design, a manufacturing. To improve the effectiveness of FMEA a literature [1] present an FMEA using fuzzy evidential reasoning approach. Conventional FMEA may lead to wrong decisions in terms of company's financial objectives. The literature [2] aim to develop an improved approach in prioritizing failures within the procedure of the FMEA. Even though FMEA is an effective technique for continuous quality improvement, since not feasible practically, it is unable to penetrate into real-time environments. TFMEA can be considered as an improved version of failure mode and effect analysis [3]. In literature [4] suggestions were made to gain the acceptance of TFMEA program. In the literature [5] TFMEA has been implemented in the forging industry. In this paper an attempt has been made to gain zero failure in the automatic High-Pressure line casting unit. Initially casual meet ups and interviews were conducted among employees of various departments. An attempt is made to implement TFMEA in the production line of the industry. The implementation suggestions of TFMEA in automatic high-pressure line casting are discussed in this paper. MEA being an analytical technique its application in real time conditions are difficult, for better results an advanced version of FMEA that is TFMEA is used to attain zero failure in the automatic hp line unit. This paper also suggests some suitable remedial actions. To prevent potential failures. Financial analysis on implementing TFMEA is also discussed in this paper.

II. ABOUT THE COMPANY

The company PQR selected for this case study is a public-sector unit of casting run by the Government of Kerala, India, established in 1981 and started commercial production in the year 1986. The optimum capacity of the unit is 18000 tons per annum. They manufacture castings like cylinder block, cylinder heads for the entire range of automotive engines. It has separate lines to cover the entire automotive castings for the smallest to the largest such as housings, pulley, manifold, brake drums. This company manufactures pump castings, machine tools in addition to automotive castings. The company has mainly two casting units, conventional casting unit and fully automatic high-pressure line unit called hp line. It is a German made fully automatic casting machine unit. The main processes include production of several types of machine components by various manufacturing processes such as casting, forging, forming etc. TFMEA can be implemented in any part of the organization to determine chances of failure and suggest suitable preventive measures.

III. MAIN OBJECTIVE

Extensive literature survey has been conducted and it was found that TFMEA can be implemented only with the involvement of top management [5]. TFMEA implementation is a team work with the involvement of various departments and its employees in an organization. Interdepartmental co-operation is also necessary for the achievement of TFMEA. As a result of implementation of TFMEA the quality of the product can be improved. It is important to find out the soft areas to implement TFMEA. Here the soft areas to implement TFMEA are Automatic high-pressure line casting production unit and administrative department. The next step followed is create methods and procedures for recording failures, change the organization for carrying out TFMEA, identify associated departments, develop TFMEA tables and cards. The next step taken after preparing the TFMEA card is a top level managerial meeting to discuss about the documentation. This meeting is very significant and acts as a central controlling

unit for the implement the technique TFMEA. Here action plans for the suggested remedial actions need to be framed.

IV. RESEARCH METHODOLOGY

The TQM trend in the company has been determined by casual interview among all levels of employees in the automatic casting unit. *Fig. 1* shows the flow chart of the TFMEA implementation. In the literature it was revealed that if the mean assessment value of the respondents is above 7 when plotted The Liker's scale of range 0-10, it is recommended to go for implementing TFMEA [1]. Here in this research work the mean assessment value is 8. Hence TFMEA can be implemented to improve the quality of the product manufactured in the automatic HP-line.

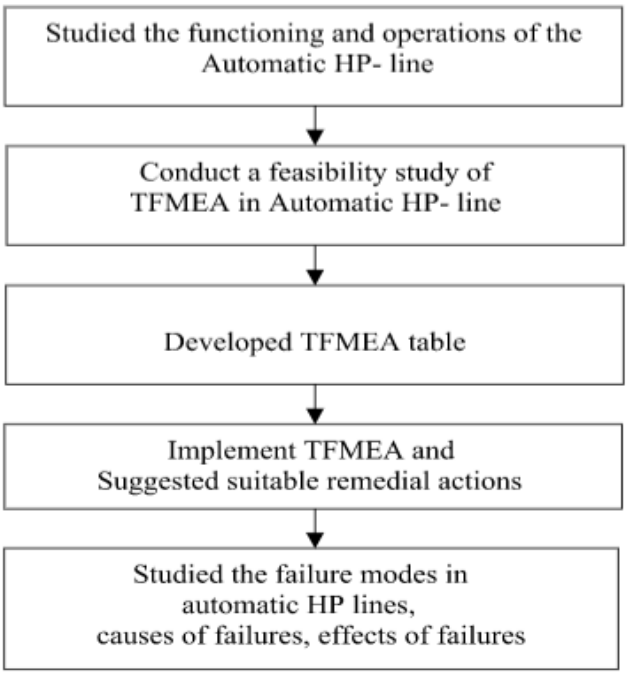

Fig. 1 Flow Chart of Tfmea Implementation

The mean assessment rating is found to above 7 in the automatic high-pressure line casting unit. Then it is preferable to proceed ahead with implementing TFMEA. Exposing the importance of failure prevention to the managers and convincing them about the continuous quality improvement through failure prevention is the next step taken. All failures that prevent the growth of the company especially in the automatic high-pressure casting unit have listed out. Prevention of these failures and its importance has been discussed with the managers. The company PQR is aware about FMEA and has practiced only once for the purpose of documentation. This is found to be due to difficulty in doing FMEA by the illiterate workers in the company. TFMEA is a comparatively improved technique to be followed by illiterate workers. Once the workers are aware of the procedures to implement the technique the execution process become uncomplicated.

A. Defect characterisation

There were two distinct journeys that was taken to correct the occurring defects. They are "the diagnostic journey from symptom to cause and the remedial journey from cause to remedy". There is a temptation to attempt to diagnose a defect by the probable causes; but, an incorrect diagnosis of the root cause can lead to an incomplete or incorrect remedy of the problem. It is important to correctly identify the defect symptoms prior to assigning the cause to the problem. False remedies not only fail to solve the problem, they can confuse the issues and make it more difficult to cure the defect. Possibilities of the implementation of TFMEA was studied based on the discussions with the officials and laborers. The literature [6] reveals that quality improvement techniques will be successful if the employees are able to express their desire and ability in improving the product quality of the company through the technique of brain storming. A brain storming session was conducted to find out the answers to the prepared questionnaire. The following defects were observed in the castings:shaping faults arising in pouring, inclusions and sand defects, shrinkage defects due to volume contraction in the liquid state and during solidification, gas defects, contraction defects occurring mainly or wholly after solidification, contraction defects occurring mainly or wholly after solidification, compositional errors and segregation. These defects are documented in TFMEA table by the selected TFMEA team members.

B. Defect analysis

Defects in castings often appear unexpectedly and it is difficult to identify. Once the defect has been properly identified, all the causes must be examined in order to point out the root cause of the problem. The fish bone diagram is an analysis tool that provides a systematic way of looking at effects and the causes that can create or contribute to those effects. Because of the function of the fishbone diagram, it may be referred to as a cause and effect diagram [7]. As a team effort that involves the quality techniques of brainstorming to uncover all possible contributions to the defect and the fishbone diagram to lead the way to corrective action. This is a common method to creatively get a high volume of input into a problem. A brainstorming session starts with a group whose participants all have information on the detected defect. All members give their ideas while one person writes down the suggestions. A central concept to this strategy is that no idea is criticized. All suggestions are used as springboards for additional ideas. Ideas are solicited during this session until all possibilities are exhausted. The group reviews the list and duplicate ideas are discarded. This list becomes the basis for the evaluation for the root cause. Once the root cause has been determined, corrective action can be taken to insure the problem will not recur. Brain storming technique and the fish bone diagram were helpful in analyzing and detecting the root cause of the defect. These are recorded in the TFMEA table.

C. TFMEA implementation

After studying the TQM trend in the company expose the importance of eliminating potential failures to the managers and employees in the company. Assess the interest among all levels of employees to implement TFMEA to achieve zero failure. Then list out all the failures, their causes, effects and remedial actions along with the interacting departments. With this information form the TFMEA table for

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each department. Failures are found to be critical I automatic high-pressure line casting unit. Table 1 shows The TFMEA table of HP -line.

Failure mode	Cause of failure	Effect of failure
Shaping faults arising in pouring	Lack of fluidity Faulty design Faulty gating	Unexpected product profile, Rejection of product
Inclusions and sand defects	Uneven compaction of sand in molds Breakup of moulds	Voids formation
Gas defects	Metal pouring temperature too low	Rejection of product
Shrinkage defects due to volume contraction in the liquid state and during solidification.	The density of a die casting alloy in the molten state is not as much of its density in the solid state. Therefore, when an alloy changes phase from the molten to the solid state, it always shrinks in size.	Not in required dimension, hence rejection of casting
Cold shut	Low melting point temperature or poor gating system	Metal unable to fill the mould cavity completely, Rejection in casting
Mismatch	This defect is due to the shifting moulding flashes and cause dislocation at the parting line.	Dislocation at the parting line

Table 1. Tfmea Table of Automatic Hp-Line For Casting

D. Corrective action

The correction of defects will vary depending upon the root cause. The corrective action for these defects will either involve making some change in the process to avoid the defect; or corrective action will involve controls to keep the process from deviating from its proven path again. The observation of one defective piece does not inevitably imply that the process is out of control. It has been well established that "predictable performance is not necessarily the same as desirable performance". It is unavoidable that a defect will occur even in a tightly controlled process. Preventing that defect from recurrence is the only way to ensure that a designer's vision will be realized in a casting. The corrective action has been taken by the central control unit considering the TFMEA card where failure mode, cause of failure, effect of failure, interacting departments, present control was documented.

The lack of fluidity in casting can be controlled by controlling the pouring temperature. If pouring temperature is high, the molten metal contracts more. The casting expands more in the absence of feed metal. Sinks, drawn and pipe occur in the last areas to solidify. The design of mould and gating should be proper to get required shape to the casting. Correct compaction of the sand has to be done to avoid the breakup in mould. To eliminate shrinkage in castings, ensure that the liquid metal under pressure continues to flow into the voids. The remedial action for mismatch is by use of proper molding box and closing pins.

V. CONCLUSION

In actual practice implementation of TFMEA in an organization is not as easy as it seems to be. A team of experts along with workers from every department was formed. The management needs to be convinced and given proper awareness about the technique and the preventive actions to be implemented. Studied the TQM trend in the company and give awareness to all levels of employees in the company. The soft areas to implement TFMEA is found to be un production department. List out all failure modes, TFMEA tables and TFMEA card were formed. In consultation with the central controlling unit, corrective actions have been taken.

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