FMEA IN MANUFACTURING OF CAR PART OF TLAXCALA. MÉXICO

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Abstract

The methodology of analysis modes and effects of faults (AMEF, FMEA, Failure Mode and Effects Analysis). It provides guidance and steps that a group of people should continue to identify and evaluate the potential failure of a product or process, together with the effect that cause them. From the above, the group sets priorities and decide actions to try to eliminate or reduce the possibility of potential failures occurring more product reliability violate or process.

Keywords: Product, Process, Failures, Reliability, Analysis.

1.0 Introduction

The tools for risk management support a scientific approach to decision-making, while provide documented, reproducible and flexible methods [1]. Among them are: analysis of failure modes and effects (AMEF); effects analysis, failure modes and criticality (AEMFC); hazard analysis and operability (APO); fault tree analysis (AAF); Preliminary Hazard Analysis (APP) and hazard analysis and critical control points (ARPCC). In this work the AMEF is used because it is a standardized analytical method to detect and eliminate problems in a systematic and overall, the objectives are: Recognize and evaluate the potential failure modes and causes associated with the design and manufacture of a product; determine the effects of potential flaws in system performance; identify actions that could minimize or reduce the opportunity for potential failure occurs; analyze system reliability and document the process. Its advantages are: Improve the quality, reliability and safety of a product or process; increase customer satisfaction; gather information to reduce future failures and deepen knowledge engineering; identify and eliminate potential problems early and reduce the time and cost of system development; emphasis on solving problems; minimize last minute changes and their associated costs and catalyze teamwork and exchange of ideas between departments [2]. The FMEA as a systematic methodology to identify problems before they occur and may affect or impact the processes and products in a given area under a given operational context. With the completion of the FMEA, the information needed to prevent the consequences or effects of possible failures, from selecting appropriate maintenance activities, which act on each failure mode and its possible consequences is obtained [3]. Total Productive Maintenance. It is a philosophy designed to integrate all maintenance of production equipment manufacturing process. Your objective is to eliminate losses linked to maintenance of equipment that serve to produce salable goods with sound equipment as fast as possible and without unexpected shutdowns. It is a management system designed to facilitate the performance of the industry. It relies on the proactive participation of all staff that makes up the company, including suppliers [4]. Six Sigma involves taking an active position to change, adopting a new "mental state" where the way they have been managing processes is in question. Under this consideration apply statistical methods to support decision making. The assumptions on which the operation and improvement of business processes is based, must be supported with data [5]. Remanufacturing is carried out as an industrial activity for at least a hundred years ago in the United States although it was not known by that name [6]. Remanufacturing defined as the process of return of a product used to a status equal to that of a new one, including the warranty. Currently, there are multiple examples of remanufactured products that can be acquired at a price from 10 to 70 percent lower than the equivalent new, with the peculiarity that some have lifetime warranty. Examples of remanufactured products include ink cartridges for printers and / or copiers, the auto parts industry (startups, shock absorbers, energy storage, pads, etc.), components of heavy machinery and industrial gas turbines [7]. The remanufacturing industry includes many market sectors and provides significant economic, environmental and social benefits [8], [9], and [10]. Successful companies in a variety of industries including Dell, General Motors, Hewlett-Packard (HP), IBM, Kodak, and Xerox, among others, which have adopted remanufacturing in different ways [12], [13]. The problem is that remanufacturing is the most complex network within reverse logistics activities. [15]. There is a high degree of uncertainty in terms of a) amount, b) quality c) the time period in which the consumer will make the return. The above factors make the remanufacturing is more complex than conventional manufacturing process, since remanufacturing planning is done, depending on the availability of core (product / component base or core on which the process is performed remanufacturing) and the conditions under which the process returns. Therefore it is of interest to know the answer to the following questions: • How can it be defined and modeled a remanufacturing system, taking into account their structural and operational factors? • What applications have been given to the measurement of the complexity in manufacturing, models generated based on? • What are the effects of complexity in the process? • What are companies doing to manage the complexity of the recovery system in the remanufacturing process?.

2.0 Proposed Methodology

In the format FMEA circled numbers figure 1, corresponding to the information that should be noted in each of the following format to explain each of these numbers. This format has allowed a uniform development of the FMEA. An example and a blank form appears in the figure 1.

1. Home /De: note the row for the page number where you work and From: Write the total number of sheets to complete the FMEA.
2. Project's name: note the number of project for which this analysis, according to the criteria used in the company.
3. Process: register the name of the process or operation on which the analysis is being done.
4. Product concerned: register the name and / or models (os) product (s) that occur in this process.
5. Responsibility: write the name of the person who has primary responsibility for the process, management has the primary responsibility of the machine, equipment or process.
6. Project leader: write down the name of the technician responsible for the project.
7. Prepared by: record the names of people you did in this FMEA.
8. Key Date: write mandatory date should be completed this FMEA, either for some special reason as production liberalization commitments or time goal in the team decides imposed.
9. FMEA original date last reviewed: if it has already done once an FMEA on this process, note the date of the first FMEA and the date of the last formal review.
10. Depending on the process (identification and purpose): Give a brief description of the function of the process tested, noting the main steps of the process and its corresponding function.
11. Potential failure mode: It is the way the process (system component) could potentially fail in meeting requirements. At this stage you should record all potential failure modes, without taking into account the probability of their occurrence. The analyst must be able to answer the following questions: How the process or part may fail in meeting specifications?. Regardless of the engineering specifications, you consider what a customer as objectionable?. A review of similar processes, reporting quality problems and customer complaints as well as previous AMEF on similar components is a good starting point. Modes or ways of typical failure are: Inadequate opening, Short circuit, Material failure, Worn tool, Operation missing, Damaged part, Inadequate control system, Incorrect speed, Handling damage, Tooling incorrect, Inadequate lubrication, Inadequate measurement, Lack of lubrication, Overheating, Out of tolerance.
12. Effect (s) of the potential failure: are defined as the effects of the failure mode, this negative effect can occur in the same process on a subsequent operation or the end customer. Thus, assuming that the fault has occurred at this stage should describe all the potential effects of the failure modes identified in the previous step. A key question for this activity is what will cause the failure mode

identified? The description should be as specific as possible. Typical descriptions of the potential effects of failure from the perspective of the end user of the product are: The product does not work, End efficiency reduced, Rough, overheating, noise, unpleasant odor, instability, bad appearance. While from the perspective of a subsequent operation, potential effects is typical: No buckles, Endangers operators, you cannot drill, Not assembled, you cannot mount, Unable to connect.

13. Severity(S): estimate the severity of the effects listed in the previous column. The severity of the potential effects of failure is evaluated on a scale from 1 to 10 and represents the severity of the fault to the client or to a subsequent operation once the fault has occurred. The severity only refers or applies the effect. You can consult product engineering degrees recommended or estimate the severity applying the criteria in Table severity. The effects can manifest itself in the end customer or the manufacturing process. You should always first consider the final customer. If the effect occurs in both, use the highest severity. The team should agree on the evaluation criteria and the grading system is consistent.

14. Control or critical items: use this column to identify or classify critical process characteristics that require additional controls; therefore he must notify the head of the design process.

15. Cause / mechanism of potential failure (failure mechanism): make a list of all possible causes for each potential failure mode. Understanding the cause of fault how the failure could occur. Each cause occupies a line. Ensure that the list is as complete as possible, for it Ishikawa diagram, relationship diagram or tree diagram can be applied. Typical causes of failure are: Inadequate opening, Excessive load, Operation missing, Handling damage, Inadequate control system, Equipment failure, Worn tool, Inadequate lubrication, Damaged tool, Damaged part, Inadequate preparation, Overheating, Incorrect speed, Inaccurate measurement, Lubrication failure, Tooling incorrect.

16. Occurrence (O): estimate the frequency with which it is expected failure occurs because each of the potential causes listed above (How often is such active failure mechanism?). The possibility that each potential cause (that the failure mechanism is enabled) occurs, it is estimated on a scale from 1 to 10. If no adequate statistical records, they must be used to assign a number to the frequency of occurrence of the failure. It is important to be aware and use the criteria in the table to assign such numbers. If no historical data I could be a subjective assessment using the descriptions in the first column of the table.

17. Current detection process controls: make a list of current process controls that are aimed at: a). Prevent the cause of failure or control mechanism to reduce the rate of failure occurs. b). Detecting the occurrence of the cause of the failure mechanism, so that corrective action can generate. c). Detecting the occurrence resulting failure mode. Obviously, the type controls a) are preferable, once the type, b) and less are preferred rate controls c).

18. Detection (D): with a scale of 1 through 10 estimating the probability of rate controls b) and c) detecting the failure (effect), once it has occurred, before the product goes to subsequent or processes before they exit the manufacturing or assembly area. It must be assumed that the cause of failure has happened and then evaluate the effectiveness of existing controls to prevent the shipment of the defect.

That is, it is an estimate of the probability of detecting, assuming that the failure has occurred, and is not an estimate of the probability that the failure occurs. Isolated checks made by the quality department are inadequate to detect a defect and therefore not result in a noticeable change of the degree of detection. However, the sampling done on a statistical basis is valid detection control. Table recommended to estimate the probability of detection criteria are displayed.

19. Risk priority number (NPR): NPR to calculate the effect-cause-control, which is the result of multiplying the severity score given to (S-13) effect fails, the probability of occurrence (O-16) for each cause of failure, and the chances of control mechanisms detect (D-18) each cusa fault. That is, for each effect have various causes and for each cause a group of controls. NPR = (S) x (O) x (D). The NPR falls within a range from 1 to 1000 and gives a relative indicator of all causes of failure. A higher number of NPR were priority should be given to remedial actions, and either to prevent or at least cusa to employ best detective controls. Special attention should be given when NPR high (greater than 80) with higher severities are taken.

20. Recommended Actions: In this column a brief description of the highest recommended corrective actions described NPR. For example when there is little understanding of the causes of the failure, then the recommendation could be running a project to improve based on the "eight steps in solving a problem (the quality cycle). A well-developed FMEA process and thought will be of limited value and effective corrective actions are not completed. It is the responsibility of all affected areas to establish effective monitoring programs to implement all recommendations. Corrective actions that meet the highest NPR are generally for the design or process. Based on the analysis, the shares can be used for the following: Generate solutions that avoid, prevent or at least reduce the likelihood of failure due to the associated cause. These solutions must be a process or product design level. The tools can be used to generate a good solution are: methodology of the eight steps, design of experiments, Poka-Yoke, systems or control charts. Sometimes it is possible to reduce the severity of the failure mode of the product by modifying its design. To increase the probability of detection require revisions to process. Generally, an increase controls of detection is costly and ineffective in improving quality. An increase in the frequency of inspection in the quality department is not a positive corrective action and should be used only as a last resort or a temporary measure. In some cases it may be recommended a change in the design of a specific part to aid detection. Changes can be implemented in existing control systems to increase the probability of detection; however, emphasis should be placed on preventing defects (i.e., reducing the occurrence), rather than its detection; for example, having a statistical process control techniques rather than random sampling. Another possibility is to design a Poka-Yoke mechanism that upon joining the process itself ensure full detection of the defect before it has worse consequences.

21. Responsibility and promised date for recommended actions: specify the area and people responsible for implementing the recommended actions, with the promised date for concluding such action. 1. Actions taken: a follow-up and once the action has been implemented, record the result of it. 2. Resulting NPR: once corrective action has been carried out, information must be updated to score

severity, occurrence and detection to study the cause of failure. All resulting NPR should be reviewed and if necessary consider further actions to this end steps are repeated 20 onwards. Tracking: those responsible for the process are required to ensure that the recommended actions are effectively addressed and implemented. The FMEA is a living document that must always reflect the latest state of process failures, the actions that have been undertaken to address them. It is therefore important that the FMEA are part of the basic documentation of the process and for major faults a history and an updated version of the FMEA is taken. Particularly in the columns of shares must be an assessment of the latest state of the importance of faults. So whenever there is a major change in the occurrence of a failure in its severity or control mechanisms, it is necessary recalculas the NPR. Characteristics of an effective FMEA: the following eight characteristics distinguish effective FMEA:

- All special features are included in the design and the process.
- We calculated the initial NPR.
- It defined what is meant by "High".
- All have high NPR corrective actions.
- Have incorporated elements foolproof (Poka-Yoke).
- The NPR have been recalculated.
- AMEF reflects the new NPR, in other words up to date.
- The NPR are still high, are indicated in the management plan and in the operating instructions.

ANALYSIS OF FAILURE MODES AND EFFECTS (FMEA)			
		FMEA Number 1	
		Page of	
Number of parts 2	Process responsibility 3	Prepared by 4	
Model year(s) / Carrier(s) 5	Key date 6	Original date of FMEA 7	Review
Key equipment 8			Results of shares

Item depending on the process / requirement 9	Potential failure mode 10	Potential effect (S) fault 11	Severity	Classification 13	Potential cause (S) / Mechanism (s) failure 14	Idea	Prevention controls 16	Detection controls 16	Detection	RPN 18	Recommended Actions 19	Responsibility & Target Completion Date 20	Actions taken 21	Sev	Occ	Det	RPN
			12			15			17								

Figure 1. Analysis of failure modes and effects.

3.0 Result

Students of the School of Industrial Maintenance Tech University of Tlaxcala, in activities relating to technical TPM / RCM. Eighth semester do a FMEA in auto parts manufacturing industries of the State of Tlaxcala to provide assemblers of cars of different brands and enabled them to make the process FMEA taking into account the following guidelines for severity, occurrence and detection process on assembling of cars.

												FMEA Number					
												Page	of				
Número de la parte: N/A			Responsibility for the process: Maintenance						Preparado por: Daniel Iván García García (247-108-48-12) UTT								
Año Modelo (s) / Vehiculos (s): 2015, FOCUS			Fecha clave: Diciembre 2014						Fecha Original del FMEA: February 2014				Revisión				
Equipo Clave													Results of shares				
Item Función del proceso / Requerimientos	Modo de falla potencial	Efecto potencial (s) de falla	Severidad	Clasificación	Causa potencial (s) / Mecanismo (s) de falla	Ocurrencia	Controles de prevención	Controles de detección	Detección	R P N	Acciones Recomendadas	Responsability & Target Completion Date	Acciones tomadas	S E V	O c c	D e t	R P N
Generate energy to recharge the car battery	I winding aterrisado	Battery not charging	9		Lack of maintenance	3	There is not		10	270	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	5	1	7	35
	Bearing in disrepair	The alternator is tied	7		Lack of maintenance	6	There is not		9	378	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	3	4	4	48
Engine thrust required to turn	Winding landed	Engine does not start	10		Lack of maintenance	2	There is not		10	200	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	7	1	8	56
	Coals	It does not generate energy for the march to work.	7		Lack of maintenance	9	There is not		10	630	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	5	8	6	240
Sparkle Crer otto cycle	Generates carbon layer	It does not generate spark	9		Overuse	5	There is not		8	360	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	6	4	5	120
	bad calibration	Very weak spark	9		Lack of maintenance	9	There is not		7	567	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	6	3	5	90
Transform the chemical energy that provides the combustion in energy	Hard starts	Lack of gasoline in the carburetor	10		Lack of maintenance	7	No effect		7	490	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	6	8	4	192
	The engine stops at idle	Low engine temperature	10		Lack of maintenance	6	No effect		9	540	Select a trained mechanic for preventive and corrective maintenance	Daniel Ivan April 2015	Recommended actions taken	5	5	5	125

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