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USING THE FMEA METHOD FOR QUALITY ASSURANCE OF THE MAINTENANCE WORKS

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Abstract — Given the increasing complexity of equipment, quality claims of the beneficiaries, reducing design and launch periods, there should be a systematic quality planning of the maintenance. Through this planning we ensure that the initially avoidable defects, will not be corrected later. From the practical operation of the equipment has been shown that the cost of correcting a defect detected in the previous step may increase up to 10 times from one stage to another implementation. The paper presents the FMEA method for (Failure Mode and Effect Analysis is) which allows the systematic study of the causes and effects of failures that may occur during an operation of a machine. This method ensures system reliability evaluation forecasting, analyzing the various failures that it may have during its use. For this to be possible failures must be systematically examined, evaluating the severity of their consequences, and triggering corrective actions according to their degree of importance.

***Keywords*—**failure, fmea, maintenance, repair

I. INTRODUCTION

INDUSTRIAL maintenance represents a set of measures and actions that allow the prevention, the good maintenance or the reestablishment of an equipment in a foreseen state or capable to ensure a certain service in the conditions of minimizing the maintenance costs.

Considering these definitions, the following conclusions [1] can be drawn:

1) Here "to restore" means "to correct", a meaning imposed by the change of the initial value of the device's functioning parameters;

2) Appointed state or determined service involves the predetermination of the functioning parameters or the service to reach, with the quantification of the characteristic levels;

3) To minimize the maintenance costs reflects the business' economical aspect;

4) Prevention – a set of operations used in order to avoid the device's unavailability state;

5) The good keeping in a given state consists in the application of some methods, procedures, proceedings and actions which contribute to the progress of maintenance in the four main directions .

The maintenance function evolved within industrial units, being subject to a continuous refining process, considering the compromise which needed to be performed between needs and exigencies, from the technical, economical and human point of view.

Historically speaking, until the 1960s, the maintenance activity remained synonym with the repair one, improving the equipment as often as possible. Systematic maintenance is applied only in the case of equipments with incidence on the human safety, stopping them for the mere reason of analyzing their wear and tear level, being completely abandoned in case the people's safety was not endangered.

In its evolution, between 1960-1970 [1] the industrial maintenance notion was enriched with the following new conceptions:

1) The diagnostic maintenance appeared through the use of non destructive techniques for the vibration control, the fluids' analysis, the surveillance technique appeared, which later led to the conditional maintenance;

2) The research regarding the reliability theory and the processing way of the experimental data on the solicitation, damage and duration were more extended and detailed.

3) The following were improved: the risk assessment evaluation method and the damage occurrence probability, the economical effects of the quantity or quality of products, including the hidden costs of the maintenance activity, reflected in the notion of decrease cost.

II. ANALYSIS OF FAILURE, EFFECT AND CRITICALITY – FMEA

The FMEA method consists of systematic investigation of the influence of defect elements on the other components and the safe operation of equipment. The method determines the potential hazards and establishes measures to reduce the likelihood of occurrence of defects and elimination or reduction of

their influences. In the method we have to take into account different failure rates and their causes.

FMEA is a method of analysis that attempts to pool their skills working groups involved in the production process, to develop an action plan aimed at increasing quality of products, work processes and production environments.

This method is oriented in three directions: the product-design, product, process, means of work-machine.

FMEA product-design: allows tracking and analysis of products from the design stage, trying to emphasize that potential faults and their implications for the utility of the final product.

FMEA product-process: it allows validating technologies to achieve a product so as to ensure its efficient fabrication. In the management of maintenance activities will mainly use such a method.

FMEA means of work - machinery and FMEA-product can be used in developing plans [2] to improve maintenance

In the management of the maintenance activities there will mainly be used a means of work type FMEA method – machinery, but FMEA as well – so the product can be used in developing plans to improve the maintenance

When a failure occurs, the main problem for a specialist is to identify the cause of it. The answer is not easy given for the following reasons:

1) cause of the fault can be caused by the appearance of another defect located downstream of the technological chain;

2) for the latest generation equipment maintenance the cause may be of unknown nature;

3) because the defect is covered outside the jurisdiction of the person in charge of the maintenance.

This method consists of a systematic analysis of possible failure modes, with the determination of causes and effects, and the establishment of critical defects. The method searches the knowledge and means to avoid or minimize the causes of failures consequences.

It is recommended that at the application of these methods to select the key-machineries of the technological processes, because their failures lead to significant loss of production.

In order to apply the AMDEC method, is necessary to form a multidisciplinary team in order to identify the causes of the defects. The team should consist of an animator, good connoisseur of the method, as well as representatives of the departments of production, and those of quality assurance and maintenance

The FMEA method's [2] objectives are:

1) identification of critical points of a machine;

2) determining the causes of the malfunction generating machine parts;

3) analysis of the effects on the environment and safety in the operation of the equipment;

4) establishes corrective actions to avoid the causes of occurrence of defects;

5) designing a program to improve product quality and maintenance;

6) provides the best level of communication between the compartments of work between individuals and hierarchical levels

The fundamental objective of FMEA method is to develop a plan to improve the maintenance activity.

The main stages of the practical application of this method are:

1) The delimitation and numbering steps.

2) The name of the machine component and brief description of its functions.

3) The formulation of hypotheses concerning the nature of failure, this step consists in considering each element of all possible defects.

4) Presenting possible cause for the type of defect involved. This step is useful to calculate the probability of defect and to establish the necessary safeguards.

5) Description symptoms that manifests the defect and its location possibilities.

6) The description of the effects that the defect has regarding the safety in the machine functioning and the fulfillment of the functions it was projected for.

7) Description of measures taken to decrease the probability of failure and the influence it has on the machine.

8) Determine the probability (or rate) of failure, taking into account the causes of the occurrence of the defect.

9) *The development of the plan including measures to remove the defect.*

The practical application of the FMEA method, through the steps shown, is performed by a multidisciplinary team consisting of representatives of the departments of production, quality assurance and maintenance.

For the determination of the criticality of the defect it is necessary to quantify the following factors:

1) *The frequency of occurrence* of the fault (F), which expresses the probability of it.

2) The severity of the defect (G) expresses the magnitude of the effect of failure and can be expressed by the average repair (MTR).

3) *Defect detectability (D)* determining the probability of occurrence of the cause of the defect..

Based on the above, the criticality of the defect is determined from the relationship:

$$C = F \cdot G \cdot D \qquad (1)$$

The difficulty of practical application of the FMEA method is to accurately assess the three factors F, G, D, this can be achieved only through leadership and consultation equipment malfunctions history.

In some enterprises the severity of the fault is encoded by the beneficiary, situation in which the supplier must avoid gross deviation from the rules imposed by it.

The application of the method is the use of standard forms, [3]-[5] which must contain the information necessary to identify the defects, their causes and about the means necessary to eliminate them .

Analyzing the data completed in the AMDEC sheets will make a plan to improve the situation,[6]-[8] trying to reduce the value of each clues G, D and F. In order to increase the efficiency of maintenance, it is sometimes useful to undertake specific assessments based on the values of these indicators.

III. CASE STUDY

The study was conducted at the company S.C. "METALICA" S.A. Oradea, a unit derived from an ancient craft cooperative founded in 1949, with the activity object of producing in small series some household products including boilers, cans, etc. In 1959 the cooperative becomes a state enterprise and introduces new products as vices and drill machines, and in 1963 it became a state enterprise.

The activity object of the company is to:

1) Manufacture consumer goods on a large range, including: cookers and gas stoves and electrical spare parts for cookers, cooker hoods, leather accessories, boilers for apartments, tools and dies.

2) Design of products, SDVs, technologies and software,

3) Marketing of products, export-import operations, construction and assembly activities,

4) Service providing operations.

The company "METALICA" S.A is the second largest domestic manufacturer of gas and electric cookers. In 2002 the unit was ranked on the fourth place in the country among small and medium-sized branch enterprises which produces electric household equipments.

The company's share capital is divided into 718.721 registered shares of which 49% belong to individual shareholders and the Association "METALICA" P.A.S holds 51% of them.

The company's shares in a ratio of 49% is traded on the RASDAQ market, and the records of the shares is held by the Independent Register of RIAVEST Timişoara

The objective of the study is the analysis of the failure of the normal lathe SN 400x1500 and its effects of the production . The lathe was chosen because it is a key equipment for the following reasons:

1) extensive technological possibilities of this machine;

2) high productivity and decisive economic impact on company results;

3) high representativity of this type of machine in the mechanical unit.

Team AMDEC consists of :

1) the coordinator,

2) the foreman from the production compartment,

3) an operator from the quality assurance compartment,

4) a maintenance operator.

The data needed was extracted from the file containing the history of maintenance activities performed on the lathe and the sheet defect analysis , and by matching them with indicators in tables [9] and the criticality calculation, the coefficients appreciation of Table I have resulted.

Based on the results in the table, the following conclusions can be drawn:

1) The highest critical point is presented by the defects of the bearings on the main axis, which definitely affects the functioning of the lathe. The main causes leading to damage to the bearings are:

a) their incorrect assembly,

b) improper lubrication,

c) The attrition of the material.

Most frequent stoppages are due to the wear of the transmission belt.

2) Although it is rare, the guides failures - especially due the wear from the friction - are the worst. In this case, returning the machine requires a longer time (about 2 weeks).

As a final result, for the more efficient use of the normal lathe SN400x1500, it is needed **a** plan to improve the quality and maintenance, containing at least the following measures:

1) Using high quality oils for the increased reliability of the pinion bearings and the gearbox;

2) To equip the machines with measuring and control devices in order to determine the degree of usage of moving parts;

3) Compliance with the maintenance programs Level I and II and their optimization (by MBF - maintenance based on reliability), in order to reduce the severity and frequency of the machine failures in all its parts..

IV. CONCLUSIONS

The FMEA method can of course apply to all types of machinery, regardless of the economic branch. Criteria may receive specific aspects that being a matter for the team FMEA to determine the priorities of the study in terms of frequency, severity and detectability. Results can successfully lead to the formulation of quality and maintenance priorities and their integration into the company's strategic plan.

TABLE I
FMEA FILE FOR THE NORMAL LATHE SN 400X1500

Subassembly	Possible main defects	Potential main causes	Main effects	F	G	D	C
Gear box	defects in main shaft bearings	- Inadequate lubrication - Fatigue wear	Oval parts	3	7	1	**21**
	Defects of the pinion in the gearbox	- Inadequate lubrication - Fatigue wear	Defect parts	3	5	1	**15**
	Padlock usage of the trolley	Abrasion	Defect threads	1	5	1	**5**
	electromagnetic couplings defects	The burning of the winding	Inoperative electric engine	1	6	1	**6**
	Defects of the bushed on quid	The usage of the gears	Defect parts	1	5	1	**5**
	Defects of the wheel lug ballads	- shocks - Blunt tools - Inadequate lubrication	- vibrations - Breaking of the gear's teeth - Breaking of the feathers - Twisting of the trees grooved axes	1	5	1	**5**
	The usage of drive belts	- overload - buffering Leakage of lubricants belts	- the stop of the machine - vibrations	6	3	1	**18**
The bed lathe	defects of the bedframe guides	Usage by abrasion	Defect parts	1	10	1	**10**
	defects of the trolley's prism	Usage by abrasion	Defect parts	1	6	1	**6**
	Defects of the mobile doll	Usage by abrasion	Defect threads	1	7	1	**7**
Electrical installation	TCA 32/AU=220V contactors	- Piercing the insulation between the contacts - The formation of the insulating film between the contact surfaces	Cutting off the electric supply of the engine	1	7	1	**7**
	The bearings of the electric motor	Fatigue usage	Stopping the engine	1	4	1	**4**
	Coil winding damage	The shorting of the coil winding	Stopping the machine	1	5	1	**5**
	Electric motor covers' defects	**-usage and blocking of the bearings -destruction of the rotor and the stator**	**-vibrations -stopping the engine**	**1**	**4**	**1**	**4**

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