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[1.] Olimpia Loredana COROIAN, [2.] Csaba GYENGE

PATTERNS OF ANALYSIS AND RISK INTERPRETATION FOR THE ROLLING STOCK REPAIR PROCESS

[1-2.] Technical University of Cluj Napoca, ROMANIA

Abstract: Due to increasing competition, reached the Romanian companies are being forced to restructure their activity in order to reduce costs. In order to fulfill this objective, and after we have analysed the current situation of a Romanian company, we have reached the conclusion that it is extremely useful to implement a maintenance system that, on one hand, it will lead to cost reduction, and on the other hand, it wil contribute to work safety and security, as well as to the enviroment's protection. The implementation of a unique method of analysing potential risks that appear due to equipment attrition and the development of a maintenance plan for the entire company as an integrated plan in the general management plan, constitute a general objective to achieve.
Keywords: analysing potential risks, implementation, work safety and security

1. INTRODUCTION

Most of the time, the production process presupposes several processes correlated between them in order to attain products. A system such as the one mentioned can be achieved by designing fabrication processes and operation sequence, and emphasizing the risks that pertain to each stage of the process.

In most cases, the production optimization assumes either the minimization of the fabrication cycle, or the cost reduction of the obtained product, or the correlation of the two functions: the dependence between time and cost to be as reduced as possible.

The repair process, or differently said, the maintenance, has been viewed as adjacent to the production processes and their importance was reduced because it affected the final cost of the product. Once company managers understood that the elaboration of a continuous maintenance program can cut costs down, and more, maintenance cost can be lower than repair cost in case of machinery malfunction, the attention given to this integrative part of the production process has increased considerably.

One of the main companies of Cluj, whose main activity consists of the construction, modernization and repair of railway rolling stock is SC Remarul 16 Februarie SA, a company that is attested and accredited to perform repair work by international institutions.

Along the tine, the company has well-performed its repair services on the locomotives of Romanian Railway, and because of professionalism has extended its activity to other beneficiaries.

The current document's purpose is to enumerate the main directions that need to be followed in order to set a risk based maintenance system within the repair activity of SC Remarul 16 Februarie SA, and its main objective is time reduction for this activity and implicitly, cost reduction.

2. SHORT PRESENTATION OF SC Remarul 16 Februarie SA

SC Remarul February 16th SA was founded in 1870 with the opening of the rail section Cluj-Oradea, it's the initial concern was the repair of railway wagons and steam locomotives.

The company has experienced rapid growth, and in 1871 has reoriented towards repair and maintenance of diesel-hydraulic locomotives, operations that since 1984 have been oriented to export by signing repair contracts in countries such as Greece, Poland, Serbia and Montenegro. In this period they concluded export contracts for repairs on some specific equipment for rolling stock equipment repair workshops in Egypt, Mozambique and Nigeria.

With the development and modernization of locomotives the company has adapted to new requirements to perform repairs and modernization operations on utility wagons of intervention trains that maintained and modernized the railway infrastructure, repair of electric locomotives of 2100 HP Diesel, repair of Duewag railcars, repair railcars of type LVT-LVS series number 79, periodic repair of passenger wagons series 19-47, 20-47, 19-57 and 20-57, modernization of hydraulic Diesel locomotives of 1250 HP for maneuver by featuring remote device, upgrading LDH 1250 CP by featuring generator, diagnosis and control air surveillance, air command

controller, LDE 2100 HP modernization, equipped for electric power supply of the travel train, repair with modernization and adapting to traffic on Romanian railways of the electrical frames with French origin, and re-monitoring and modernization LDH 450 HP with Caterpillar engine adapted to traffic in metro tunnel.

Figure 1. Pictures from SC Remarul 16 Februarie SA

Given that the construction of rolling stock occupies a very small share in the company's activities (perhaps nonexistent) attention is required on the repair and maintenance side, seen through the perspective of quality and also the inherent risks

3. WEAR CHARACTERISTICS THAT MUST BE REMOVED

In the maintenance process of rolling material we face most often whith the wear of the material, wear that must be slown down, for the normal lifespan to be as long as it can.

The wear must be perceived as beeing the deterioration process of physical quality or technological updates of an asset as a results of its use. If obsolescence (the use of asset become unprofitable because the emergence of new fixed assets, more efficient) it can't be controled, even more the advance of technology must be looked as auspicious, physical wear can be controlled and thus the quality of operations performed with the asset to keep for a longer period of time.

The wear as a physical phenomenon involve fine cracks and scratches on working surfaces, changes in shape of the processed parts and sometimes bendings and twistings of those. Also, as it grows the wear, we can have changes in hardness of the processed parts. The wear curve can be represented as a normal law, either as a gap (j) variation between the conjugated parts, either as a workpiece size variation depending on time.

Analyzing the wear curve by time, (figure 2), we differentiate 3 distinct periods [8]:

- First period – initial wear period, also called running-in period and denoted with T_r, phase in which workpiece irregularities is leveled intense under the action of frinction forces; wear in this phase is more accentuated, more intense.
- Second period – denoted with T_n, is characteristic to normal operating period and is characterizes by relative constant intensity of the wear; by a lower value. In normal wear operation phase, period T_n, until reaching maximum variation gap allowed it is higher. This period is also know as jointing durability and is calculated according to formula:

$$T_n = \frac{Jmax - jmin}{tg\ \alpha}\ ,\ \text{where tg } \alpha = \text{ct}$$

- Third period – also called failure wear T_d, is period further normal function wear. In this phase appears an increase in the variation gap, appears rattling, loud noises, heating and insufficient lubrication, and can lead to destruction of conjugated parts.

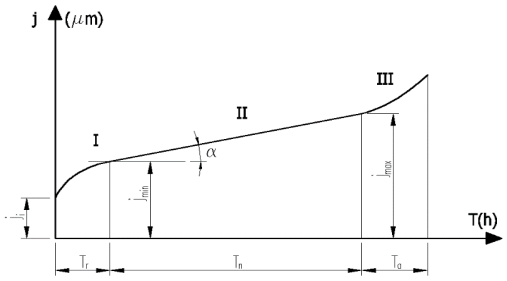

Figure 2. Wear variation

During equipment working period to increase the operating time it must be applied measures to decrease the intensity of the wear, and during repairs it must resorted to measures that reduces the gap variation up to a minimum allowable functional value.

Graphic analyzing the wear speed and the accleration, we conclude that the speed value is always positive and wear acceleration is negative or null on the running-in period and normal operating period, taking positive values in the risk failure operating period. Depending on acceleration values, it can be appreciated the normal operating period. In practice, in the absence of an adequate maintenance system, it can be notice repairs initiations made early or late, thus the importance of technical verifications and establishing technical condition of the equipment is beneficial. Moreover, using the equipment reach his third operating period will lead to possible risks that needs to be analyzed to implement methods to prevent or to eliminate their effects.

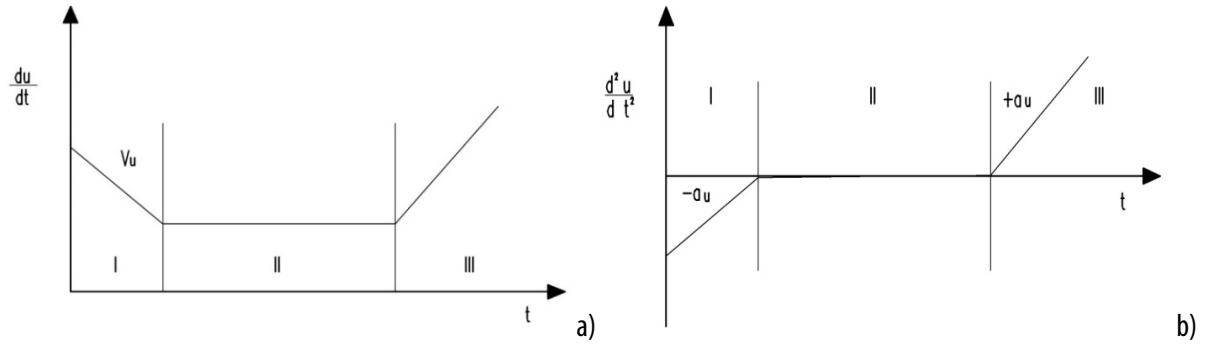

Figure 3. a. Wear speed for the 3 intervals, b. Variation in wear acceleration in time [8]

4. THE MAINTENANCE SYSTEM AT Remarul 16 Februarie SA

In accordance with STAS 8174 / 2-77, the maintenance consists of all technical and organizational actions associated with them, performed in order to maintain or restore technical equipment (machinery, equipment, etc.) in state to perform the specified function.

The maintenance strategies have witnessed a continuous development starting from repairs in cases of emergency and developing based on the need to reduce costs, a maintenance strategy based on measurement and assessment of equipment during operation, in order to prevent adverse events.

The maintenance system consists of technical revisions (R) - Operations undertaken in order to establish the technical condition of equipment, current repairs (Rc) - operations that run periodically in order to process normal wear attenuated or removal of defects that make the machine not operate in optimum design, and overhaul (k) - are undertaken in order to return the original operating equipment parameters and prevention of faults majore. The time between overhauls is the so-called second cycle of repair, and the sequence of operations is repeated periodically. Both technical revisions, current repairs and overhauls run under a maintenance plan, drawn up in advance by a team of specialists from various departments of the company.

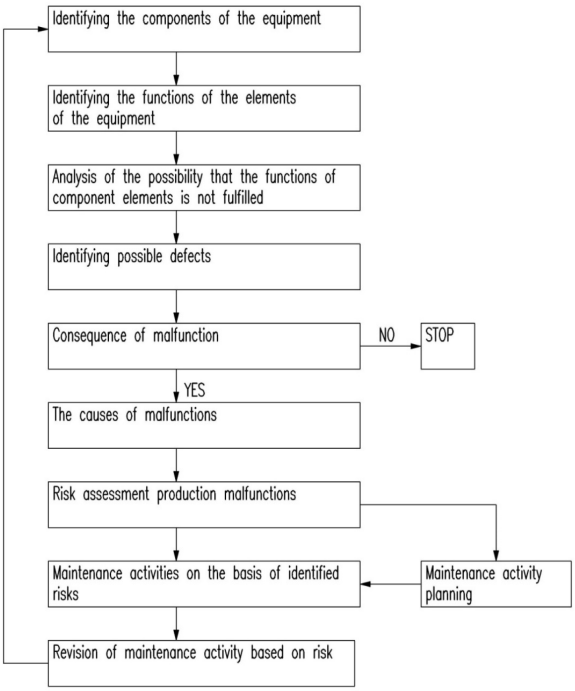

Figure 4. Risk Based Maintenance - general model [2]

The ultimate goals of drafting a maintenance plan are not only related to the reduction of costs incurred in its implementation but, under the new legislation in health and safety, also environmental. Implementing a risk-based maintenance would make it possible to reduce the exploitation of up to 40% as shown in a study conducted in 2002 in the US.

The risk-based maintenance system has as main pawn, the risk. Based on risk regular analyzes are carried out and a maintenance plan is established. A general model of implementation programs for risk based maintenance is shown in figure 4.

An important step in the process, which can be determined step, consists in identifying the possible defects because a premature reorganization of the components would lead to an increase in the consumption of spare parts and consequently the production and use of government spending over the wear limit admissible would lead to an increase in energy consumption, failure technical conditions, prevention and reconditioning opportunities even to an accident affecting the safety and security of personnel work.

Different operational conditions of the equipment, lead to wear of different component parts that can change the life of the equipment. The check to establish the technical condition and possible solutions in order to subsequently restore the equipment in normal operating condition and avoiding risks can be achieved through [8]:

- Checking the technical condition without dismantling - is done according to certain functioning criteria initially established, state of the oil, noises and vibrations, response speed order received, power consumption, processing errors, changes in pressures, etc.
- Checking the technical condition after dismantling - control of the component parts after cleaning and degreasing the equipment. Trace hidden defects, wear and surface defects taking into account the functional factor (size limit no longer providing functional parameters) and economic factors (size limit below which we have a decrease in productivity, increases in losses and consumption);

- The check of hidden defects - can be achieved either hydraulic, pneumatic, magnetic, luminescent, fluoroscopic or ultrasonic, depending on the component which are to be analyzed.

These data obtained when performing the periodic inspections could be sources for the development of maintenance plan based on a risk [7]:

- Qualitative analysis - the risk of occurrence of faults or damage are evaluated considering all likelihood of faults and failures, then using graphical representations for Distinguishing the probability-consequence relationship;
- Semi-quantitative analysis - determine the unique numeric value for each probability of occurrence of a malfunction or failure, and the consequences and effects of each case, based on data obtained from experience or general data specific to the type of malfunction;
- Quantitative analysis - the likelihood and consequences of faults in is determined separately for each part of the distribution scenario variables based on reliability analysis methods equipments and installations.

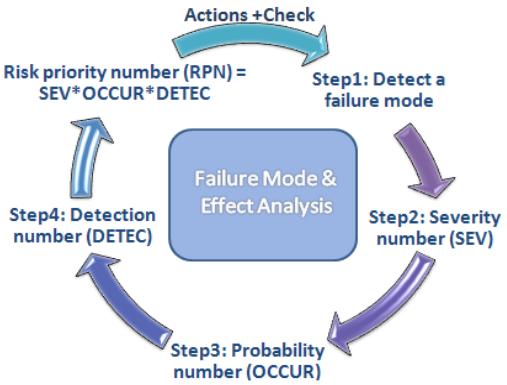

Figure 5. Steps of the FMEA analysis

You can choose for a wide range of risk analysis methods, but the most commonly used as Failure Modes and Effects Analysis - FMEA (Failure Mode Analysis and Effect Analysis). It is one of the methods widely used in engineering to define, identify and eliminate risks, problems, system errors, design, process or service, before the final product reach the client, that is still in the process of planning production. Strict in the maintenance field the method is structured qualitative identifying the immediate effects of malfunctions or accidental stops of each piece of equipment and every risk causing effects on the entire system which includes the equipment.

In relation to each equipment components are highlighted the potential defects, failure mode the effect and their cause. Considering that risk assessment has a high degree of subjectivity, the analysis of processes will be done in teams of the personnel from different departments of research and development, production, management, quality and sometimes even by customers and suppliers.

5. CONCLUSIONS

Any company, regardless of its size, functions according to an important economical desideratum that is to obtain as large of a profit as possible, while costs are as low as possible. On the first looking, things don't seem as complicated, but we need to keep in mind the health and security of the employees, and the consequences of the activity on the environment. These aspects, corroborated with the objective of obtaining profit (which, of course, means that we have to continue developing quality products) lead us to increasing the efficiency of the processes that are performed within the company, among which, the maintenance process.

The advantage of using a risk based maintenance plan is emphasized in specialty studies. Although, until not long ago, Romanian companies were using a maintenance plan for the equipment, more and more mangers have understood and implemented a new maintenance system that can insure significant cost reductions. Based on cost reductions, there will always be preoccupations in order to improve maintenance methods. However, without an extremely exact risk analysis, the entire maintenance plan is compromised.

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