

# MAINTENANCE OF TECHNICAL SYSTEMS IN THE FUNCTION OF SAFETY AT WORK

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**Abstract:** *Safety engineering is consistently promoted and there is an evident need for improvement and development. The maintenance process is dependent on the method of editing and organizing the setup and execution of such kind commitments.*

*Working with the maintenance system itself determines the manner of maintenance.*

*The contractor's responsibility for providing a high level efficiency of system maintenance because the process involves detecting and reducing degradation and restoring the functions of the system in working order.*

*The purpose of this paper is to overcome the shortage of updating data for occupational safety for maintenance, knowledge and to introduce new methods to protect workers and the working environment, as well as monitoring the current trends and standards.*

**Keywords:** ORGANIZATION, MAINTENANCE, SYSTEM, SAFETY ENGINEERING.

## 1. Introduction

Safety at work and safety throughout the maintenance of the technical system is of utmost importance in order to preserve the health of both the operator and the health of those who care about the system's correctness, so that they can continuously meet the expected norms. For that purpose, analyzes, constant surveillance and regular checking of the correctness of the system are performed. There are also several ways to check, monitor the situation and maintain the technical system, because as such it is an assemblage of multiple smaller systems, multiple parts, and elements. Any irregularity, inadequate functioning, deviation, and alteration must be noted.

The role of safety and the protection of health at work is determined by its purpose, rights and obligations of the employer and the employee. It is difficult to comply with the law and other regulations in these areas, to achieve the highest level of health and psychophysical protection. In that sense, the working conditions, the means and the organization of work must be tailored to the needs of the worker, and at the same time workers must be motivated to actively engage in all activities. The significance of safety and health at work is perceived as a human, social and economic point of view.

Working in humane conditions is a pleasure for every individual, but also success and pride for the employer and the society as a whole. The social significance is mostly the case with a large number of employees who get injured or lose a life at work, get sick from occupational diseases and other work-related illnesses, but often in relation to their family, for which the company takes care. The economic dimension of occupational safety and health is dealt with through the consequences of injury at work, occupational and other diseases and ends with certain financial indicators that depend on the number and severity of such cases.

Occupational injuries and occupational diseases are often given absenteeism, which makes expenses because the worker is not working, because of the stagnation that occurs in production and because of the knowledge that is being issued for the treatment of the employee, his earnings and other expenses fall at the expense of the employer and the social security fund. This means that safety and health at work affect the productivity and economy of the work, as well as the quality and competitiveness of the product on the market, the employer has an immediate interest in the product to be as efficient as possible.

Safety engineering affects on the maintenance which is a process that is carried out in order to extend the life cycle of the technical system, as well as to increase the time-consuming exploitation of that system, which can last longer.

## 2. Maintenance goals of technical systems

Technical production systems are becoming more complex and parallel, they must work with greater reliability. The permissible level of reliability can be ensured by an adequate application of maintenance, which is a process that allows managing the technical condition and reliability throughout the "life cycle" of the system.

Maintenance, as a function of the production system, aims to provide opportunities for functioning of the means of operation according to the requirements of other functions of the production system, at given time and conditions at certain costs. This objective prior to maintenance sets complex and diverse tasks.

It is certain that every maintenance worker, regardless of his position and role in the given process, has the desire to provide reliable and safe operation of the system with minimal costs. Thus, the maintenance objectives include, inter alia, the sphere of economic activity. Therefore, modern science of maintenance is increasingly studying and increasing the level of importance in the economy and society.

The maintenance objective can be fully realized only through the efficiency of the basic production process, so that the maintenance costs and the cost of production downtime can be as small as possible and the productivity in the production as large as possible.

All costs incurred in the exploitation process should weigh to a certain minimum. Maintaining the technical systems greatly influences the increase in the efficiency of the efficient operation of the manufacturing enterprises.

The basic objectives to be achieved through the maintenance process are:

- providing the necessary level of reliability;
- minimizing maintenance costs;
- limitation of the aging of the technical system;
- increasing productivity at work;
- increasing the level of motivation;
- timely performance of the function, etc.

It can be said that the maintenance of the technical systems encompasses all the procedures that should be undertaken for the technical system to work longer in a working state, i.e. in a lifetime, with the permissible level of reliability, productivity and economy.

## 3. The maintenance function and its structure

The maintenance function affects the overall flows and outputs of the work in the production system, and its influence increases with the mechanization and automation of the means of production. Maintenance is a function of the production system which contains all the activities and elements necessary for ensuring

the functioning of the means of operation, from determining the requirements for their construction to exclusion from exploitation.

Maintaining is essentially related to the underlying production process, since it contributes to the production being rational with the optimal level of reliability of all systems in the enterprise. Maintaining as a function of the production system has all the elements of a single system: goal, input, output, structure, condition and process, (Figure 1).

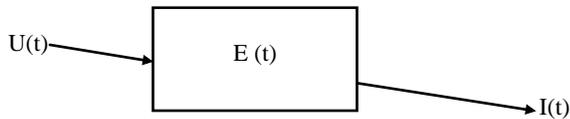


Fig. 1 Maintaining as a function of the production system

- $U(t)$  -vector for entry in function of maintenance;
- $I(t)$  - the output from the maintenance function;
- $E(t)$  -transform vector.

The components of the output vector of the maintenance function have different appearance patterns.

Basic forms are:

- the functioning of the maintained funds, ie the state "in operation" and the condition "in the rejection";
- activities carried out with the maintenance function and
- total income realized with the contribution of the maintenance.

As a natural form of a product from the maintenance function are the forms of "working" condition and a condition "in the cancellation" of the funds being maintained.

The input components coming from the production system and its environment are:

- spare parts and maintenance materials;
- maintenance persons;
- energy;
- the influence of the production function;
- objectives of the maintenance function and others.

The structure of the maintenance function is complex because it is composed of natural-technical and organizational systems. It consists of:

- executors of maintenance;
- maintenance means;
- maintenance strategy;
- funds that are being maintained;
- concept of maintenance approach and
- connection of all elements.

Maintenance is a constituent part of the reproduction process and therefore is studied as an integral activity in ensuring the planned "life cycle" of each technical system. Modern predictions give it a major role to play in production, in order to achieve optimum production results by introducing new maintenance technologies, in fact, creates modern technical maintenance that provides all the maintenance activities, plans, coordinates, controls the technical and economic efficiency of the production plants.

#### 4. Confidentiality and safety of the technical system

Technical systems represent a set of components, their relationships and their characteristics structured in a way that ensures operation in the work and performance of the function in day time and given conditions. The problem of achieving confidentiality in technical systems is most closely related to the behavior of the system at a given time and given environmental conditions. The development of technical systems and their increasing complexity require a greater degree of confidentiality. Therefore, research on increasing the degree of confidentiality

should be one of the tasks that should be given special attention in order to achieve safer and more economical production.

The reliability of the entire system is a new approach to this problem and it covers the confidentiality of the entire system of the production system or of several common production systems. Modern concepts require the confidentiality of the entire system to be managed with appropriate measures, while using the same parameters and measured characteristics throughout the system's lifespan.

It should be emphasized that the confidentiality of the whole system is understood as the characteristics of the components of the system, as well as the needs of the planned and preventive maintenance activities. The production systems need to accomplish the function of the target, but this function can not always be maintained, because there must be interruptions or cancellations, interventions or repairs occasionally i.e. maintenance procedure. On this basis, the basic characteristics of the system (achieved and expected production) are obtained, which is in fact the reliability of the system.

The reliability of the technical system is measured by the relative time for which the system is capable of production in terms of time required to work without any omissions and no standby maintenance. Due the exploitation of the technical systems, special attention must be paid to the proper maintenance of these systems. In addition to achieving "good" production, it is also necessary to achieve cost-effective operation, by mutually harmonizing production and costs, by optimizing confidentiality. But in some cases, the higher the level of reliability of the technical system is of much greater importance.

Researching about confidentiality in production-technological systems is carried out in order to define and plan the maintenance process and make the right choice of a maintenance strategy. The motives that appear for the study of the reliability of the technical systems are the following:

- the technical systems are becoming increasingly complex, which increases the likelihood of failure and the inability to maintain them with maximum effectiveness;
- striving to increase production;
- maintenance difficulties can occur in difficult access parts of the system;
- the need for safe and safe operation;
- economic damages arising from the bad functioning of the technical system and
- increased confidentiality ensures a quality system as a whole.

The reliability of the system is an integral part of the effectiveness of the system. The effectiveness of the system is a probability for the system to successfully enter into operation and perform the function of the criterion at projected time and given conditions.

The effectiveness of a system in mechanical engineering is a product of the components:

- system reliability (R),
- the system's availability (G),
- functional eligibility (FP)

expressed by the formula:  $E_s(t) = R(t) \cdot G(t) \cdot FP$   $0 < E_s < 1$

The availability of the system is a probability that the system can successfully enter into operation and realize the projected output sizes in the necessary minimal time for the given conditions in the environment. The conditions of the environment are a particularly important factor that makes the availability function complex. The availability of the system is a direct indicator of the readiness of the system to perform its function, which reflects the value of the function of confidentiality and the function of system eligibility.

Functional eligibility is the ability of the system to successfully adapt to the environment at a given time. If the functional suitability is greater, even its adaptability to environmental conditions is greater - more flexible. However, this does not give the right to design systems with maximum possible changes, as this leads to a minimal utilization rate. The functional eligibility of the system

moves within the limits  $0 \leq FP \leq 1$  and shows to what extent the system is able to adapt to the changing conditions and disruptions in the process of operation.

The working ability of the system is in fact the ability to perform the criterion function at a given time. Each technical system is exposed to different influences, by size, direction and dimensions that cause deviation from the ground of the set function of the criterion and decrease of the working ability of the system. Each technical system when introducing into production should satisfy the function of the target with given criteria.

However, it is not known how long the system will be able to fulfill the function of the target with the given criteria. The fulfillment of the desired parameters of the system according to some criteria is conditioned by the exploitation of the system and the mode of operation of their elements. The ability of the system to maintain the working ability at the time of exploitation is called *confidentiality*.

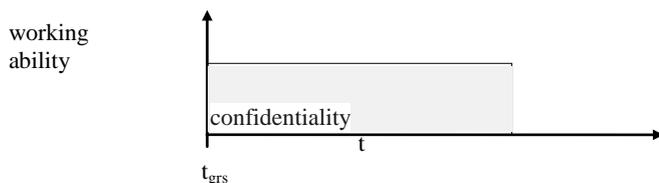


Fig. 2 Working ability of the system

Determination of the function is done by the following formula:

$$F(t) = \int_0^t (\text{working ability}) dt$$

The sketch shows that the working ability has a constant value, that is, the system is or is not capable of working. This particular confidentiality is the size that can be determined after a failure occurs in the system.

## 5. Basic conditions and system failures

The technical system is exposed to different by size and direction influences. Changing the criterion function under the influence of many influences within the permitted deviations determines the baseline situation as follows:

- condition in operation (the system is capable of working);
- failure state (the system is incapable of working).

The system is capable of working if it provides the required designs and permitted output sizes, that is, it meets the performance criterion. An incompetent system is one in which the mutually established dependencies of the parts and the relations between them and their characteristics are disturbed, i.e. it does not perform the criterion function, and it is therefore necessary to undertake measures for returning to a state of work that we call maintenance intervention.

In the case of technical systems, the following failures can occur: complete failures where the working capability is zero, partial failures where the system performs work under the given limit of the allowed deviations. Failure conditions and reduce the degree of utilization of working time - to the next sketch.

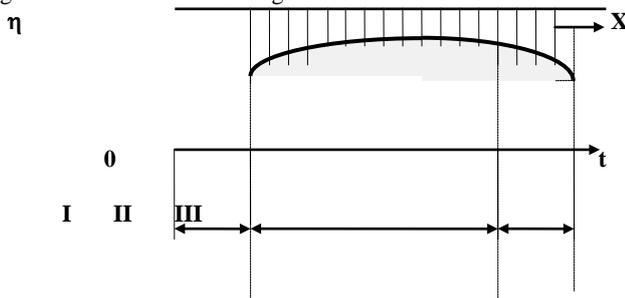


Fig. 3 Basic conditions and system failures

X – loss from a standstill  
t – time unit

The basic state of the technical system is conditioned by the operating, operating and managed mechanisms of the system, whereby the situation in the work results in the performance of the criterion function within the limits of the allowed deviations, and the state of failure to lose the working ability of the system, that is, the inability of the system performs the function of the criterion.

The failures conditioned by changing the parameters of the systems can be:

- sudden abnormalities, caused by the cause of random, nonmonotonic, which are difficult to predict and
- gradual failures, caused by systemic, monotone of known sizes.

Failures caused by the inadequacy of parts of the system are:

- independent refusals, retain the internal state of the parts of the system, that is, the inability of the system to perform the criterion function in the boundary of deviation and
- dependent failures, which arise as a consequence of interdependent parts in the system.

The appearance of failures studied through causes and consequences is of particular importance through perceiving the relative frequency of phenomena of failure. There are three basic periods in the „life cycle“:

- I – period of early dismissal, occurs during the introduction of the system in operation;
- II – period in regular work, where there are random failures and
- III – period of increased number of failures, which arise from fatigue, corrosion, etc.

## 6. Maintaining complex technical systems

The maintenance of complex technical systems has its own special purpose. The purpose covers the procedures that are being undertaken in order for the systems to be as long as possible in the so-called. The state of operation, it is necessary during the life cycle to work on the necessary them, allowing them to complete their lifespan safely. Maintaining is a very complex problem and for its resolution it is necessary:

- detailed analysis;
- possible source of cancellation at all stages of development and
- exploitation of the system.

It is clear that maintenance is not a goal for itself. It is also deterring from harmful consequences which in fact are a failure of the technical system, partly in some part of it, establishing a specific technical system.

To achieve this goal technical system, during the exploitation period, must fulfill the foreseen functions with a satisfactory responsibility, suitable for fulfillment. Responsibility and convenience are also different, but also complementary features of complex technical systems.

The need for improving the maintenance of the existing system, in terms of safety and health protection during work, is the result of:

- scientific achievements in the field of preventive engineering and engineering maintenance;
- technological development of the facility of maintenance;
- the development of the technological elements applied in the maintenance and
- the desire to increase the end result and to reduce the total maintenance costs, all supported by the creation of safe working conditions and the working environment.

The lifetime of a machine, device or any other technical system has a complex structure. It goes through separate but

interconnected and time-synchronized group activities. The relationship of these segments is determined by the action of a number of facts. Life span covers five time phases:

- conceptual and ideal solution;
- development and design;
- production and commissioning;
- use, maintenance and expenses.

### 7. Safety engineering – safety and health at work

Safety and health at work means realization of working conditions, in which certain measures and activities are undertaken in order to protect the life and health of the employees and other persons entitled to it. The dangers of the workplace and the consequences of the working conditions (injuries and disease) should be studied and determined at the very beginning, ie in the phase of preparation of the construction of the product, and the production technology itself. The organization of work protection in production processes has two types of approaches, one of which is conventional and the second is contemporary.

The maintenance of the technical equipment is largely carried out with appropriate tools, because appropriate tools make the maintenance easier, more precisely and safer, for about what show the results of the survey presented in the next graph in percent of respondents (Fig. 4)

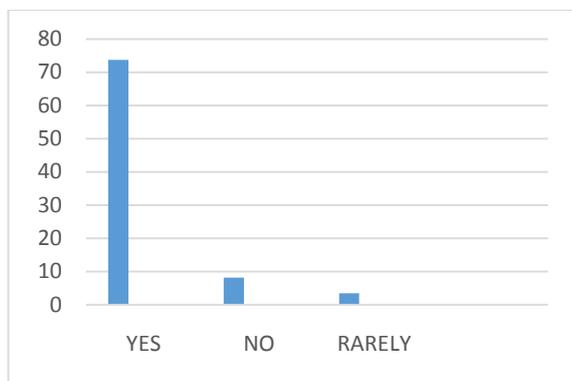


Fig 4 Using appropriate maintenance tools

Results about that question from the survey presented in percent in figure 4, clearly show that more than 70% of the respondents agree that the using appropriate maintenance tools is important for them and for the entire maintenance process.

Do workers need to know how safety engineering works? A significant question, whose answers (showed on the next graph in percent of respondents - the Fig.5) indicate the need for training, in terms of safety and health at work for each employee.

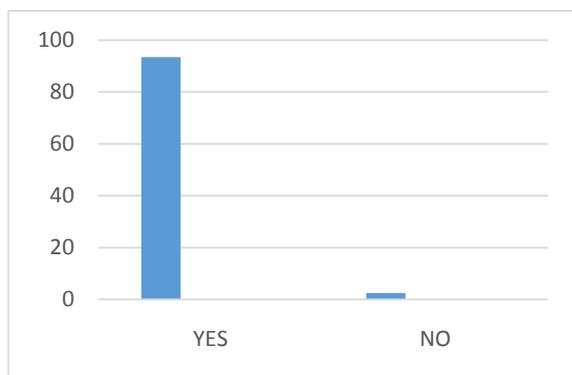


Fig.5 Workers need to know how safety engineering works

Most of 90% of respondents agree with that the workers need to know how safety works.

Safety engineering at work is one of the most important issue, because his ignorance will harm the life and health of the workes,

and that is more important than the correctness of the technical system itself.

### 8. Conclusion

Maintenance, as part of the organization, should follow modern trends and standards, especially with regard to workers' safety and environmental protection.

The purpose of the maintenance is to provide a high level of utilization and availability of the technical system during its lifetime.

Safety at work and safety throughout the maintenance of the technical system include analyzes, constant supervision and regular checking of the correctness of the system. There are also several ways to check, monitor the condition and maintain the technical system.

Appropriate tools for safety maintenance should be used due the maintenance of the technical systems.

All workers, especially workers who are directly included in the maintenance of the technical systems use to know how safety engineering works, what safety and health at work mean, what kind of safety should apply to achieve their life and health till they are at work.

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