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SPECIAL CHARACTERISTICS OF SPARE ELEMENTS INVENTORY MANAGEMENT

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***Abstract:** Some aspects in the problem of management inventory system for spare elements are presented in this paper. The life cycle management of spare elements and their special characteristics is considered in the inventory process. The machine time-down divided with partial weighing range is shown. Emphasis is on the delivery time of spare elements, as the main reason for a fast repair of the failing machine. It's therefore necessary to predict the demand for spare elements.*

***Key words:** inventory system, spare elements.*

I. Introduction.

Material resources are a basic company activity of a production plant; a trade company or a state institution. The effective management of the inventory and minimizing the stock materials together with guaranteed ensuring of the production process are warrant for the successful company functioning. The provision of inventory is a basic priority for every production or servicing structure from a technical and economical point of view.

A special part of the inventory is the spare elements and the system which ensures its timely supply in the storehouse. The management of the processes which are connected with the creation of stored spare elements is of basic importance for maximum efficiency of the machines and with

the use of optimal financial and material resource. [2].

The time when the machines stop because of lack of spare elements is unduly expensive and in some special cases when it's connected with the exploitation safety and the ecology of the work place: the lack is inadmissible. According to some authors the time when the industrial process stops due to lack of spare elements is 50% of the whole time for repairing the failed machines. [1, 5]. Another huge financial factor is the price of the spare elements which ensure the machines during the exploitation stage which is about 50% of their technical maintenance.

The problems connected with the production of spare elements require stable prognoses and insightful analyses. The extent to which the problem of ensuring the machines

during their whole life cycle with spare parts is connected with the idle time of the machines. The problem is of basic importance especially for the state institutions, for example the Ministry of Defense when they purchase new weapons. In this case a unilateral answer should be provided to the question what the financial and technical conditions are at which a certain inventory of spare elements will be maintained which will ensure unfailing exploitation of the systems during their whole life cycle until their utilization.

II. Process characteristics of the inventory management of spare elements.

The inventory management includes a few steps – definition of inventory policy (structuring and concentration of inventory) and development of short-term, mid-term and long-term prognosis for the necessity of elements. With the help of this prognosis we can plan the inventory (when and how many elements of a certain kind to be available); storing the inventory in different storages – this is especially important for the distribution storages; defining the strategy of the inventory management; choosing a management system and technology for inventory management.

The system of inventory management of spare elements functions effectively if there are adequate rules which allow minimization of the idle time of the machines from the moment the order is placed for the spare element up to

the moment the order is fulfilled and thus using a minimum recourse of material and non-material inventory.

When a suitable policy of inventory management for spare elements is being formed, the following basic stages of their life cycle should be considered: [6]:

- identification of spare elements;
- prognosis of searching for spare elements;
- analysis of the storage system;
- formulation of management policies for the different kinds of spare elements;
- developing the system of inventory management;
- policy for capital investment in spare elements;
- policy for inventory management of restorable elements or unit assemblies;
- policy for spare elements exchange;
- control of the spare elements;
- production of the spare elements;
- restoration of the spare elements;
- creating a data base of the spare elements;
- computer software for the spare elements management.

The spare elements are distinguished by most of the other inventory. They have specific characteristics which differentiate them from the elements and materials which are used in a production or service system. In connection with their necessity, their most important characteristic is the irregularity of

their demand which means that the quantity is different and the interval of time between the moments when the demand for elements emerged is different. These values are random and due to the insufficient statistic information it is difficult to find a theoretical law according to which they change in time.

Another distinctive characteristic of the spare elements is the specificity of their use. Usually they cannot be universally used. The purpose of their production is to function only for what they had been created. The stored quantity creates a risk of moral and physical aging, which is especially important when the company decides to change the equipment: the nomenclature of spare elements which is not used again in other systems is automatically transformed into obsolete.

The production of spare elements requires a big technical resource and this results in a high unit price. For the acquiring and

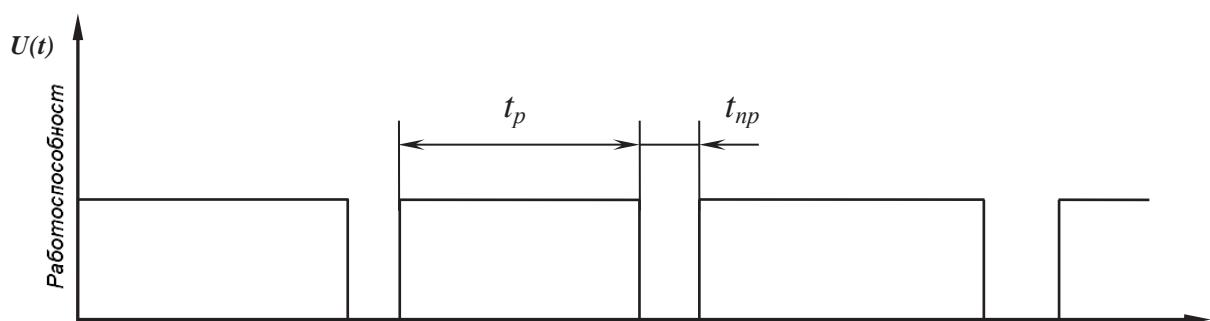
elements which parameters should be maintained in certain conditions: temperature, moisture, corrosion resistance, etc.

Whatever the characteristics, the basic problem with the inventory management of spare elements is the irregularity of the time when there is a demand for working spare elements and the quantity of the corresponding nomenclature.

III. System for maintenance of the machines' life cycle.

The stage of the life cycle of a machine in which it is used according to its function, is a process which represents a process containing intervals of normal functioning t_p , which are separated by unwanted pauses of the machine in result of failures of its elements or blocks (the process is presented as a scheme in Fig. 1)

The time interval t_{np} , during which the machine is not working can be divided into sub intervals which



maintenance besides the price for the purchase, substantial finances are required for subsequent technical servicing.

On the other hand, the storehouses for keeping the spare elements have certain requirements, especially when storing complex

include activities for:

- localization of the failure;
- preparation for dismounting;
- dismounting of the failed element;
- finding the reasons for the failure;
- supply of a working element;

- calibration;
- preparation for mounting;
- mounting;
- technical check;
- start of exploitation.

These activities of setting the machines to working mode are presented in the scheme in Fig. 2.

One of the basic economic and technical goals when leading the recovery process is minimizing the time during which the machine is not operating, i.e. $t_{np} \rightarrow 0$. From all sub intervals, which constitute the time for the repairing of the machine, the one that includes the activities of finding and supplying the spare element has the highest level of uncertainty. The deficit of the wanted spare elements in the storage of the servicing workshop blocks its operation and increases the financial losses both for the workshop and for the owner of the failed machine. The duration of the sub interval of supply of the spare element can vary from some minutes up to hours, days or weeks.

It's obvious that a considerable part of the stage of maintaining the exploitation reliability of the machines is connected with setting the parameters of two processes: appearance of the failures and supply of the spare elements.

The time for supplying the necessary spare element and for exchanging the failed one is a random process which depends on different factors, part of which are changing without any trend. Due to the necessity to ensure a continuous working cycle of the machine and

insufficient statistical data for prognosis of the supply time of a spare element, it is necessary to create an inventory. Depending on the type of the machine and the policy of the producing company, it is possible to have a set of spare elements for every item or group of items. The optimal maintenance of a certain nomenclature and quantity of spare elements requires the application of the theory of inventory management. By means of statistical analysis of the inventory, evaluations can be made for the condition of the equipment, for the stability of the production process of the company; the low effective equipment can be discovered by such criteria as material expenditures for a certain period, readiness coefficient, usage coefficient, storage time, etc.

The appearance of failures in the exploitation stage is also a random process and is a subject of research by the reliability theory. Failure emergence in the machine elements depends on different factors which is the reason for its random character. For example, the intensity of the wearing is a function of the precise design of the elements, the choice of proper materials and production technology. The basic parameter which is used and is a premise for prediction of the necessary quantity of spare elements is the intensity of the failures or the parameter of the sequence of the failures. Practice shows that the calculated quantity spare elements by the methods of the reliability theory do not correspond to the real needs [3]. The reasons are different and are a function of the

machine work regime, the exploitation conditions, etc. but the dominating reason is the improper machine exploitation [4] which includes not conforming to the instruction manuals for the proper use, the time and volume of the servicing work.

In conclusion, to increase the precision evaluation of the planned nomenclature and quantity of spare elements, mathematical methods

should be applied which should take into consideration a greater number of factors and their influence on the need of working elements which to replace the failed elements. This is the reason for the use of the methods for the prognosis of the spare elements inventory which application is a complex process which requires sometimes non-stereotypical solutions.

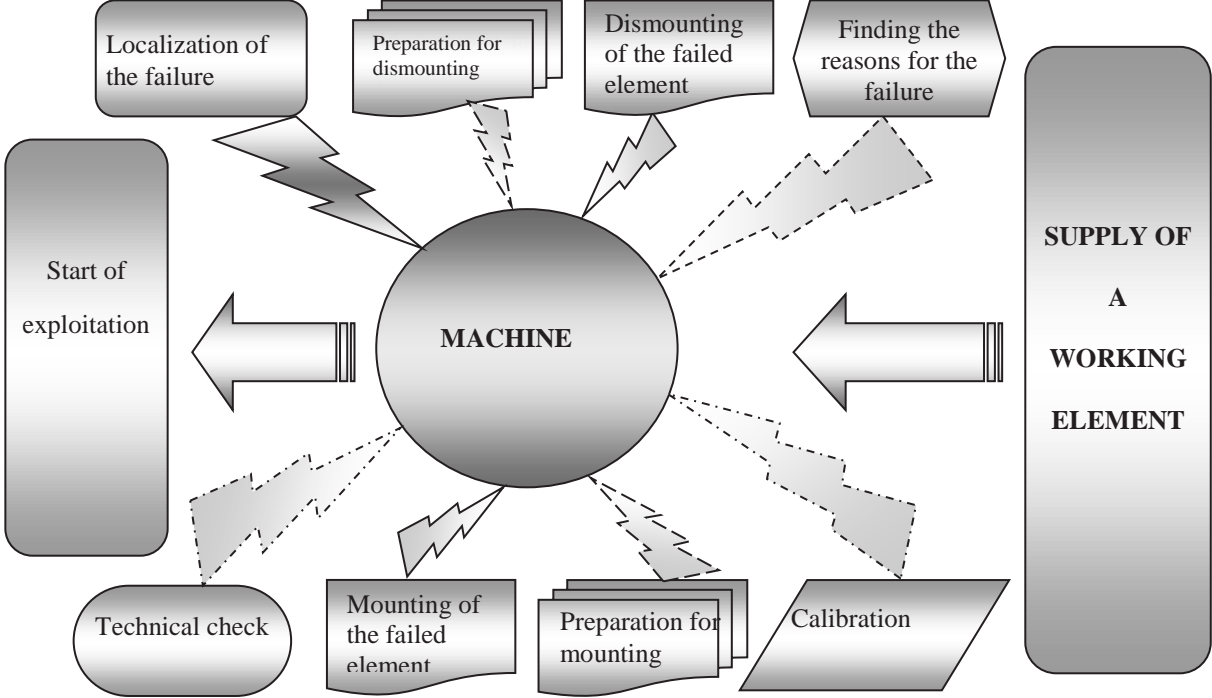


Fig. 2.

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