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INTEGRATED APPROACH TO ENSURING THE RELIABILITY OF COMPLEX SYSTEMS

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The study of reliability tracks the change in the quality of the machine over time, which allows you to study the reliability through the implementation of the processes of diagnosis and forecasting directly during its operation. Considering the dynamics of changing the state of the machine as a technical object, we can conclude that reliability is a multi-stage form of changing the state of the machine [1,2].

Product reliability is laid down in the design, provided during manufacture and maintenance, ie the problem of ensuring the reliability of the machine should be solved throughout the life cycle - from design to disposal of the machine. When designing a machine, all the basic and necessary requirements for ensuring the reliability of the machine after its manufacture are substantiated and laid down. In the manufacture of the machine taking into account the intended modes of operation, the quality of the machine is realized and the quality of manufacture of mechanisms, components is controlled, where each of them will be endowed with reliability characteristics, including structural rigidity, geometric accuracy of structural elements and other parameters [3-5]. In the process of operation of the machine its reliability is realized, and it depends on the methods and conditions of operation of the machine, the adopted system of its repair, maintenance methods, applied modes of operation of components and mechanisms and other operational factors.

Ignoring the reliability of a technical object is the most unreliable way to create it, which reduces the technical resource of the application. Any failure of the machine will lead to significant material and financial losses. Statistics of failures and their causes provide a large amount of information about the reliability of mechanisms and components of machines and are the main source of information and identify the actual values of reliability parameters and causes of disability and durability [6,7]. Statistics on the operation of the machine allow you to get a real idea of how the design, production and conditions of use, operation correspond to the established level of reliability and safety of operation. The statistical data received during diagnostics allow to carry out forecasting of a future condition of the car and improvement of process of functioning in the conditions of operation. Thus, a comprehensive approach to the study and research of the actual state of reliability of technological equipment will be

laid. If the machine, its mechanisms and components are unreliable, then there will be a partial or complete loss of performance, forcing it to restore it to a given level by organizing and conducting maintenance and repair. Unreliable machine is the main sign of loss of efficiency of its application, as each its stop due to damage of mechanisms or decrease of technical characteristics of knots with loss of technical and operational parameters will lead not only to big material losses, but also will affect deterioration of industrial and technospheric safety.

It is well known that for the entire period of operation, the cost of repair, maintenance of machines in connection with their wear and tear is sometimes several times higher than the cost of a new machine. Thus, for cars - 6 times, aircraft - up to 5 times, technological industrial equipment - up to 8 times, electrical equipment - up to 12 times. The reliability of the machine is greatly influenced, on the one hand, by external operating conditions, on the other - internal physico-chemical processes that promote destruction, such as aging, corrosion, increased wear, changes in the properties of materials from which components and mechanisms are made. The analysis of reliability of difficult systems has the features. The specificity of assessing the reliability of a complex system is that a large role is played by the relationships between its elements.

The construction of a model of a reliable system is based on properties, parameters and characteristics. This takes into account the state of technological equipment:

S_1 - working state in standby mode,

S_2 - working state in the mode of functions, work, tasks;

S_3 - inoperable state, recovery period

When calculating reliability, use structural diagrams with the possibility of dividing a complex system into separate elements, for each of which you can determine the probability of failure ($P_i(t)$ - the probability of failure of the i-th element during a given period). Then you can determine the probability of failure P(t) of the whole system. Such calculations are called system reliability calculation. Considering the above parameters of mechanisms and units, we can conclude that the most typical are cases when downtime of one mechanism or unit disables the entire system. For example, most drives of machines and mechanisms, transmissions are subject to this condition. So, if in the drive of the car anything fails: a gear wheel, the bearing, the coupling, the control lever, the electric motor, the pump of greasing, etc., all car with the drive will cease to function. Then the probability of failure-free operation of such a system will be equal to the product of the probabilities of failure-free operation of its mechanisms and components:

$$P(t) = P_1(t)\ P_2(t)\ P_3(t).\ P_n(t) = \prod P_i(t).$$

An integrated approach solves the problem of ensuring reliability at all stages of the life cycle of the machine. The system approach involves considering the machine and ensuring its reliability as a system of causation. The organizational direction of work involves the development of a program to ensure the reliability and risk reduction for all stages of the life cycle of the machine, regulations and standards that define the provisions and requirements for ensuring the reliability of equipment.

The consequence of disability is the failure of components, mechanisms, which leads to machine downtime. The main downtime occurs for technical reasons, due to poor maintenance, for organizational reasons. Simple characterize the unreliability of the machine with the appearance of failures of its operation. Failure to operate is considered as an out-of-cycle loss and as an event that is a malfunction of the machine. In this case, the failure of the machine has objective causes, but is random, and the probability of its occurrence can be described by different laws of probability distribution of reliability parameters during operation.

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