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FEATURES OF ENGINEERING MANAGEMENT INDICATORS OF FAILURE OF FUNCTIONAL UNITS OF GRAIN HARVESTING COMBINERS

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Each complex object changes its state over time, passes from one to another. Such a transition is accompanied by changes in qualities. The quality of any product is a set of its properties, which determines the suitability of meeting certain needs in accordance with the purpose of this product.

The quality of functioning of technical systems is determined by various indicators. And one of these indicators is reliability – the property of the object to keep over time within the established limits the values of all parameters characterizing the ability to perform the necessary functions in the given modes and conditions of use. This is a complex property, which generally consists of such components as reliability, durability, maintainability and storage of the product.

The condition of the object, in which it meets all the requirements of regulatory and technical and design documentation, is a working condition. A workable state is a state in which the value of all technical parameters and qualities characterizing the ability to perform the specified functions meets the requirements of regulatory and technical and design documentation. If the value of at least one of these parameters of the object meets the specified requirements, then the object is in an inoperable state. The transition of the object to a faulty but operable state is called damage, and an inoperable state is called a failure. Both damage and failure occur as a result of the influence of many factors on the system, such as the system's operating time, the load imposed on it, its operating conditions, and others [1].

A workable object, in contrast to a serviceable one, must satisfy only the documentation requirements, the fulfillment of which ensures the normal use of the object for its intended purpose. The concept of failure is associated with the most important component of reliability, such as fail-safeness - the property of an object to continuously maintain a workable state for some time [2]. The duration or amount of work performed by the object is called the working life. Performance can be measured in units of time or volume of work performed. The object's working time from the start of its operation to the first failure is called the working time to failure.

The transition of an object from an inoperable state to an operable state occurs as a result of restoration or repair operations. The object, for which the restoration of the working condition in the situation under consideration, is provided for by the technical documentation, is called recoverable. Otherwise, the object is called non-recoverable.

Repairability is a property of the object, which consists in adaptability to the prevention and detection of the causes of failures, maintenance and restoration of a working condition by carrying out technical maintenance and repair. Durability is the ability of an object to maintain a workable state until the onset of a limit state - a state of the object in which its further use as intended is unacceptable.

One of the most important means of ensuring a given level of object reliability is redundancy. Redundancy is the application of additional measures to preserve the working condition of the object in case of failure of one or more elements. The use of redundancy is one of the most common measures to increase equipment reliability [3].

When using the concept of reliability in engineering practice, there is a need to introduce its quantitative assessment, convenient for calculations, comparison of the reliability of various options of technical solutions. For this, single and complex indicators of reliability are used - quantitative characteristics of one or more properties.

Events such as the failure or restoration of an object's operational state are random events. Progress to the object, recovery time – random values.Sequences of failures and restorations that occur during the operation of the object form streams of random events, and many of those quantitative characteristics of random events, quantities and processes used in the theory of probabilities are used as reliability indicators. However, the theory of reliability ceased to be a subdivision of the theory of probabilities. Its engineering character consists primarily in increasing reliability. Theoretically, the methods of probability theory are used for reliability, but they are modified to provide both an estimate and an increase in the probability of failure-free operation.

In the general case, this consists in the maximization and back-calculation of reliability estimation formulas based on system properties.

The working life of a completely non-renewable object is a random variable, for which its distribution function P(1) is an exhaustive quantitative characteristic.

This function has the following properties:

P(1) = 0 for 1 = 0, since device learning starts when it is working, and failure in a very short time is unlikely.

P(1)^ 1 at 1 ^ yes, because any technical means fails sooner or later, and therefore, with an unlimited increase in time, the probability of failure tends to unity.

P(1) as any distribution function is a nondestructive function [4].

It is also possible to introduce the concept of "probability of failure", defining it as the probability that the object will fail within a given time, being operational at the initial moment of time.

For the failure probability 0,(1) in the interval from 0 to 1, the expression is valid:

$$Q(t) = F(t) \tag{1}$$

The probability of failure-free operation is determined by the expression:

$$P(t) = 1 - F(t) \tag{2}$$

An indicator of the reliability of non-renewable objects is also the intensity of failures – the conditional density of the probability of the failure of a recoverable object, which is determined for the moment of time under consideration, provided that no failure has occurred until that moment. The intensity of failures 1 (1) is defined by the ratio of the distribution density P(1) to the probability of failure-free operation.

The density of the distribution is defined as the derivative of P(1) over time. The dependence of the intensity of failures on time shows the nature of the operation of technical systems over time.

The period of operation of the device is divided into three sections. On the first, the intensity of failures is high, this area is called the processing area, it reveals manufacturing defects. On the second, the intensity of failures is constant, this section is called the section of normal operation. In the third stage, the intensity of failures increases due to increased aging and wear processes.

To determine the reliability of the object in the area of normal operation, it is enough to specify one number A, and in this connection, the intensity of failures is used as the main indicator of the reliability of the elements.

To assess the reliability of objects being restored, both single indicators characterizing only fault-free or only maintainability, and complex indicators, which are a generalized assessment of both these properties, are used.

The recovery time 1c is usually a random value. Therefore, the probability characteristics of 1c are the recovery time distribution function /(1 sec) and the recovery time distribution density /(1).

As indicators of serviceability, the probability of restoration of operational state is used - the probability that the time of restoration of operational state of the object will not exceed the specified one, and the average time of restoration of operational state - mathematical expectation of the restoration time.

By analogy with the intensity of failures for objects that are being restored, it is possible to introduce the concept of "intensity of restorations" – the conditional density of the distribution of the restoration time up to moment 1, provided that the restoration of the object has not taken place up to that moment. When A(1) = const, we get an exponential distribution of recovery time [5].

The following are used as indicators of failure-free operation: the average failure rate is the ratio of the operating time of the recoverable object to the mathematical expectation of the number of its failures during this operating time, and the failure flow parameter is the ratio of the average number of failures of the recoverable object for an arbitrarily small operating time to the value of this development [4]. Efficiency is considered to be the most universal characteristic of a complex technical system (TSS), meaning the degree of adaptability of the system to the performance of its assigned functions [6]. The effectiveness of the STS depends on a number of indicators or parameters. The main ones are: the cost of development, manufacture and operation of the product, the quality of operation, the power of consumed energy, weight, dimensions, conditions of normal operation, etc.

In addition, the effectiveness of the product depends on its structure, the nature of the connections between the elements, the type of control algorithms and other patterns of functioning that cannot be described using the specified parameters. Thus, the efficiency of an industrial robot is characterized by the load capacity, drive power, speed and acceleration, positioning accuracy, the amount of memory of the control device, the number of degrees of freedom, the number of technological redistributions that this robot can carry out, and the cost. The efficiency of the automated production system is characterized by the cost of all types of equipment, the reliability of technical means, the speed of operation of technical means, the number of service personnel, the number of controlling programs, productivity, the load factor of technological equipment, flexibility, profitability, survivability, and the duration of the production cycle. The effectiveness of computer equipment is characterized by: the amount of memory – operational and storage devices, the quality of visual display, the number of communication channels, cost.

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