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ASSESSMENT OF THE EFFECT OF PROBABILITY FACTORS ON REPAIR DURATION

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Keywords: *planning, event, factor, probability, repair*.

Abstract: *This paper investigates the problem about the effect of probability factors on the average time of machine outage at field conditions. The developed algorithm enables the accurate planning, organization, and operational management of repair activities, knowing the number of repair operations and the time for their accomplishment.*

ОЦЕНКА ВЛИЯНИЕТО НА ВЕРОЯТНОСТНИТЕ ФАКТОРИ ВЪРХУ ПРОДЪЛЖИТЕЛНОСТТА НА РЕМОНТА

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Ключови думи: *планиране, събитие,фактор, вероятност, ремонт*

Резюме: *В предложения доклад се разглежда въпроса свързан с влиянието на вероятностните фактори върху средното време за престояване на машините в ремонт при полеви условия. Разработеният алгоритъм позволява, знаейки броят на ремонтните операции и времето за изпълнението им, правилно да се планира, организира и оперативно управляват ремонтните дейности.*

The following paper investigates the question of taking into account the influence of organizational and technical factors on the average time for machine repairs at field conditions.

One of the basic problems that should be solved at machine repairs at field conditions is the accomplishment of scheduled repair planning. The accurate scheduled planning depends on the exact determination of outage time of the repaired machines (B). It is determined by laying out optimal work schedules and is the average expected time for the repair. But since the repairing process of the machines is an accidental quantity the average expected time of the accidental quantity is its mathematical expectation (E). Different probability factors will influence on the outage time of the machine and as a result it will derivate from its mathematical expectation.

In order to find the width of dispersion of machines outage repair time around its mathematical expectation it is necessary the influence of the probability factors on B to be taken into account. At scheduled planning the probable character is accounted through the entering of three assessments:

a – optimistic assessment /it shows the accomplishment of the repairs at most favorable conditions/;

b – Pessimistic assessment /it shows the maximum time for accomplishment of the repairs under the influence of all organizational and technical factors on the repairs time/;

m – The most probable assessment /it shows the average expectance time for outage of the repaired machines/.

It is supposed that all possible times for repair are in the interval between (a and b).

The researches in the repairs field show that repair operations subordinate to the normal law for distribution of the accidental quality with the mode in point m matching to the mathematical expectation E.

In [2] it is proved that dispersion width in the normal law equals 6 mean quadratic deviations /or every probability density is situated in the limits of 3 mean quadratic deviations on the left and on the right of the mathematical expectation/. Hence the dispersion of the accidental quantity in this case will be determined by the expression:

(1) $$V = \frac{b - a}{6}$$

Where:

V – Dispersion of the accidental quantity that shows the width of dispersion of the accidental quantity around its mathematic expectation.

Having assessments a, b and m and the duration of the repair operations that should be done we can assess the probability of occurrence of every event in the interval (a, b).

Let η j is the earliest beginning for an event occurrence from a certain graph, representing the technological process of the repairs. But the durations of the activities, which are done before an event j are accidental quantities, hence η j is an accidental quantity, too. Since the operations that will be accomplished for a certain machine to be repaired are of accidental character then the trouble of an aggregate or an assembly does not influence on the probability of a break-down of another one, it turns out that the operations, which will be accomplished at the repair activities are statistically independent. Then we receive the mathematical expectation and the dispersion of the accidental quantity this way:

If the event j is connected to the initial event only in a single path, then E(η j) is determined a s a sum of the durations of the activities on this path.

Hence for the chosen path the value of the mathematical expectation E(η j) and the dispersion V(η j) are determined with the expressions:

(2) $$E(\eta_j) = B_j \quad ,$$

(3) $$V(\eta_j) = \sum_{i=1}^{n} Vn$$

Where **Bj** - the directive time for the machines repair outage, determined by the critical path of the graph.

$\sum_{i=1}^{n} Vn$ - number of operations lying on the critical path of the graph to operation j.

But on condition we supposed that all the operations, which will be accomplished, are statistically independent and according to probability theory [1] the central limit theorem operates. The latter proves that the accidental quantity η j is distributed on normal law with mathematical expectation η j and dispersion **V (**ηj). Normal distribution in this case means that η j distinguishes from its mathematical expectation E(η j) with probability 0.68 per a mean quadratic equation and with probability 0.997 per three mean quadratic equations. Since η j is the earliest time for the occurrence of the event **j**, this event will occur in the directive time with probability.

(4) $$P\{\eta_j \le B_j\} = P\left\{\frac{\eta_j - E(\eta_j)}{\sqrt{V(\eta_j)}}\right\} \le \frac{B_j - E(\eta_j)}{\sqrt{V(\eta_j)}} \le P\{Z \le Kj\},$$

Where: Z – the norm meaning of the accidental quantity with normal distribution with dispersion 1 and mathematical expectation 0.

(5) $$K_j = \frac{B_j - E}{\sqrt{V(\eta_j)}}$$

After the calculation of $E(\eta_j)$ and $\sqrt{V(\eta_j)}$, is immediately determined. K_j

Later it is easy to calculate the probability for accomplishing repairs for certain time.

In order to determine what influence probability factors /unseasonable delivery of spare parts and tools, break-up of a tool during work, unsuitable qualification and education and so on/ will have on the repair duration we must accomplish hundreds of repairs, something impossible at present. This fault can be avoided through modeling of the repair process and taking into account the influence of the probability factors on the repairs duration. For this purpose, knowing the duration of the operations that will be done and mean quadratic deviations of the probability factors we can report their influence on the time of machine outage for repair.

The algorithm of the model is as follows:

Step 1 We constitute a multitude of operations On{1,2,…,j,……….n.}, lying on the critical path of the graph, representing the technological process of the repair.

Step 2 We constitute 12 random numbers distributed according to the plane probability law with parameter 2l = 1 of 0,1. For the case there is a sensor for pseudo-numbers.

Step 3 If X is that random number, we will obtain it with the formula:

(6) $$X_i = RND(1)$$

Steep 4 Since the duration of the repair is an accidental quantity, distributed along a normal law, we generate a random number at normal law with characteristics:

(7) $$R = \sum_{I=1}^{12} - 6 \qquad E(R) = 0, \; V(R) = 1$$

Step 5 We generate the durations of the operations works lying in the critical path of the graph with the equation:

(8) $$B_j = (E_1 + \sqrt{V}_1 . R) + (E_2 + \sqrt{V}_2 . R) + ...+(E_j + \sqrt{V}_j . R),$$

Which is a realization of the repair?

Realizing the mentioned algorithm repeatedly we obtain the duration of the repairs with an account of the probability factors.

On the basis of the accomplished analysis for the average expected time for machine outrage for repair and the offered algorithm for accounting the influence of organizational and technical factors on the duration of the repair The work of the repair authorities is optimized the supervisor of the repair unit is given the chance to plan, organize and manage operationally the time of the repair process.

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