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ҚАЗАҚ ҰЛТТЫҚ УНИВЕРСИТЕТІНІҢ

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ИЗВЕСТИЯ

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РЕСПУБЛИКИ КАЗАХСТАН

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NATIONAL UNIVERSITY

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VERIFICATION OF RELIABILITY TECHNICAL DEVICES THROUGH RESOLVING PROBABILITY OF FAILURE AND FAILURE

Abstract. This article describes the basic concepts and definitions of reliability theory and its applications to problems of probability theory. Probability theory makes it possible to take into account the random nature of events and processes occurring in the system, to form the mathematical foundations of the theory of reliability. The problems on the probability of failure-free operation of the element are considered.One of the main tasks solved in the course of operation and maintenance of technical devices is to ensure their reliable operation. The importance of this problem is due to the complexity of modern technical devices and high values of operating loads (temperature, pressure, humidity, etc.). Reliability refers to the ability of technical devices to perform specified functions, maintaining their performance within the specified limits for the required period of time or the required operating time in certain operating conditions.Reliability as a qualitative characteristic has always been taken into account when solving various issues of operation and maintenance.

Keywords: failure, probability, technical devices, information system, reliability.

The functional quality of technical devices, including information systems, largely depends on their reliability.

Information system is a complex software and hardware system, which includes ergatic (man-machine) links, technical or hardware and software. Speaking about the reliability of the information system, it is necessary to take into account its two components: the reliability of hardware and software reliability. If the methods of research and ensuring the reliability of the technical (hardware) component of information systems are similar to the corresponding activities of other technical devices, the software differs from such a methodology. Thus, the study of these structures refers to the reliability of the information, its correctness, correctness of its interpretation. We will note that further, speaking about technical devices, we will mean, including, and hardware components information systems (computers, the peripheral equipment, the switching equipment, the cable equipment, etc.).

These categories do not exclude, but complement each other, because in a complex system such as information systems it is possible to provide the necessary level of reliability only taking into account the peculiarities of its components. The most advanced initial technical characteristics of technical devices are necessary, but insufficient conditions of high operational qualities of these devices. Initial characteristics of technical devices show its potential technical capabilities. Important is the ability of technical devices to maintain these characteristics throughout their life cycle or during operation [1].

The ability to maintain its original technical quality during operation is called reliability. This ability depends both on the properties that were incorporated in the technical devices during the design and manufacture, and on the intensity of operation, correctness and timeliness of maintenance.

Therefore, the physical meaning of reliability is the ability to maintain these properties, to resist aggressive operational factors.

Reliability can act as an independent operational characteristic, and serve as a component of other operational characteristics.

One of the main tasks solved in the course of operation and maintenance of technical devices is to ensure their reliable operation. The importance of this problem is due to the complexity of modern technical devices and high values of operating loads (temperature, pressure, humidity, etc.).

Reliability refers to the ability of technical devices to perform specified functions, maintaining their performance within the specified limits for the required period of time or the required operating time in certain operating conditions.

Reliability as a qualitative characteristic has always been taken into account when solving various issues of operation and maintenance. Quantitative determination of reliability appeared with the emergence of the theory of reliability. Mathematical platform of reliability theory is probability theory and mathematical statistics.

Indeed, failures in technical devices occur at random at unexpected times. This is typical even for many similar devices manufactured at the same plant and put into operation at the same time. Despite the single project, the same production technology-each of them has an individual ability to maintain its original quality. Initially it seems that there is no regularity in the appearance of cracks. However, such a pattern exists. It manifests itself when not one but many technical devices in operation are monitored.

As the main quantitative measure of reliability of technical devices, characterizing the regularity of occurrence of failures in time, adopted the probability of failure-free operation.

The probability of failure – free operation is the probability that during a certain time of operation of technical devices and in specified operating conditions failure does not occur. Since the occurrence of a failure is a random event, the time of its occurrence t0 - is also a random event. Therefore, the probability of failure-free operation:

$$p(t) = p(t_0 \geq t)$$

where t is the specified operating time.

The probability of failure is the probability of the opposite event:

$$q(t) = p(t_0 < t)$$

But the event of failure and the reliability of event – opposite the essence of the event. Therefore, according to the probability property of opposite events, it is possible to record[2]

$$p(t) + q(t) = 1$$

In practice, estimates of these probabilities are determined. Let N - be the total number of the same type of technical devices operated during time t . During this time N (t) the technical device worked smoothly, and n(t) – refused. Thus:

$$N = N(t) + n(t)$$

that is, after a time t the total number of both serviceable and failed technical devices is equal to the original. The statistical probability of failure-free operation is determined by the expression

$$p^*(t) = \frac{N(t)}{N}$$

a failure rate

$$q^*(t) = \frac{n(t)}{N}$$

Find the sum of these frequencies:

$$p^*(t) + q^*(t) = \frac{N(t)}{N} + \frac{n(t)}{N} = \frac{N(t) + n(t)}{N} = \frac{N}{N} = 1$$

that corresponds to the theoretical conclusions. For the transition from p*(t) and q*(t) to p(t) and q(t) need to take the limit relations of frequencies:

$$p(t) = \lim_{N\to\infty} \frac{N(t)}{N}$$
$$q(t) = \lim_{N\to\infty} \frac{n(t)}{N}$$

As N→∞ cannot be achieved under this Declaration into practice can mean the whole Park is set on the operation of the same technical devices.

It is obvious that over time the total number of failures in technical devices increases. Consequently, q(t) increases and, hence, p(t) decreases. The curves that determine the nature of these changes are as follows:

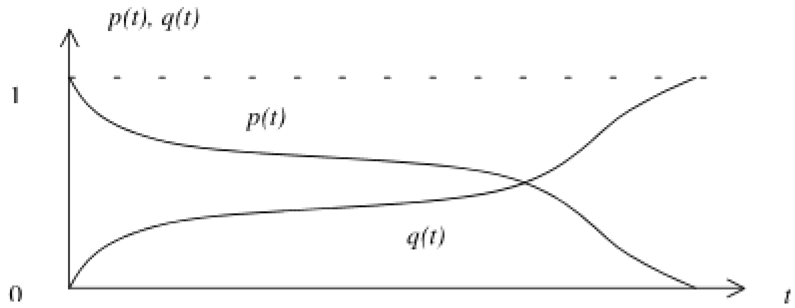


Рис. 1. Характер изменения кривых $p(t)$ и $q(t)$

In practice, it is often necessary to determine the reliability of technical devices for some time interval from ta to tb (for example, during the period of operation of this device), provided that it has already been in operation for some time tb. The TDB of technical devices during the time (tb-ta), provided that it has worked smoothly for ta hours, is determined by the conditional probability[3]

$$p\left(\frac{tb - ta}{ta}\right) = p(ta \geq tb)$$

This conditional probability is numerically equal to the probability $p\left(\frac{tb}{ta}\right)$. Indeed, the probability that an object has not failed during the time (tb-ta), provided that it has run smoothly for ta hours, consists of the probability of failure during ta hours and the probability of failure during the hours from ta to tb. According to the concept of conditional probability,

$$p\left(\frac{tb - ta}{ta}\right) = p\left(\frac{tb}{ta}\right) = \frac{p(tb)}{p(ta)}$$

But p(tb, ta) is numerically equal to the probability that the technical device will run smoothly for tb hours:

$$p(tb, ta) = p(tb)$$

Then

$$p\left(\frac{tb}{ta}\right) = \frac{p(tb)}{p(ta)}$$

In private, this formula will take the form of

$$p^*\left(\frac{tb}{ta}\right)=\frac{N(tb)}{N(ta)}$$

Since

$$p^*(ta)=\frac{N(ta)}{N}p^*(tb)=\frac{N(tb)}{N}$$

Using the probability of failure p(t), it is possible to estimate the average number of elements or devices of information systems (for example, computer networks or its periphery) n(t), which may fail during the time interval Δt at the known operating time t[4]:

$$n(t)=Np(t)-Np(t+\Delta\text{t})$$

where N – number of serviceable elements of information systems at the beginning of its operation.

Example. Reliability function

Reliability function R (t) is a function that determines the probability of failure of the element during the duration of t:

$$P(T<t)=e^{-\lambda t}$$

λ - is the failure rate (the average number of failures per unit time.

An example of solving the problem of the probability of failure of the element:

The duration of the uptime of an element has exponential distribution

$$F(t)=1-e^{-0,01t}\ (t>0).$$

Find the probability that during the duration of t=50 h:

a) the item will be denied;

b) element will not refuse,

c)find the reliability function

Task solution

a) Since the distribution function

F (t) = 1-e-0.01 t determines the probability of failure of the element during the duration of t, then substituting t = 50 in the distribution function, we obtain the probability of failure:

$$F(50)=1-e^{-0,01*50}=0,394;$$

b) events "element will refuse" and "element will not refuse" are opposite, so the probability that the element will fail P = 1-0, 394 = 0.606.

The same result can be obtained directly using the reliability function, which determines the probability of failure of the element during the duration of t:

$$R\ (50)=e^{-0,01*50}=0,606.$$

c) reliability function

$$R\ (t)=e^{-0,01*t}$$

Example 1.1.On a test set of 1000 of the same type of electron tubes. For 3000 hours refused 80 lamps. It is required to determine the probability of failure-free operation and the probability of failure of electronic lamps within 3000 hours.

Decision. By formulas (1.1) and (1.2) we define

$$\widetilde{P}(3000)=\frac{N_O-n(t)}{N_O}=\frac{1000-80}{1000}=0{,}92$$

$$\widetilde{Q}(3000)=\frac{n(t)}{N_O}=\frac{80}{1000}=0{,}08$$

or

$$Q(3000)=1-P(t)=1-0{,}92=0{,}08$$

Example 1.2. The test delivered 1000 of the same type of lamps. For the first 3000 hours of work refused 80 lamps, and for an interval of 3000 h – 4000 h refused 50 more lamps. Determine the frequency and failure rate of electronic lamps in the interval 3000 h-4000 h[5].

Decision. By formulas (1.3) determine the failure rate

$$\widetilde{\alpha}(3500)=\frac{n(\Delta t)}{N_O\Delta t}=\frac{50}{1000\cdot 1000}=5\cdot 10^{-5}\ \text{(1 / h)}$$

Determine the average number of working items in the interval Δt.

$$N_{cp}=\frac{\mathrm{N}_i+N_{i+1}}{2}=\frac{920+870}{2}=895\ \text{(PCs)}$$

By the formula (1.5) we find the failure rate

$$\widetilde{\lambda}(3500)=\frac{n(\Delta t)}{N_{cp}\Delta \mathrm{t}}=\frac{50}{895\cdot 1000}=5{,}6\cdot 10^{-5}\ \text{(1 / h)}$$

Example 1.3. The test was 1000 samples of the equipment beyond repair. The number of failures was recorded every 100 hours of operation (h). Data on failures are given in the table. 1.2. It is required to calculate quantitative characteristics and to construct dependence of characteristics on time.

Table 1.2 - The data on failures for example 1.3

Δt_i, ч	$n(\Delta t_i)$	Δt_i, ч	$n(\Delta t_i)$	Δt_i, ч	$n(\Delta t_i)$
0 – 100	50	1000 - 1100	15	2000 – 2100	12
100 – 200	40	1100 - 1200	14	2100 – 2200	13
200 – 300	32	1200 – 1300	14	2200 – 2300	12
300 – 400	25	1300 – 1400	13	2300 – 2400	13
400 – 500	20	1400 – 1500	14	2400 – 2500	14
500 -600	17	1500 – 1600	13	2500 – 2600	16
600 – 700	16	1600 – 1700	13	2600 – 2700	20
700 – 800	16	1700 – 1800	13	2700 – 2800	25
800 – 900	15	1800 – 1900	14	2800 – 2900	30
900 - 1000	14	1900 - 2000	12	2900 - 3000	40

Decision. The equipment belongs to the class of non-renewable products. Therefore, reliability indicators are $P(t)$, $\alpha(t)$, $\lambda(t)$, $\tilde{\tilde{\bar{T}}}_O$.

Calculate $P(t)$. Based on the formula (1.1) we have

$$\widetilde{P}(100)=\frac{N_O-n(100)}{N_O}=\frac{1000-50}{1000}=0{,}95,$$

$$\widetilde{P}(200)=\frac{N_O-n(200)}{N_O}=\frac{1000-90}{1000}=0{,}91,$$

……………………………………………

$$\widetilde{P}(3000)=\frac{N_O-n(3000)}{N_O}=\frac{1000-575}{1000}=0{,}425.$$

To calculate the characteristics $\alpha(t)$ and $\lambda(t)$ apply the formulas (1.3) and (1.5), then

$$\widetilde{\alpha}(50)=\frac{n(\Delta t)}{N_O\Delta t}=\frac{50}{1000\cdot 100}=5\cdot 10^{-4}\ \text{(1/h)},$$

$$\widetilde{\alpha}(150)=\frac{n(\Delta t)}{N_O\Delta t}=\frac{40}{1000\cdot 100}=4\cdot 10^{-4}\ \text{(1/h)},$$

……………………………………………

$$\widetilde{\alpha}(2950)=\frac{n(\Delta t)}{N_O\Delta t}=\frac{40}{1000\cdot 100}=4\cdot 10^{-4}\ \text{(1/h)},$$

$$\widetilde{\lambda}(50)=\frac{n(\Delta t)}{N_{cp}\Delta \text{t}}=\frac{50}{100\cdot\left(\frac{1000+950}{2}\right)}=5{,}13\cdot 10^{-4}\ \text{(1/h)},$$

$$\widetilde{\lambda}(150)=\frac{n(\Delta t)}{N_{cp}\Delta \text{t}}=\frac{40}{100\cdot\left(\frac{950+910}{2}\right)}=4{,}3\cdot 10^{-4}\ \text{(1/h)},$$

……………………………………………

$$\widetilde{\lambda}(2950)=\frac{n(\Delta t)}{N_{cp}\Delta \text{t}}=\frac{40}{100\cdot\left(\frac{465+425}{2}\right)}=9\cdot 10^{-4}\ \text{(1/h)}$$

The values $\widetilde{P}(t)$, $\widetilde{\alpha}(t)$, $\widetilde{\lambda}(t)$, calculated for all Δt_i are shown in the table. 1.3, and their dependence on time on rice. 1.3 and 1.4.

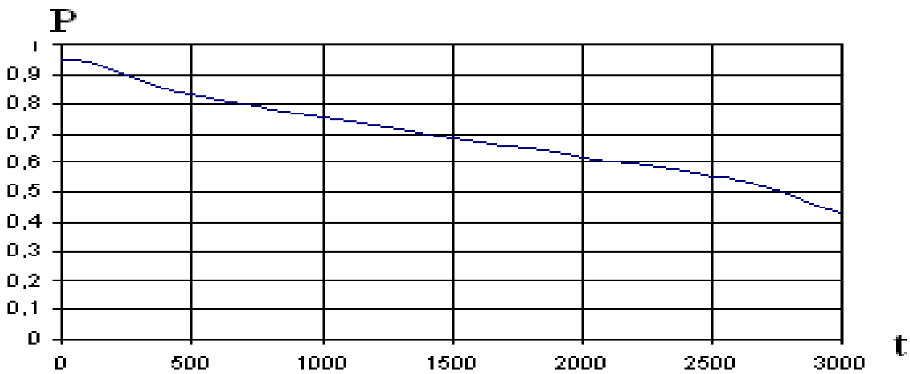
Calculate the average uptime, assuming that the test were only those samples that failed.

The calculation is carried out using the formula (1.11), given that $m=\frac{t_n}{\Delta t}=\frac{3000}{100}=30$ and $N_O=575$, have $\widetilde{\widetilde{T}}_O=\frac{\sum_{i=1}^{m} n_i t_{cpi}}{N_O}=\frac{50\cdot 50+40\cdot 150+32\cdot 250+...+30\cdot 2850+40\cdot 2950}{575}=1400$ (h).

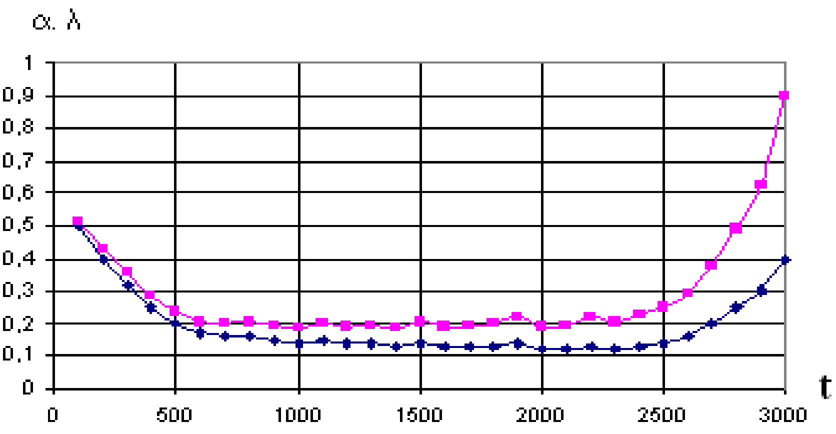
The mean value obtained before the first failure is underestimated, because the experiment was terminated after the failure of 575 samples out of 1000, put to the test.

Table 1.3 - Calculated value $\widetilde{P}(t)$, $\widetilde{\alpha}(t)$, $\widetilde{\lambda}(t)$ for example 1.3

Δt_i, h	$\widetilde{P}(t)$	$\widetilde{\alpha}(t)\cdot 10^{-4}$, (1/h)	$\widetilde{\lambda}(t)\cdot 10^{-4}$, (1/h)
0 – 100	0,950	5	5,14
100 – 200	0,910	4	4,3
200 – 300	0,878	3,2	3,58
300 – 400	0,853	2,5	2,89
400 – 500	0,833	2	2,38
500 -600	0,816	1,7	2,06
600 – 700	0,800	1,6	1,98
700 – 800	0,784	1,6	2,02
800 – 900	0,769	1,5	1,93
900 – 1000	0,755	1,4	1,84
1000 - 1100	0,740	1,5	2
1100 - 1200	0,726	1,4	1,91
1200 – 1300	0,712	1,4	1,95
1300 – 1400	0,699	!.3	1,84
1400 – 1500	0,685	1,4	2,02
1500 – 1600	0,672	1,3	1,92
1600 – 1700	0,659	1,3	1,95
1700 – 1800	0,646	1,3	2
1800 – 1900	0,632	1,4	2,2
1900 – 2000	0,620	1,2	1,92
2000 – 2100	0,608	1,2	1,95
2100 – 2200	0,595	1,3	2,17
2200 – 2300	0,583	1,2	2,04
2300 – 2400	0,570	1,3	2,25
2400 – 2500	0,556	1,4	2,48
2500 – 2600	0,540	1,6	2,9
2600 – 2700	0,520	2	3,76
2700 – 2800	0,495	2,5	4,9
2800 – 2900	0,465	3	6,24
2900 - 3000	0,425	4	9



Rice. 2 - The dependence of P from t to example 1.3.



Rice. 3 - Dependence α and λ from t to example 1.3

Example 1.4**.** For some time, the operation of one copy of the radar station was monitored. During the whole observation period, 15 failures were recorded. Before the beginning of the observation, the station worked for 258 hours, and by the end of the observation, the operating time of the station was 1233 hours. You want to determine the mean time between failures $\tilde{\tilde{T}}$.

Decision. Operating time of the radar station for the observed period is equal to $t = t_2 - t_1 = 1233 - 258 = 975$ (h)

By accepting $\sum_{i=1}^{n} t_i = 975$ h, according to the formula (1.13) we find the mean time between failures: $\tilde{\tilde{T}} = \frac{\sum_{i=1}^{n} t_i}{n} = \frac{975}{15} = 65$ (h).

Example 1.5. The work of three copies of the same type of equipment was monitored. During the observation period, the first copy was recorded 6 failures, the second and third – 11 and 8 failures, respectively[6]. Operating time of the first copy made 181 h, the second – 329 h and the third 245 h. it is Required to define operating time of the equipment on failure $\tilde{\tilde{T}}$.

Decision. Let's define the total operating time of three samples of the equipment:

$$t_{\Sigma} = \sum_{j=1}^{N} \sum_{i=1}^{nj} t_{ij} = 181 + 329 + 245 = 755 \text{ (h)}$$

Determine the total number of failures:

$$n_{\Sigma} = \sum_{j=1}^{N} n_j = 6 + 11 + 8 = 25 \text{ (refusal).}$$

Find the mean time to failure by the formula (1.14)

$$\tilde{\tilde{T}} = \frac{\sum_{j=1}^{N} \sum_{i=1}^{nj} t_{ij}}{\sum_{j=1}^{N} n_j} = \frac{t_{\Sigma}}{n_{\Sigma}} = \frac{755}{25} = 30{,}2 \text{ (h).}$$

Example 1.6. The system consists of 5 devices, and failure of any one of them leads to failure of the system. It is known that the first device refused 34 times during 952 hours of work, the second -24 times during 960 hours of work, and other devices during 210 hours of work refused 4, 6 and 5 times respectively. It is required to determine the time to failure of the system as a whole, if the exponential law of reliability for each of the five devices[7].

Decision. To solve this problem, we use the following relations:

$$\lambda_c = \sum_{i=1}^{n} \lambda_i \; \overline{T}_O = \frac{1}{\lambda_c}.$$

Determine the failure rate for each device:

$$\tilde{\lambda}_1 = \frac{34}{952} = 0{,}0357 \text{(1/h)}, \; \tilde{\lambda}_2 = \frac{24}{960} = 0{,}025 \text{(1/h)},$$

$$\tilde{\lambda}_{3,4,5} = \frac{4+6+5}{210} = 0{,}0714 \text{(1/h)}.$$

The failure rate of the system is equal to

$$\lambda_c = \sum_{i=1}^{n} \lambda_i = \lambda_1 + \lambda_2 + \lambda_{3,4,5} = 0{,}0357 + 0{,}025 + 0{,}0714 = 0{,}1321 \text{(1/h)}$$

Mean time to system failure

$$\overline{T}_O = \frac{1}{\lambda_c} = \frac{1}{0{,}1321} = 7{,}57 \text{ (h)}.$$

Example 1.7. During the observed period of operation 8 failures were recorded in the equipment. Recovery time was t1 = 12 min, t2 = 23 min, T3 = 15 min, t4 = 9 min, T5 = 17 min, T6 = 28 min, T7 = 25 min, T8 = 31 min. Determine the average recovery time of the equipment $\tilde{\overline{T}}_B$.

Decision.

$$\tilde{\overline{T}}_B = \frac{\sum_{i=1}^{n_i} t_i}{n_i} = \frac{\sum_{i=1}^{8} t_i}{8} = \frac{600}{8} = 75 \text{(min)}.$$

Example 1.8. The instrument had an average MTBF of 65 hours and the average recovery time of 1.25 h. it is Required to determine availability[8].

Decision. By formula (1.17) we have

$$K_Г = \frac{\overline{T}}{\overline{T} + \overline{T}_B} = \frac{65}{65 + 1{,}25} = 0{,}98$$

Example 1.9. Let the time of the element to failure is subject to the exponential distribution law with the parameter $\lambda = 2{,}5 \cdot 10^{-5}$ 1/h.

You want to calculate the quantitative characteristics of the reliability of the element $P(t)$, $\alpha(t)$, $\overline{T}_O$, if t = 500, 1000, 2000 h.

Decision. Use the formulas for $P(t)$, $\alpha(t)$ and $\overline{T}_O$, shown in table.1.1.

Calculate the probability of failure-free operation:

$$P(t) = e^{-\lambda \cdot t} = e^{-2,5 \cdot 10^{-5} \cdot t}.$$

$$P(500) = e^{-2,5 \cdot 10^{-5} \cdot 500} = 0,9875;$$

$$P(1000) = e^{-2,5 \cdot 10^{-5} \cdot 1000} = 0,9753;$$

$$P(2000) = e^{-2,5 \cdot 10^{-5} \cdot 2000} = 0,9512.$$

Calculate the failure rate:

$$\alpha(t) = \lambda(t) \cdot P(t) = 2,5 \cdot 10^{-5} \cdot e^{-2,5 \cdot 10^{-5} \cdot t}.$$

$$\alpha(500) = 2,5 \cdot 10^{-5} \cdot e^{-2,5 \cdot 10^{-5} \cdot 500} = 2,5 \cdot 10^{-5} \cdot 0,9875 = 2,469 \cdot 10^{-5} \text{ (1/h)};$$

$$\alpha(500) = 2,5 \cdot 10^{-5} \cdot e^{-2,5 \cdot 10^{-5} \cdot 1000} = 2,5 \cdot 10^{-5} \cdot 0,9753 = 2,439 \cdot 10^{-5} \text{ (1/h)};$$

$$\alpha(500) = 2,5 \cdot 10^{-5} \cdot e^{-2,5 \cdot 10^{-5} \cdot 2000} = 2,5 \cdot 10^{-5} \cdot 0,9512 = 2,378 \cdot 10^{-5} \text{ (1/h)}.$$

Calculate the mean time to the first failure:

$$\overline{T}_O = \frac{1}{\lambda} = \frac{1}{2,5 \cdot 10^{-5}} = 40000 \text{ (h)}.$$

Example 1.10. In the operation of the system was n = 40 failures. Distribution of failures by groups of elements and time spent on recovery are given in table 1.4. It is necessary to find the value of the average recovery time of the system[30].

Decision. We determine the average recovery time of the equipment by groups of elements.

For semiconductor devices:

$$\widetilde{\overline{T}}_B = \frac{\sum_{i=1}^{n_i} t_i}{n_i} = \frac{\sum_{i=1}^{8} t_i}{8} = \frac{600}{8} = 75 \text{ (min)}$$

Likewise:

- for resistors and capacitors 76 min;
- for relays, transformers, chokes 113 min;
- EVP for 50 min.;
- for other elements 120 min.

Calculate the average recovery time of the system by the formula:

$$\widetilde{\overline{T}}_{BC} = \sum_{i=1}^{m} t_{вi} \cdot m_i,$$

Where $t_{вi}$ average time of restoration of elements of the i-th group; m_i the weight of failures on groups of elements.

Table 1.4 - The number of registered failures in groups for example 1.10

Groupofelements	Number of failures per group n_i	The weight of failure in the group $m_i = \frac{n_i}{n}$	Recoverytime t_i, мин
SPT	8	0,2	80 59 110 91 45 43 99 73
Resistorsandcapacitors	10	0,25	61 73 91 58 44 112 82 54 91 94
Relays, transformers, chokes	4	0,1	102 98 124 128
EVP	14	0,35	60 64 56 36 65 44 42 33 32 23 86 75 61 23
Otherelements	4	0,1	125 133 115 107

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ПРОВЕРКА ТЕХНИЧЕСКИХ УСТРОЙСТВ НАДЕЖНОСТИ ЧЕРЕЗ РЕШЕНИЕ ВЕРОЯТНОСТИ НЕИСПРАВНОСТИ И НЕИСПРАВНОСТИ

Аннотация.В этой статье описываются основные понятия и определения теории надежности и ее приложения к задачам теории вероятностей. Теория вероятностей позволяет учесть случайный характер происходящих в системе событий и процессов, сформировать математические основы теории надежности. Рассмотрены проблемы с вероятностью безотказной работы элемента. Одной из основных задач, решаемых в процессе эксплуатации и технического обслуживания технических устройств, является обеспечение их надежной работы. Важность этой проблемы связана с сложностью современных технических устройств и высокими значениями рабочих нагрузок (температура, давление, влажность и т. Д.). Надежность - это способность технических устройств выполнять определенные функции, поддерживая их работу в указанных пределах на требуемый период времени или требуемое время работы в определенных условиях эксплуатации. Надежность как качественная характеристика всегда учитывалась при решении различных вопросов эксплуатации и обслуживания.

Ключевые слова: отказ, вероятность, технические устройства, информационная система, надежность.

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ТЕХНИКАЛЫҚ ҚҰРЫЛҒЫЛАРДЫҢ ЖАУАПКЕРШІЛІКТІ ЖӘНЕ АТАЛҒАН МҮМКІНДІКТЕРДІ ТИІМДІЛІКТІ АРҚЫЛЫ

Аннотация. Бұл мақалада сенімділік теориясының негізгі ұғымдары мен анықтамалары және ықтималдықтар теориясының мәселелеріне қолданылуы сипатталған. Ықтималдық теориясы жүйедегі оқиғалар мен процестердің кездейсоқ сипатын ескеріп, сенімділік теориясының математикалық негіздерін қалыптастыруға мүмкіндік береді. Элементтің сәтсіз жұмыс істеу ықтималдығы мәселесі қарастырылады. Техникалық құрылғыларды пайдалану мен күту процесінде шешілетін басты міндеттердің бірі олардың сенімді жұмысын қамтамасыз ету болып табылады. Бұл проблеманың маңыздылығы заманауи техникалық құрылғылардың және жұмыс жүктемелерінің жоғары мәндерінің (температура, қысым, ылғалдылық және т.б.) күрделілігіне байланысты.Сенімділік - техникалық құрылғылардың белгілі бір функцияларды орындауы, белгілі бір уақыт ішінде белгілі бір лимиттерде жұмыс істеуін немесе белгілі бір пайдалану жағдайларында талап етілетін жұмыс уақытын сақтау қабілеттілігі. Сапалы сипат ретінде сенімділік әртүрлі мәселелерді шешу кезінде әрқашан ескеріледі.

Түйін сөздер: бас тарту, ықтималдық, техникалық құрылғылар, ақпараттық жүйе, сенімділік.

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