

The use of an optimization algorithm layout of elements on the basis of the method of branches and borders taking into account the thermal coefficient will improve the reliability of electronic tools, and avoid overheating.

REFERENCES

1. Ivanov I. A., Konashenkova A. Yu., Lyshov S. M., Uvaysov S. U., Tsyzdov M. B. Evaluation of the reliability of detecting defects in the printing unit using built-in emulators for generating vibration vibrations //Quality. Innovation. Education, 2016. No. 11(138). pp. 55-60.
2. Bushmeleva K. I., Bazhaev A. B., Uvaysov S. U., Bushmelev P. E. Automated system for calculating rejection tolerances for electric radio elements of electronic means //Vestnik of Cybernetics, 2018. No. 1 (29). pp. 72-81.
3. Thermal regime [Electronic resource]. Mode of access: http://oplib.ru/himiya/view/1161251_teplovoy_rezhim (date accessed: 22.01.2021)
4. Sheremet M. A. On the question of passive cooling of hermetic elements of radio-electronic equipment and electronic equipment //Microelectronics, 2013. No. 6. pp. 472.
5. Bushmeleva K. I., Dimitrieva E. A., Zang Van Thanh, Dao An Kuan Automated system for optimizing the layout of elements in electronic media //Innovative, information and communication technologies: proceedings of the XVII International Scientific and Practical Conference. Moscow, 2020. pp. 378-383.
6. Tuishchev, A. I. Calculation of thermal modes and characteristics of printed circuit boards of radioelectronic means and computer technology in conductive heat exchange /A. I. Tuishchev, I. O. Gubanov. Tolyatti: Vestnik NGIEI, 2014. pp. 84-88.
7. The method of branches and boundaries [Electronic resource]. Mode of access: http://www.math.nsc.ru/LBRT/k4/or/or_part4.pdf (date accessed: 22.01.2021)

EVALUATION OF THE DEPENDABILITY INDICATORS OF THE RESTORED EQUIPMENT BY THE SIMULATION METHOD

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Abstract - The report discusses the application of simulation modeling to dependability prediction of the restored equipment. A formal model is described that allows forming time diagrams of the states of both the components and the equipment as a whole. It is shown that the use of such a model allows us to estimate the availability function and the mean restoration time of the equipment if the law of the distribution of the restoration time of the components differs from the exponential one.

Keywords - equipment, dependability, availability function, mean operating time between failure, mean restoration time, statistical modeling.

INTRODUCTION

Consider the of the dependability prediction of the restored equipment under the following conditions, assumptions and restrictions:

- RBD - "Serial connection of the Component Part (CP)";
- failures and recoveries of the CP - independent events;
- when restoring one CP, the remaining CP remain in loaded mode;
- the time-to-failure distribution law of the CP (t_{Fi}) is exponential with the parameter λ_i ;
- the law of the distribution of the recovery time of the CP (t_{Ri}) - exponential with the parameter

μ_i .

In this case, the Mean Time To Restoration (MTTR) of the equipment (T_R) is calculated according to the standard formula [1]:

$$T_R = T_F \cdot \frac{1 - K_A}{K_A}, \quad (1)$$

where

$$T_F = \frac{1}{\sum_{i=1}^I \lambda_{O_i}}, \quad K_A = \prod_{i=1}^I K_{A_i},$$

where

$$K_{A_i} = \frac{T_{F_i}}{T_{F_i} + T_{R_i}}, \quad T_{F_i} = \frac{1}{\lambda_{O_i}}, \quad T_{R_i} = \frac{1}{\mu_i},$$

where T_F is the Mean Time To Failure (MTTF) of the equipment; K_A is stationary availability function; λ_{O_i} is operational failure rate of the i -th CP; I is the number of CP in the RBD; K_{A_i} is stationary availability function of the i -th CP; T_{F_i} is MTTF of the i -th CP; T_{R_i} is MTTR of the i -th CP; μ_i is the restoration time of the i -th CP.

PROBLEM STATEMENT

However, Data Sheet for CP lead maximum allowable restoration time (T_{Rmax}) - deterministic value, mean time to repair CP (T_{Ri}), including tolerance to it ($T_{Ri} \pm \delta_i$) or the time interval [T_{Rie} , T_{Riu}]. In the last two cases, the standard [2] recommends using a truncated normal distribution to calculate the probability of recovery of parts (P_{Ri}):

$$P_{R_i} = \frac{C_i}{\sqrt{2 \cdot \pi}} \cdot \int_{T_{R_{iE}}}^{T_{R_{iU}}} e^{-\frac{[t_{B_i} - m(t_{R_i})]^2}{2 \cdot \sigma(t_{R_i})^2}} dt_{R_i} \quad (2)$$

where C_i is the normalizing coefficient; $m(t_{Ri})$ and $\sigma(t_{Ri})$ are the distribution parameters.

Obviously, if the distribution of t_{B_i} differs significantly from the exponential one, then the use of the standard [1] for calculating T_B can lead to an error, the value of which is difficult to estimate.

SOLUTION OF THE PROBLEM

At the same time, the standard [3] states that "The universal method of calculation ... is the method of statistical modeling". Therefore, we will consider the possibility of using this method to calculate the T_R , or rather, a formal model for obtaining the implementation of the process of functioning of the restored equipment during the time t_F for the above RBD with independent restoration of CP during which the remaining CP remain in operation [4, 5]. As the value of t_E , we take the service life of the equipment.

It is obvious that at $t_E=0$, the probability of failure-free operation of each CP (P_i) is equal to 1, and, consequently, $K_{A_i}=1$. However, let's assume that for $t_E=0$ $K_{A_i} \neq 1$, and their values are calculated by the formula:

$$K_{A_i} = \frac{T_{F_i}}{T_{F_i} + T_{R_i}}. \quad (3)$$

Note: it is possible to perform the calculation even if $K_{A_i}=1$.

As a result, you can form an array of $K_{Acp}=[K_{A1}, K_{A2}, \dots, K_{Ai}, \dots, K_{AI}]$, which is necessary to determine the states of the CP at the initial time (running or recovering) for each simulation experiment, which is determined from the condition:

$$l_i = \begin{cases} 0 & \text{by } x > K_{A_i} - \text{mode of restored} \\ 1 & \text{by } x \leq K_{A_i} - \text{operating mode} \end{cases}, \quad (4)$$

where x is the implementation of the Base Random Variable (BRV).

Next, the implementation of its Time State Diagram (TSD) is calculated for each CP.

If at $t_E=0$ $l=1$, then the implementation of the operating time (t_O) is calculated. For example, for an exponential distribution:

$$t_O = -\frac{\ln y}{\lambda}, \quad (5)$$

where y is the implementation of the BRV.

Then the total time $t_\Sigma=t_O$ is calculated and the condition is checked:

$$t_\Sigma \geq t_O \quad (6)$$

If condition (6) is satisfied, then the implementation of the TSD has the form shown in Fig. 1.



Fig. 1 Implementation of the TSD CP

If condition (6) is not met, the implementation of the recovery time (t_R) is calculated. For example, for an exponential distribution:

$$t_R = -\frac{\ln z}{\mu}, \quad (7)$$

where z is the implementation of the BRV.

Then the total time $t_\Sigma=t_O+t_R$ is calculated and condition (6) is checked. If condition (6) is satisfied, the implementation of the TSD has the form shown in Fig. 2.



Fig. 2 Implementation of the TSD CP

If condition (6) is not met, then a new implementation of the operating time is calculated, t_Σ is calculated, condition (6) is checked, and so on, until condition (6) is met. In this case, the implementation of the TSD will have the form shown in Fig. 3.

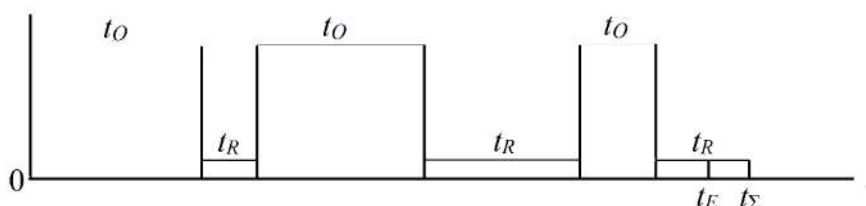


Fig. 3 Implementation of the TSD CP

If at $t_E=0$ $l=0$, then the implementation of the recovery time (t_R) is first calculated, and then the TSD of the midrange is constructed in the way discussed above.

After calculating the TSD implementations for all CP, the TSD implementation for the equipment is calculated by sequentially "superimposing" the TSD (see Fig. 4).

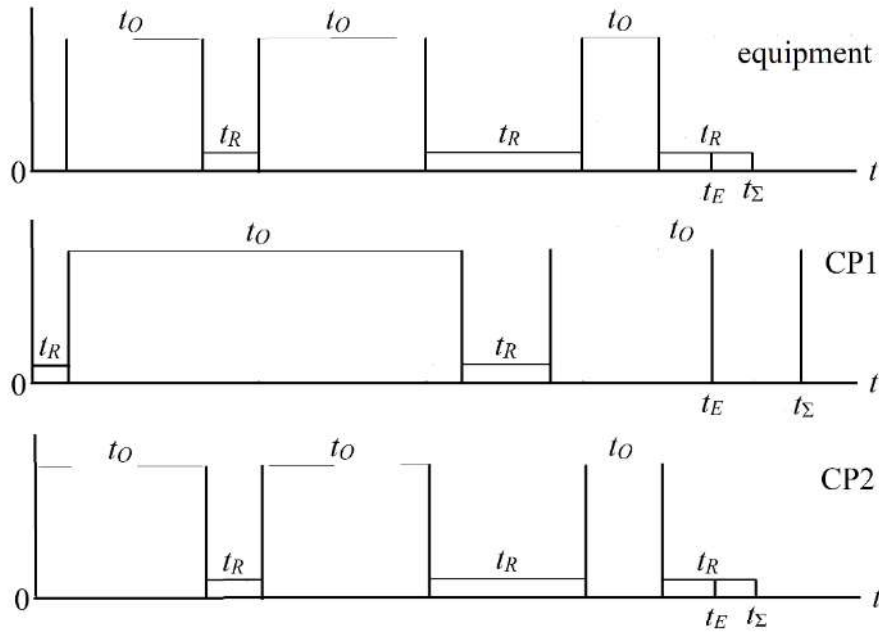


Fig. 4 Implementation of the TSD equipment

As can be seen from Fig. 4, t_{Σ} of the equipment is equal to the minimum value of t_{Σ} of the TSD of the midrange.

After calculating the implementation of the TSD of the equipment, the MTTF of the equipment (T_{Fn}) in this simulation experiment is calculated:

$$T_{Fn} = \frac{1}{J_n} \cdot \sum_{j=1}^{J_n} t_{O_{n,j}}, \quad (8)$$

where J_n is the number of intervals in which the equipment is in operation (see Fig. 4); n is the number of the simulation experiment.

And also the value of R is calculated:

$$R = \begin{cases} R, & \text{if } T_{Fn} = 0 \\ R+1, & \text{if } T_{Fn} > 0 \end{cases} \quad (9)$$

Similarly, the MTTR of the equipment (T_{Rn}) in this simulation experiment is calculated:

$$T_{Rn} = \frac{1}{K_n} \cdot \sum_{k=1}^{K_n} t_{R_{n,k}}, \quad (10)$$

where K_n is the number of intervals in which the equipment is in recovery mode (see Fig. 4); n is the number of the simulation experiment.

The value of S is calculated:

$$S = \begin{cases} S, & \text{if } T_{Rn} = 0 \\ S+1, & \text{if } T_{Rn} > 0 \end{cases} \quad (11)$$

In addition, the value of m is calculated:

$$m = \begin{cases} m, & \text{if at } t = t_E \text{ the equipment is being restored} \\ m+1, & \text{if at } t = t_E \text{ the equipment is working} \end{cases} \quad (12)$$

After performing all simulation experiments, the MTTR of the equipment is calculated:

$$T_R = \frac{1}{S} \cdot \sum_{s=1}^S T_{R_s}, \quad (13)$$

The MTTF of the equipment is calculated in the same way:

$$T_F = \frac{1}{R} \cdot \sum_{r=1}^R T_{F_r}. \quad (14)$$

The equipment availability function is calculated:

$$K_A(t = t_E) = \frac{m}{N}. \quad (15)$$

The stationary availability function of the equipment is calculated by the formula:

$$K_A = \frac{T_F}{T_F + T_R}. \quad (16)$$

CONCLUSION

Thus, the above is a formal model for the formation of TSD implementations of CP and equipment as a whole, which allows you to calculate the reliability indicators of the restored equipment with a "sequential" RBD, in which failures and recovery of CP are independent events and when restoring one CP, the remaining CP remain in the loaded mode.

REFERENCES

1. Radio-Electronic Equipment. Method of Dependability Prediction, Industry Standard 4G 0.012.242, 1984.
2. Maintainability Prediction, Military Standard MIL-HDBK-472, 1984.
3. Dependability in Technics. Dependability Prediction. Basic Principles, Interstate Standard 27.301, 1995.
4. V. V. Zhadnov, "Modern Problems of Automation of Dependability Prediction" (in Russian), Dependability, no. 2, pp. 3-12, Jun. 2007.
5. V. V. Zhadnov and A. N. Tikhmenev, "Simulation Modeling in Estimating Reliability of Fail-Safe Electronic Equipment", *Dependability*, no. 1, pp. 44-54, Apr. 2013. DOI: 10.21683/1729-2646-2013-0-1-32-54.

DIGITAL ENVIRONMENT OF THE UNIVERSITY

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Annotation – The article examines the features and issues of organizing distance learning for students in Russian universities based on the use of the digital environment. In the context of a viral pandemic and a general transition of distance learning students, the administration and university professors design the most optimal technical and software solutions that contribute to the development of network, telecommunication forms of organizing education with limited opportunities for movement. The main problems arising in distance learning are considered. The efficiency of using the digital environment at St. Petersburg State University is shown.

Keywords: organization of distance learning, digital environment, students, Internet services

Today, the concepts of «digital society», «network learning», «electronic educational environment» have become integral parts of our life. The digital environment of the university in the context of universal distance learning associated with the spread of coronavirus infection is an important link between sources of information services and consumers of educational resources. The digital environment includes organizational and methodological support, computer technology, educational models [1], telecommunications and information technologies [2].