UDC 519.21

The Asymptotic Estimation The System Refuse Intensively When Elements Are Repaired Without Waiting And Elements That Have Reach The Repair Return Into The System With Minimal Standby Beginning Off any Quantity

A. V. Makarichev*, I. V. Brysina†

* *Department of Transportation Systems and Logistics, Kharkiv National Automobile and Highway University, Yaroslav Mudry str. 25, Kharkiv, 61002, Ukraine*

† *Department of Higher Mathematics and System Analysis, N. Ye. Zhukovsky National Aerospace University «Kharkiv Aviation Institute», Chkalov str. 17, Kharkiv, 61070, Ukraine*

Abstract. The asymptotic estimation the system refuse intensity when elements are repaired without waiting and elements that have reach the repair return into the system with minimal standby beginning off any quantity are obtained.

Keywords: return into the system with minimal standby beginning off any quantity.

1. Introduction

In work [1] for complexes of the restored systems with a cold reserve for a wide class of repair service systems the rule of return of the restored elements to systems with the minimum reserve that allows to increase significantly of systems and complexes when number of reserve elements in systems not less then two is considered. Further as repair system the system like $M|G|\infty$ is considered.

2. Main section

The group of N identical repairable systems with n standby is considered. Failed elements of each system are to be repaired. We assume that the stream of repairing demands from every system is Poisson with parameter λN^{-1}. Every failed element immediately enters the unlimited repair facility so that its repairing starts immediately. Each element after it has been repaired returns into that system which has the largest group beginning off ℓ ($\ell \geq 2$) of faulty elements. Let $G(x)$ be the distribution function of random repairing time of element. Repairing times of different elements are independent and identically distributed. We use the notation

$$m_1 = \int\limits_{x \geq 0} x dG(x).$$

Let $\rho = \lambda m_1$ be the total load to repair facility formed by all systems. Let $\Lambda_j(r_0)$ be the refuse intensity of the j system $(1 \leq j \leq N)$.

Theorem *Suppose there exists finite first moment $m_1 < \infty$. Then for any natural number $n \geq 2$ and $\ell \geq 2$ we have*

$$\Lambda_j(r_0) \leq B(\lambda, N, G, \ell, n),$$

where

$$B(\lambda, N, G, \ell, n) = \left(\frac{\lambda}{N}\right)^{n+1} \underset{0<x_1<x_2<\ldots<x_n}{\int \cdots \int} \exp\left(-\frac{\lambda x_n}{N}\right) \times$$

$$\times \left\{\prod_{r=1}^{\ell-1} [1 - G(x_n - x_r)]\right\} \sum_{k \geq 0} \frac{\rho^k}{k!} \exp(-\rho) \left\{\frac{1}{m_1} \int_{x_n - x_{\ell-1}}^{\infty} [1 - G(t)]dt\right\}^k \times$$

$$\times \left\{\prod_{j=\ell}^{n-1} [1 - G(x_n - x_j)]\right\} dx_1 dx_2 \ldots dx_n,$$

$$\left(\frac{\lambda}{N}\right)^{n+1} \frac{\exp(-\rho)}{(\ell-1)!} \sum_{k \geq 0} \frac{\lambda^k}{k!} \frac{\left[\int\limits_{t \geq 0} [1 - G(t)] \exp\left(-\frac{\lambda t}{N}\right) dt\right]^{k+n}}{(k+\ell)(k+\ell+1)\ldots(k+\ell+n)} \leq$$

$$\leq B(\lambda, N, G, \ell, n) \leq$$

$$\leq \left(\frac{\lambda}{N}\right) \left(\frac{\rho}{N}\right)^n \frac{\exp(-\rho)}{(l-1)!} \sum_{k \geq 0} \frac{\rho^k}{k!} \frac{1}{(k+\ell)(k+\ell+1)\ldots(k+\ell+n)}$$

and for $\frac{\rho}{N} \to 0$

$$B(\lambda, N, G, \ell, n) \sim \left(\frac{\lambda}{N}\right) \left(\frac{\rho}{N}\right)^n \frac{\exp(-\rho)}{(\ell-1)!} \times$$

$$\times \sum_{k \geq 0} \frac{\rho^k}{k!} \frac{1}{(k+\ell)(k+\ell+1)\ldots(k+\ell+n)}.$$

3. Conclusions

The top estimates (and their asymptotic) for intensity of refusals of systems allow to estimate from below effect from use of the rule r_0 returns of the restored elements to systems with the minimum reserve in comparison with the usual rule r of return of the restored elements to those systems where they refused, a case when number of reserve elements in system not less than two.

References

1. *Makarichev A. V.* Optimal Allocation of Elements in a Complex of Renewable Stanby Systems // Theory Probab. Appl. — 1995. — Vol. 40, no. 1. — P. 66–75.