THEORY OF AGING ELEMENTS

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1. Introduction

At the present time, the exponential law is the fundamental law used in reliability theory. The popularity of this law is explained principally by the fact that almost all problems occurring in reliability theory are solved incomparably more simply if it is assumed that all the random variables in the problem are distributed according to an exponential law. The same problems for arbitrary laws are either not solved in closed form, or lead to formulas which are awkward and not readily usable.

On the other hand, it is known that the random variables used in reliability (time of faultless operation, recovery time, time to find the imperfection, and so on) have a distribution radically different from the exponential distribution, for many systems and elements. In these cases the solutions obtained under the assumption that all the laws are exponential will not describe the processes we are interested in as accurately as desired. How does one get out of this blind alley?

In the first place, methods worked out in similar disciplines, principally in queueing theory and renewal theory, methods which permit the solution of problems for cases when part of or even all the distribution laws are arbitrary, may be used in reliability theory. Unfortunately, the class of such problems is quite narrow.

Another very promising direction is to search for approximate formulas in the proofs of any limit theorems from which other approximate formulas may, in turn, be obtained. Thus, for example, it can be proved that a large number of rarely recurring events generate a Poisson flow, and therefore, the time prior to the first appearance of an event is distributed according to an exponential law. Here it should also be noted that as a rule, a rigorous proof of such limit theorems requires great efforts.

The third possible direction, to one aspect of which this paper is devoted, is that some natural physical conditions may be imposed on the distribution laws encountered in reliability, and estimates for the different reliability characteristics may be sought in the given class of laws.

2. The hypothesis of aging

As is known, the exponential distribution of the time of faultless operation of an element has a simple physical meaning—the probability of failure of such