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# ABOUT THE PAPER BY KOFANOV YU.N. AND STRELNIKOV V.P. “METHODOLOGICAL IMPRECISION OF PREDICTION OF ELECTRONICS’ MEAN LIFE TIME”

The main auditory of the journal is engineers and researchers concerned about development of highly reliable equipment and its failure-free operation. We can possibly assume that due to the character of their professional activities they may not know the theory of reliability sufficiently to comprehend all mathematical aspects of papers, however they are good at practical issues of application of paper results.

In this point of view, it is worth to note the clear statement of research, compliance of the paper’s title with its contents, correct use of terms, justified assumptions made in the mathematical model, possible to be proved during operation or testing, provable statements made by the authors, the practical values of theoretical results and its summary in the concluding part of the paper.

Thorough consideration of the paper’s materials have brought some comments that among other things are to provide answers to possible readers’ questions, to help them adequately estimate the results of the paper and warn them about mistakes in using them.

## 1. About the title of the paper

The title uses the term “mean life”. In our opinion, accepted term in the theory of reliability should be used very carefully and cautiously. According to the valid standard GOST 27.002-89 «Dependability in equipment. General concepts. Terms and definitions»: useful life is the total life of a facility from the start of its operation or its renewal after repair till the transfer into limit state (term 4.5), and mean life is the mathematical expectation of life (term 6.16). This is a longevity parameter. The paper in fact considers mean time to failure (term 6.10). This is a reliability parameter that has nothing to do with limit state. The authors also point out at this fact in the paper’s abstract. Yet, in the list of keywords they again treat time to failure and life as synonyms.

## 2. About two-parametric distributions and variation coefficient hypothesis

Page 3 of the paper says: “Since there is no statistical data for assessment of parameters of two-parametric distributions, we assume that the variation coefficient of time to failure distribution is equal to entity (v=1), as for exponential distribution”.

In relation to this we can ascertain that there is neither statistical data for assessment of parameters of two-parametric distributions, nor statistically reliable proofs that electronic products have any distribution of time to failure other than a one-parametric exponential distribution.

Even more surprising is the statement that some unknown (there are no references in the paper) “…researchers using a one-parametric exponential distribution to solve tasks automatically assume that the variation coefficient of time to failure distribution is equal to entity”.

For the information of those who don't know, exponential distribution cannot have any other variation coefficient as the ratio of mean square deviation to mathematical expectation than unity. So, the statement looks like the statement: "some mathematicians automatically assume that two times two equals four".

Due to the same reason, it certainly remains unclear how in Table 2 the variation coefficient of distribution happens to equal 0.8. Absolutely improvable is the statement on page 7 (right column) that "… a more correct value of variation coefficient of time to failure of electronic devices in operation modes, including IC, will be v=0,8". It is not clear where the value 0.8 as assumption comes from (why is it not 0.75 or 0.85?) and why it is correct.

The hypothesis of variation coefficient stability itself has no physical and technical justification. It is known that life cycles of technical products have stages of running-in, normal operation and ageing. At the stage of running-in the coefficient of variation decreases as a failure rate decreases. For example, for Weibull's distribution with the parameter of form m increasing from 0.5 up to 0.9, the coefficient of variation decreases from 2.24 down to 1.11. For Weibull's distribution with the parameter of form m increasing from 1.1 up to 2.0, the coefficient of variation decreases from 0.91 down to 0.52. And these values do not depend on a scale parameter.

## 3. About mean time to failure as a reliability parameter of electronics

Mean time to failure is convenient as a reliability parameter due to its simplicity (this is one figure and easily interpreted as time interval). Though A.M. Polovko and B.V. Gnedenko already noted that mean time to failure is not a suitable reliability parameter due to several reasons.

It is known that in quantitative terms mean time to failure is an area under the curve of a failure-free operation probability. For highly dependable products that include electronics the interval of averaging exceed many times (by one or two orders) the interval of a product's actual operation.

For qualitative illustration of this effect, let us use the paper's materials. Mean operation time of 26980 products equals 102412 hours or 11.7 years. Mean time to failure for exponential distribution equals 26287 years, which is 2250 time bigger than mean operation time. If we use two different distributions – one-parametric exponential and Weibull's two-parametric distributions, then for similar failure probabilities 0.00044477 on the operation interval of 11.7 years the mean values of time to failure will be different – 26287 and 5347 years respectively. But this will happen only due to differences on the operation interval of from 11.7 to 26287 (or more) years. However it should not matter since differences will become evident after a product has long been put out of operation as to criteria of longevity. This effect is shown in Figure 1 in the paper but stays unnoticed and uncommented (rather the authors bring us to quite an opposite conclusion).

## 4. Economical damage from application of exponential distribution

In the conclusion of the paper the authors make a statement that "the exponential law of failure-free operation time distribution recently received wide application doesn't reflect real conditions for emergence of electronic devices failures. Its application brings a huge economic damage, first of all, to users of electronic devices who apply them as part of avionics and in other vital cases".

As many other statements in the paper, this one is not justified and does not correspond to the paper's contents. Nothing has been said about the nature of economical damage.

## 5. About necessity of use of two-parametric distributions of time to failure

The concluding statement that two-parametric diffusive distribution laws provide the most adequate parameters of reliability for electronics products are not demonstrated by the paper's materials in any way. The first question to be answered is what volume of statistical data should be in order to identify a two-parametric distribution as to criteria of mathematical statistics for sure. Even for exponential distribution it is not easy. Based on the materials of the paper we can calculate that even for such impressive total time to failure of 2.76 bln hours, the variance of point estimate of mean time to failure is such that two-sigma boundaries are 59 per cent of point estimate, and the confidential interval with the importance level of 0.2 has dimensions of ±40 per cent from the value of point estimate.

The second question not less complicated is whether there are any physical or physical and chemical prerequisites for ageing of electronic products beginning so early (during the first 10-15 years with mean time to failure of hundred years).

## 6. Carelessness and superfluity

Ambiguous impression is made by a careless treatment of numerical material in the paper. For instance, estimate of mean time to failure for exponential distribution is 26287 years (not 22830 years, as in Table 2). Statistical time to failure per one failure is 230.37 mln hours, not 200 mln hours, as on p. 7 (left column). Failure rate is $4.34*10^{-9}$ hour$^{-1}$, not $5*10^{-9}$ hour$^{-1}$, as on p.4. Mean time to failure in Weibull's distribution for the variation coefficient of 0.8 equals 5347 years, not 5275 years, as in Table 2 etc.

The paper has some redundant materials not pertaining to issue in question that litter the text and draw attention away from the purpose of the paper, for example contemplations on accelerated tests on p. 6 which are not further used anywhere.

The above drawbacks of the paper are regrettable, and even more since the authors are well-known researchers recognized for their achievements in the theory of reliability. The author of this note expects further discussions on the paper's subject matter and the quality of publications.