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INSTRUMENTAL TOLERANCE CREDIBILITY OF CONTROL

O.I. SCHEPOTYEV, *Ph.D.*
A.V. ZHILTSOV, *PhD*
V.V. VASYUK, *postgraduate**

Questions instrumental reliability of the results of a tolerance control. The requirements to the accuracy characteristics of measurement tools.

Reliability, tolerance control, instrumental reliability, object control.

One of the most important controls – access, is to establish correlations between the values of the parameters monitored in some way and set boundaries (tolerances) to reject. Since measuring devices inherent error tolerance control results require the quantitative characteristics reflecting the credibility of the results obtained control.

The reliability of test results - a measure of the degree of control the results properly reflect the actual technical state of the control object. It can be imagined as two components - the methodological validity and reliability of tool.

$$Д_K = Д_M \cdot Д_i,$$

where $Д_M$ – methodological validity control; $Д_i$ – instrumental reliability of control.

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* Supervisor – PhD A.V. Zhiltsov

Articles reliability is defined minimum set of parameters that are monitored, control methods and evaluation criteria adopted by the technical state of the object.

Instrumental reliability - component reliability test results, defined probabilistic properties of attributes of the object type algorithm processing features, precision characteristics of measurement tools and others. [1].

When tolerance control "fit" is defined with object parameters, measurement results which are within the set of assumptions and "unfit" – an object with parameters, measurement results which are not within.

Size operational limits established operating manual or other relevant documents to the parameters of the object in controlled conditions.

Limits - is established by experience or expectation bounds for parameter values of the object at which it is able to perform specified functions, while maintaining its operational performance for the required time under certain conditions.

The aim – to identify indicators and methods of assessing the quality of results tolerance control of technical objects.

Materials and methods research. Model implementation process tolerance control is shown in Fig. 1. This allowed the complete reliability of controls and possible outcomes of control, due only to their accuracy characteristics and actual state of the control object [3].

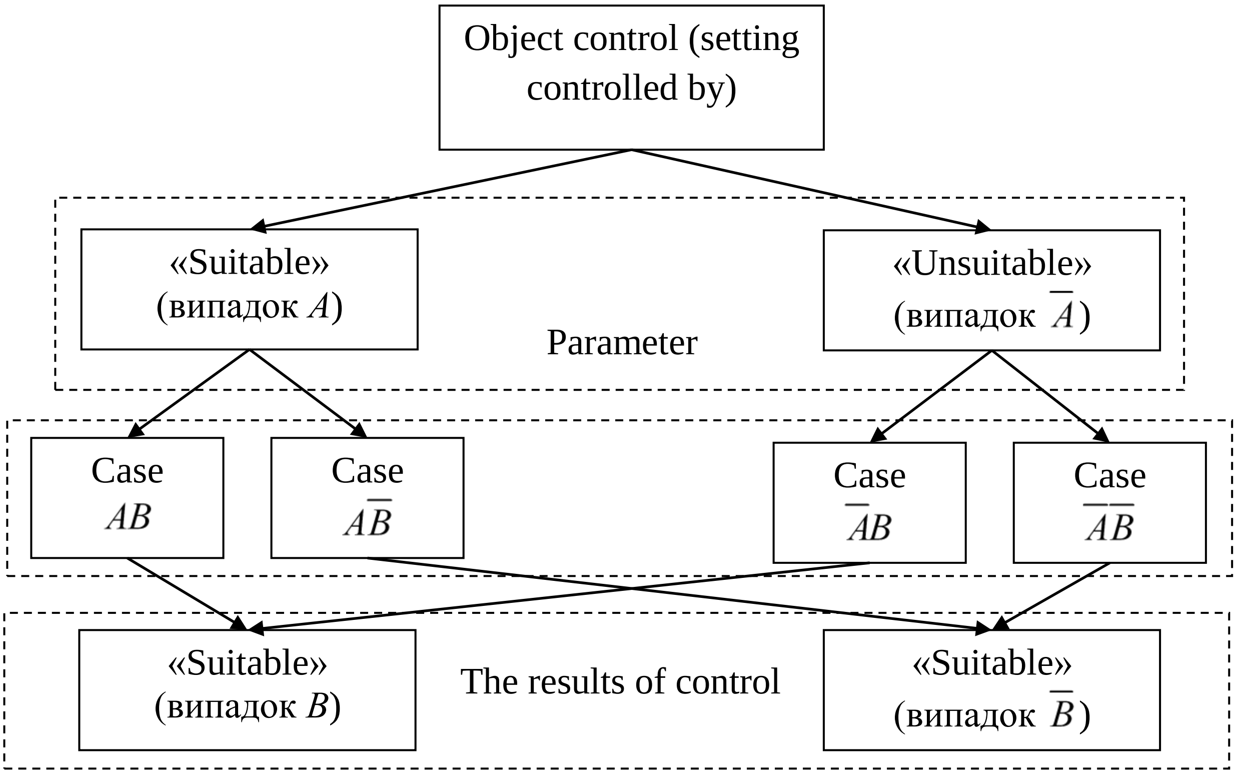

Fig.1. Model implementation process tolerance control

Legend:

A – case, which is that the value of the parameter that is monitored is within the tolerance field (object control "fit");

$\overline{A}$ – case, which is that the value of the parameter that is controlled, not within the tolerance field (object control "unfit");

As a result, control or obtain a result that defines the object of control "fit" (control result is within specified tolerances) – case B, or outcome that defines the object of control "unfit" (control result is outside specified tolerances) – case $\overline{\mathrm{B}}$. Because of the inherent measuring device measurement errors the results can not be regarded as absolute.

Because of this, consider the following possible events:

AB – area $ABFEDHN$;

$A\overline{B}$ – area $FCDE$;

$\overline{A}B$ – area BFG and DHI;

$\overline{A}\overline{B}$ – area $-\infty AB,KH\infty$.

The probability of these events $P(AB), P(\overline{A}B), P(A\overline{B}), P(\overline{A}\overline{B})$ characterize the quality of tolerance control, but they do not take into account factors apriornosti or aposteriornosti events. However, as they constitute the entire group of possible events: $P(AB)+P(\overline{A}B)+P(A\overline{B})+P(\overline{A}\overline{B})=1$.

The variation of the probability density values of the controlled parameter $f_A(x)$ and the probability density values of test results $f_B(x)$ shown in Fig. 2.

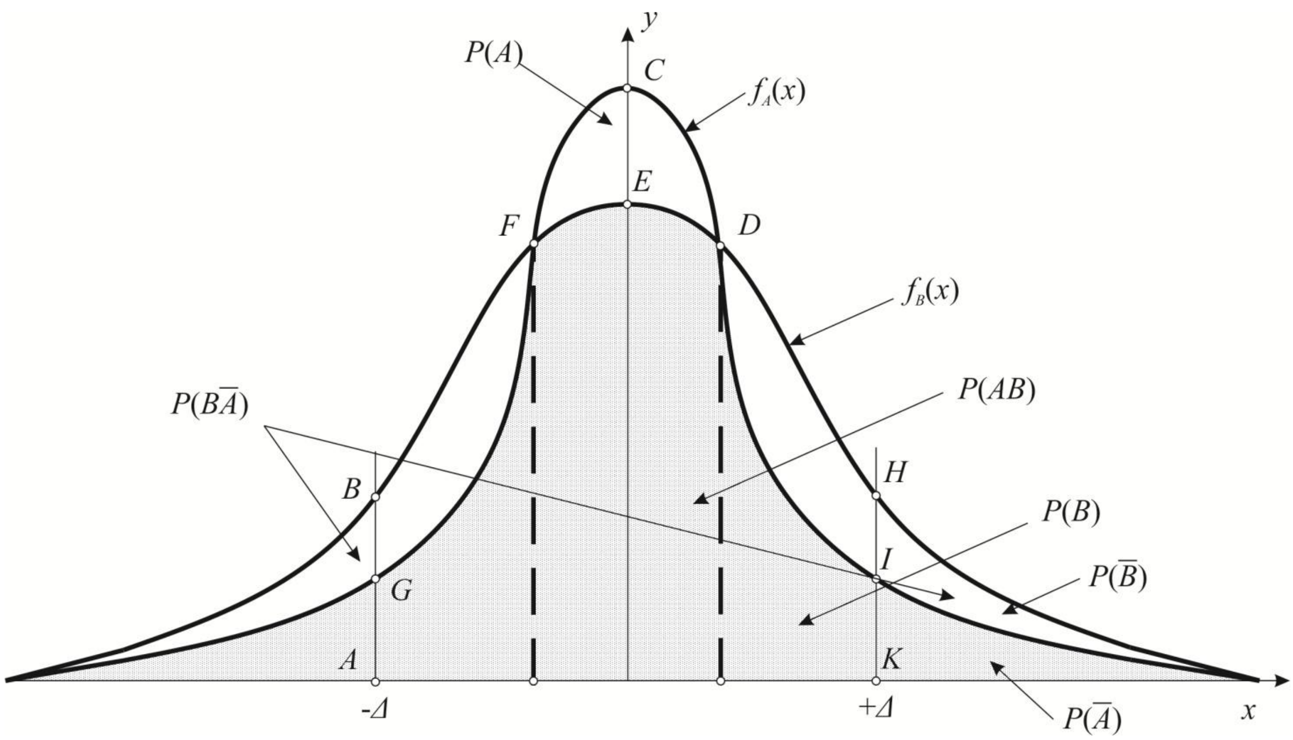

Fig.2. The variation of the probability density controlled parameter values and probability density test results

As more sensitive indicators of reliability can be applied a priori conditional probability $P(B/A), P(B/\overline{A}), P(\overline{B}/A), P(\overline{B}/\overline{A})$ or posterior conditional probability $P(A/B), P(\overline{A}/B), P(A/\overline{B}), P(\overline{A}/\overline{B})$.

In the development and creation of diagnostics primarily a question of a priori estimates of its features (reliability assessment of the control object). Therefore, it is advisable to use a priori probability $P(B/A), P(B/\overline{A}), P(\overline{B}/A), P(\overline{B}/\overline{A})$. In this case, the parameters set in advance in the field of access (or in the field of admission) and the results of these controls determine the value of a priori probabilities.

$P(B/A)$ – priori conditional probability of obtaining results "fit" if the value of the monitored effectively within specified tolerances.

$P(B/\overline{A})$ – priori conditional probability of obtaining results "fit" if the value of the monitored effectively outside the tolerances.

$P(\overline{B}/A)$ – priori conditional probability of obtaining results "not applicable" if the value of the monitored effectively within tolerances.

$P(\overline{B}/\overline{A})$ – priori conditional probability of obtaining results "not applicable" if the value of the monitored effectively outside the tolerances.

Obtained results of testing the system diagnostics values specified a priori probabilities are used to determine a posteriori probability values that truly reflect the state of the control object on the results of the control (reliability test results).

$P(A/B)$ – conditional probability events is to find the value actually controlled within specified tolerances, provided that the result of control "fit" (reliability test results by the decision of "suitable").

$P(\overline{A}/\overline{B})$ – conditional probability events is to find really setting controlled outside the specified tolerances, provided that the result of control "unfit" (reliability of test results by the decision of "not applicable").

According to Theorem Bayes' posterior probability $P(A/B)$ can be determined from the relationship:

$$P(A/B)=\frac{P(AB)}{P(B)}=\frac{P(AB)}{P(A)\cdot \mathrm{P}(B/A)}.$$

As a result,

$$P(B/A)==\frac{P(AB)}{\mathrm{P}(A)\cdot P(A/B)}=\frac{P(AB)}{P(B)}=dr.$$

Similarly, we can define a posteriori conditional probability $P(\overline{A}/\overline{B})$, ie the probability that the value that is controlled, is outside the tolerance provided that the result of control "unfit": $P(\overline{B}/\overline{A})=\dfrac{P(\overline{A}\overline{B})}{P(\overline{A})}=\dfrac{P(\overline{A}\overline{B})}{P(\overline{B})\cdot P(\overline{A}/\overline{B})}=d_{ng}$.

The value of probability $P(A/\overline{B})$ i $P(\overline{A}/B)$ taken as type I and type II errors [2].

The value of the reliability of control depends on the tolerance for deviation values of the controlled parameter values and error controls. Fig. 3 shows the dependence of the reliability of test results by the decision of "fit" dn the ratio of standard deviation error meter σ_i and RMS deviation tolerance parameter setting, controlled, σ_n. The nature of the dependence of the authenticity control of decision "not applicable" σ_{ng} has a similar character.

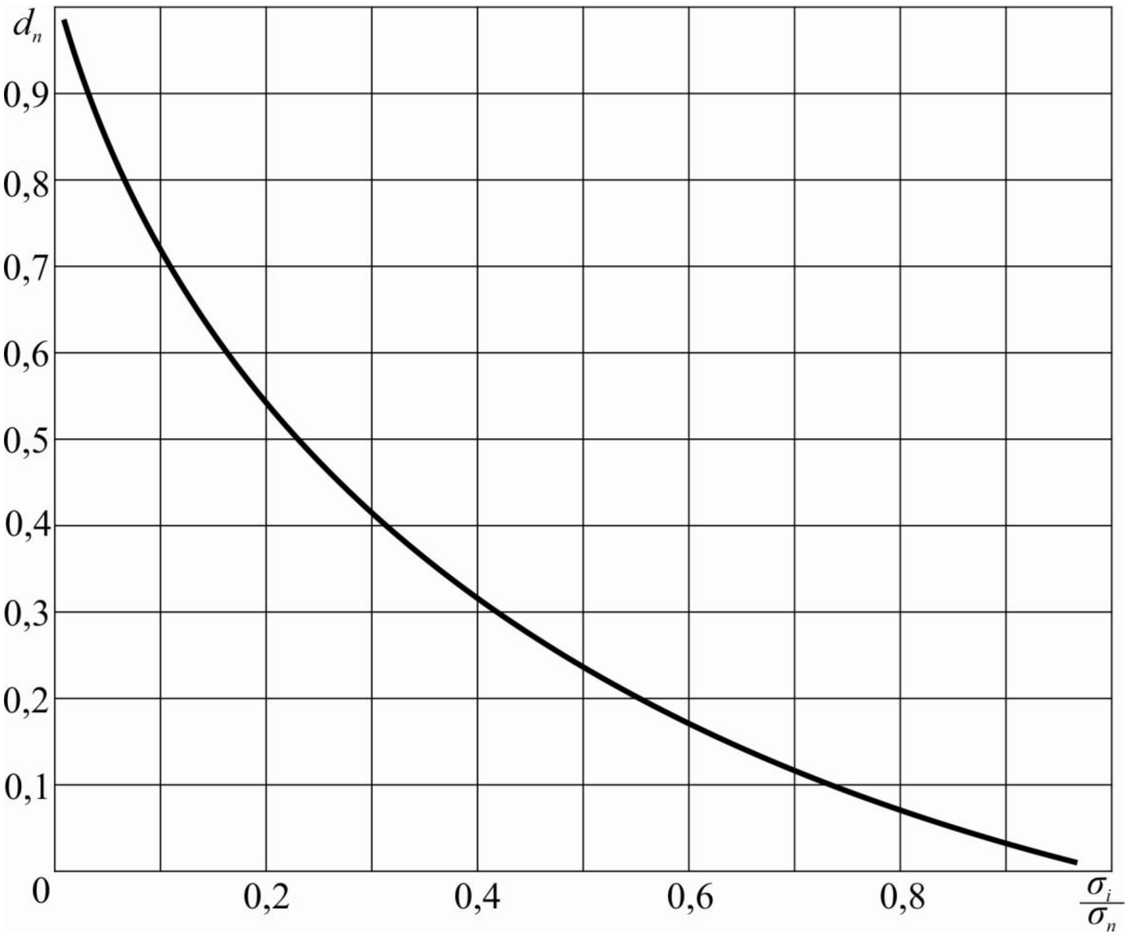

Figure 3. Dependence instrumental accuracy of the solution "fit"

By increasing the $\frac{\sigma_i}{\sigma_n}$ instrumental reliability of the control value decreases. By increasing the size of the field parameter tolerances, controlled, instrumental reliability of test results $Д_i$ by the decision of "fit" - increases, and to address the "unfit" - is reduced. The known values of the controlled parameter $\Delta_n(\sigma_n)$ and desired values of reliability test results $d_n(d_н)$ determine the allowable value measurement error $\Delta_i(\sigma_i)$ actual value or authenticity control of known Δ_n і Δ_i.

Results. *Example.* Determine the amount of instrumental reliability of control over decision "fit" d_n under the following conditions: admission to the setting $\Delta_n = 10\ \%$; error meter Δ_i=0,3 %.

Solution: $\frac{\sigma_i}{\sigma_n} = 0{,}03,$ тому $d_n = 0{,}9.$

Size instrumental reliability of information in the whole control object when the number of parameters n can be defined as follows:

$$Д_i = \prod_{i=1}^{n} Д_{ii},$$

where $Д_{ii}$ – instrumental parameters for the accuracy of the information *i.*

Conclusions

To assess the quality of a tolerance control should be used a priori (to assess the performance of the control system) or posterior (for quality control of the object whose state is unknown) characteristics of reliability control.

Thus, the reliability of the control system should be much higher reliability for object control and measurement error of means or less in size admission to the controlled setting (at least three times).

References

1. Wentzel E.S. Probability Theory: Textbook. for high schools. / ES Wentzel. [6th ed. ster].– M .: High society. HQ., 1999. – 576 с.

2. Mushyk E. Methods prynyatnyya tehnycheskyh decisions / E. Mushyk, P. Muller. – M .: Mir, 1990. – 206 p.

3. Schepotyev A.I. Instrumental dostovernost results of controls and Her dependence characteristics from funds controlled parameters and control / A.I. Schepotyev, A.J. Smakovenko // Stredstva yndykatsyy management and control systems avtomatyzyrovannoho avyatsyonnoy Technics: Sat. – M., 1972. – №6. – P. 19-21.

Рассмотрены вопросы инструментальной достоверности результатов допускового контроля. Определены требования к точностным характеристикам средств измерений.

Надежность, допусковый контроль, инструментальная достоверность, объект контроля.

The examined questions of the instrumental reliability of the results of tolerance control. The requirements for the accuracy characteristics of measuring instruments.

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