EFFICIENCY OF METROLOGICAL PROVISIONS FOR A PRODUCTION-QUALITY CONTROL SYSTEM

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The problem of ensuring high quality has an independent significance in marketing industrial products, and experience shows that its satisfactory solution can be attained on the basis of an efficiently-operating quality control system. Such a system is interrelated in its information and physical respects with a number of other systems and subsystems, among which an important part is played by the metrological provisions system. The latter can be considered as a combination of organizational and technical measures and control and measurements means constructed on a hierarchical principle of obtaining data and adopting decisions.

The information required for quality control is obtained by means of highly precise technical, diagnostic, testing, and checking means of measurement. Metrologists and instrument makers are mainly interested in the degree of perfection and quality of measurements, which are determined by the uniformity and accuracy (trustworthiness) of measurements, labor productivity in measurements, and other factors.

Production efficiency is affected by trustworthiness, precision in localizing deviations in the technological process, productivity, and costs. The significance of these characteristics and their quantitative indexes are shown in Table 1.

A low trustworthiness of measuring equipment leads to a rise in the number of substandard products released onto the market. A rise in the percentage of falsely rejected products reduces the output of satisfactory ones and leads to delays in the production owing to the time spent on clearing falsely rejected products. Therefore, it is necessary to reduce the probability of failing to discover either deviations from high-quality production or falsely rejected products.

The probability of detecting production quality infringements can be raised by a more complete coverage of production with testing. However, insufficient measurement precision prevents the detection of all the production quality infringements. Measurement errors could be compensated by setting the measured parameter's testing tolerance to a value smaller than the specified tolerance. However, the smaller the testing tolerance the larger will be the amount of detected infringements. In the limit when the upper and lower tolerances coincide there will be no undetected quality infringements.

However, the narrowing of the testing tolerance, as well as the utilization of measuring equipment with a low precision leads to a considerable amount of false rejects.

Higher measurement precision helps to determine production quality correctly, but it leads to a sharp rise in the expenditure on metrological provisions. The product parameters' tolerated error limit should normally be 3-5 times smaller than the tested parameter's tolerance. A smaller ratio reduces substantially the measuring equipment's trustworthiness (especially if the parameter's tolerance has been incorrectly specified), whereas a larger ratio leads to a sharp rise in unjustified expenditure on metrological provisions.

The measuring equipment's efficiency is determined by its speed of operation and idle time due to failures. The larger the operation time before failure and the smaller the time required for clearing failures, the smaller will be the lost time, i.e., the production efficiency will rise.

Operation time before failure can be increased by using more reliable components and standby testing equipment. However, there exist limitations on raising the operation time before failure, which are due, on the one hand, to the existing development level of components and, on the other, to the rise in metrological provision


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TABLE 1. Certain Measuring Equipment Characteristics

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<tr>
<th>Name</th>
<th>Significance</th>
<th>Type of indications</th>
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<tr>
<td>Trustworthiness</td>
<td>The level of objectivity and the technical condition of production are evaluated. The percentage of released satisfactory and falsely rejected products is affected.</td>
<td>Probability of detected and false failures, of measurement errors, and the controlled parameters' tolerances.</td>
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<td>Precise location of deviations in the technological process</td>
<td>The efficiency of the entire production is effected, since inaccurate determination of the time and place of the deviations' appearance in the technological process leads to rejects and disruption of the quality control process.</td>
<td>List of technological operations which determine quality of controlled parameters. Probability of the products being satisfactory in specific technological operations.</td>
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<tr>
<td>Efficiency</td>
<td>The speed of operation and idling of the testing and measuring means are evaluated, and this affects production efficiency.</td>
<td>Degree of automation or the ratio of the time spent in automatic and manual measurements. Mean operation time before failure.</td>
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<tr>
<td>Cost</td>
<td>Economic factors of the metrological provisions system and the effect on all metrological provision characteristics are evaluated. This characteristic serves to optimize the metrological provisions system.</td>
<td>Expenditure on development, production, utilization, and reconditioning (repairs).</td>
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expenses. Therefore, an efficient way of decreasing the measuring equipment's idle time consists of reducing the time required for clearing failures by speeding up their detection. This can be attained by providing the measuring equipment with highly efficient testing and fault-locating devices. The precision in localizing the technological-process deviations also affects the entire production efficiency, since an inaccurate determination of the time and place of the deviations' appearance in the technological process leads to rejects and to inopportune production quality control. Therefore, it is necessary to locate the measuring equipment along the technological process stages in such a manner that the time and place of the production quality infringements' appearance should be unambiguous.

Production quality is affected in addition to the measurement error, also by other factors: the intensity of latent and evident failures of metrological means, the delay in applying these means at the places of operation, the time required for testing products and the metrological means, and the availability of spare means.

The effect of these characteristics on production quality can be represented by the probability of the products being in working order and the possibility of preparing them for operation. The relationship of the products' serviceability to the measuring equipment characteristics assumes different forms depending on the type of production and measuring means, as well as the conditions of their application. The products' serviceability increases with reduction of the measuring equipment's evident failures, since there is a greater probability that metrological means will be available in the place of operation at the required time, i.e., the measuring equipment's availability coefficient increases.

When the measuring equipment fails, it is removed for servicing and production is suspended for a certain time in expectation of its return to the place of operation. The longer the waiting time, the greater will be the lost production time.

In certain cases production has to be suspended for testing the equipment. Therefore, an increased testing time reduces production efficiency.

Latent failures, which are sometimes called "metrological," are linked with measurement errors. The higher the intensity of the testing equipment's latent failures, the greater will be the measurement error.

The methods for computing the measuring equipment parameters' effect on the efficiency of controlling production quality are examined in [1, 2].