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The Role of Metrology in the Development of Modern Industry

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Abstract: Metrology in the broadest sense is the science of measurements, methods and means, ensuring their unity, and ways to achieve the required accuracy. Metrology serves as the theoretical basis for measuring technology. metrology deals with the theory and practice of ensuring the uniformity of measurements. And the more measuring technology develops, the more important metrology becomes, creating and improving the theoretical foundations of measurements, summarizing practical experience in the field of measurements and guiding the development of measuring technology.

Keywords: metrology, measuring instruments, accuracy, quality, measurement, technique, production accounting, value.

Metrology is the science of measurements, methods and means of ensuring unity and ways to achieve the required accuracy.

In practical life, man everywhere deals with measurements. At every step there are and have been known since time immemorial measurements of such quantities as length, volume, weight, time, etc.

The importance of measurements in modern society is great. They serve not only as the basis of scientific and technical knowledge, but are of paramount importance for accounting for material resources and planning, for domestic and foreign trade, for ensuring product quality, interchangeability of units and parts and improving technology, for ensuring labor safety and other types of human activity.

Metrology is of great importance for the progress of natural and technical sciences, since increasing the accuracy of measurements is one of the means of improving the ways of understanding nature by man, discoveries and practical application of exact knowledge.

To ensure scientific and technological progress, metrology must be ahead of other areas of science and technology in its development, because for each of them, accurate measurements are one of the main ways to improve them.

Measurements are one of the ways of understanding nature by man, combining theory with practical human activity. They are the basis of scientific knowledge, serve to account for material resources, ensure the required product quality, interchangeability of parts and assemblies, improve technology, automate production, standardization, health and safety, and for many other branches of human activity. Measurements quantitatively characterize the surrounding material world, revealing the regularities operating in nature. The founder of Russian metrology, Dmitry Ivanovich Mendeleev, spoke about this very figuratively: “Science begins as soon as they begin to measure.”

Under the measurement technique in the broadest sense, the meanings of these words mean both all the technical means by which measurements are made, and the measurement technique.

Hundreds, thousands of billions of measurements are made every day all over the world. It is in the interest of each country, in the relationship between countries, that the results of measurements (wherever they are carried out) can be harmonized. In other words, it is necessary that the results of measurements of the same quantities, obtained in different places and using different measuring instruments, be reproducible at the level of required accuracy.

First of all, this requires uniformity of units of physical quantities and measures that carry out their real reproduction. Ensuring a high degree of uniformity of measuring instruments is one of the conditions for ensuring the reproducibility of measurement results. In addition, it is necessary to fulfill a number of other conditions in order to ensure all the qualities of the measurement results that are necessary for their comparability and proper use, which is generally called the uniformity of measurements.

With all the multitude and variety of enterprises that manufacture measuring instruments, and with an even greater multitude (many times greater) of enterprises, organizations and institutions that make measurements and use their results, metrology has created and implemented a system aimed at universally ensuring the uniformity of measurements and the uniformity of means measurements. This system resulted in a single public service, which is called the metrological service of the country.

Throughout the development of human society, measurements have been the basis of people's relationships with each other, with surrounding objects, and nature. In modern conditions, three main functions of measurements in the national economy can be distinguished:

- accounting for the products of the national economy, calculated by weight, length, volume, consumption, power, energy;
- measurements carried out to control and regulate technological processes (especially in automated production) and to ensure the normal functioning of transport and communications;
- measurements of physical quantities, technical parameters, composition and properties of substances, carried out in scientific research, testing and control of products in various sectors of the national economy.

The effectiveness of the performance of these functions depends on the quality of measuring instruments.

Increasing the accuracy of measurements makes it possible to identify the shortcomings of certain technological processes and eliminate these shortcomings. All this ultimately leads to an increase in product quality, saving energy and heat resources, as well as raw materials and materials.

For example, it is known that the yield of agricultural crops largely depends on the optimal and predetermined amount of fertilizers applied to the soil and water consumption during irrigation and, therefore, on the accuracy of measurements of the mass of fertilizers and water consumption. A 40% increase in the technical life of bearings is the result of the introduction of a roundness deviation standard, and the roughness standard allows saving 1 kg of paint per ton of casting during its painting.

About 200 billion measurements are made in our country every day, more than 4 million people consider measurements to be their profession. The share of measurement costs is 10–15% of the cost of social labor, and in industries producing complex equipment (electrical engineering, machine tool building, etc.), it reaches 50–70%.

The development of each new technological process, the creation of a new product should be based on already developed and certified methods and measuring instruments.

With the increase in the complexity of industrial enterprises, the number of “measurement points” has increased many times over. As a result, it was necessary to allocate separate premises

for the measuring complexes of the control service for individual industrial installations. The amount of information received from all measuring devices turned out to be so large that for its processing it is necessary to use a computer.

Every year the task of collecting and processing measurement information is becoming wider. Modern information-computer systems allow to collect in a central point all significant measurement results related to one installation or to a workshop or to an enterprise as a whole. This information, properly processed, recreates a picture of all the most important processes occurring at a given facility (installation, workshop, enterprise) and makes it possible to manage them in an optimal way.

The speed of the instruments makes it possible to accumulate a large number of measurement results in a short period of time. The possibility of transferring these results for processing to a computing device makes it possible to reduce measurement errors due to random causes. The speed determines the possibility of reducing systematic errors, and eliminating the influence of inconstancy, say, the operating current of the potentiometer on the measurement result. The accuracy of indirect measurements is significantly increased, since the speed of the device causes a decrease in the dependence of the measured quantity on the variability of the parameters of the influencing quantities.

At present, they strive to build measuring instruments according to the modular-block principle, according to which the measuring instrument is completed with standard blocks that perform certain functions of the measuring circuit. This speeds up the construction of measuring instruments, simplifies its operation and reduces the cost of their production.

More and more often, various quantities are measured by converting them into unified electrical or pneumatic signals. It must be emphasized that many modern measuring devices, especially if they operate using an auxiliary electrical or pneumatic connection, themselves contain a control circuit and in their development and application it is necessary to use the theory and technology of automatic control.

There are other problems in the field of mechanical engineering. Such is the previously mentioned continuously growing need to improve the measurement accuracy over the entire range of linear dimensions, especially in the areas of measurement of small quantities, as well as large distances. The quality of the form of the product is not yet measurable to the extent that it is necessary.

Automation of the manufacturing process imposes increased metrological requirements on measuring devices, since the management of this production is based on the use of measuring information.

The most important problem of modern instrumentation is to increase the operational reliability and, in particular, the long-term metrological reliability of measuring instruments. If, in general, the failure of one of the entire complex of measuring devices can be the cause of the failure of the machine or any other installation, then the "metrological failure", i.e. violation of accuracy, loss of sensitivity, etc., which remain unnoticed, can become the reason for the release of substandard products, distortion of signals in communication lines, the appearance of violations in the functioning of transport, a decrease in the effectiveness of defense equipment, etc.

Left unnoticed for a long time, these "metrological failures" in the end, under unfavorable circumstances, can cause a catastrophe.

The quality of measurement results is the reliability of information about the quality and quantity of goods. For this reason, the metrological support of technical regulation prevents actions that mislead purchasers. Therefore, each technical regulation must specify the minimum necessary requirements to ensure the uniformity of measurements.

Thus, measurements are the most important tool for understanding objects and phenomena of the

surrounding world and play a huge role in the development of the national economy.

Improving the quality of measurements and the successful implementation of new measurement methods depend on the level of development of metrology as a science.

Theoretical metrology deals with issues of fundamental research, the creation of a system of units of measurement, physical constants, and the development of new measurement methods.

Applied (practical) metrology deals with the issues of practical application in various fields of activity of the results of theoretical studies within the framework of metrology.

Legal metrology includes a set of interdependent rules and norms aimed at ensuring the uniformity of measurements, which are elevated to the rank of legal provisions (by authorized state authorities), are binding and are under the control of the state.

It should be noted that not only metrologists are involved in metrological support activities, i.e. persons or organizations responsible for the uniformity of measurements, but also every specialist: either as a consumer of quantitative information, in the reliability of which he is interested, or as a participant in the process of obtaining, processing and ensuring the reliability of measurements.

The current state of metrological support requires highly qualified specialists. Mechanical transfer of foreign experience to domestic conditions is currently impossible, and specialists need to have a sufficiently broad outlook in order to be creative in developing and making decisions based on measurement information. This applies not only to workers in the manufacturing sector. Knowledge in the field of metrology is also important for product sales specialists, managers, economists, doctors, teachers, etc., who must use reliable measurement information in their activities.

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