NEW STATE STANDARD ON "REFERENCE STANDARDS AND MEANS OF MEASUREMENT"

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In order to provide uniform measurements in the country it is first of all necessary to ensure equal dimensions of units used in calibrating the measuring means for each physical quantity. Then all the lengths will be expressed in the same meters, all the masses in the same kilograms, etc.

One of the principal tasks of the metrological service consists of ensuring the equality of analogous measuring units.

This task, however, does not amount to a simple selection of systems of units and the formulation of their verbal descriptions can only provide knowledge of the units, a mental concept of them, but they are insufficient for carrying out practical measurements. For the latter purpose each unit must be materialized, embodied in a specific physical object's property suitable for comparing with analogous properties of other physical objects; i.e., it is necessary to measure physical quantities.

This task requires an efficient organization for reproducing and storing measurements units by the metrological service agencies and transferring unit dimensions to all the country's measuring means for the purpose of calibrating the measuring equipment of each physical property in the same standardized units.

The reproduction of various physical quantity units differs in the complexity of the entailed equipment owing mainly to the differences in the precision with which the various physical quantities can be measured and the differences in the complexity of the most precise methods for their measurement. In certain cases unique, expensive installations are required for obtaining the highest precision, whereas in others it can be obtained by relatively simple means. Therefore, the problems of reproducing any given unit should be solved in different ways.

The reproduction of units, however, is only the first part of the problem. The reproduced unit must be stored and its value transmitted regularly to all the other measuring means. Thus, it is necessary to have a large stock of technical means which would provide a most rational solution for these metrological problems, or, expressing it in a more specific manner, it is necessary to have a large stock of reference standards and means of measurement. Their production, storage, application, legal enforcement, and supervision of their condition must be subjected to uniform rules. It is only under such conditions that a given order can be attained in the most important state task of providing uniform measurements.

The state standard [1] which was developed by Prof. M. F. Malikov and contained the classification of reference standards and reference means of measurement (the term "means of measurement" was introduced later [2]) was approved as long ago as 1942; however, it did not specify the relevant rules. Therefore, this standard was canceled and replaced by a more complete one [3] which was approved by the Principal Chamber of Measures and Measuring Instruments of the USSR. However, this document was not applied in practice, and in recent years a new state standard was developed and approved in 1971. It contains general regulations and the classification and rules for legalizing reference standards and reference means of measurement, as well as rules for their storage and application.

The standard specifies the basic purpose of reference standards and measuring means to serve as a material and technical basis for reproducing and storing units of physical quantities and for transmitting unit dimensions to all the means of measurement used in the country in order to obtain uniformity. The standard was compiled on the basis of the principle of classifying reference standards by means of the units they reproduce, and not by the combi-
nation of physical quantities to be measured in the course of testing any given technical object (machines, com-

clicated technological aggregates, means of transportation, etc.). With the advancement of science and technology

the tested objects are becoming increasingly complicated, new ones arise constantly, and their testing requires

the measurement of physical quantities in the most varied combinations and under the most diverse conditions.
The classification of reference standards by means of such a principle would lead to an unlimited expansion of the

number of reference aggregates, whose production would inevitably lag behind the objects to be tested, since it is

impossible to establish reference standards suitable for testing specific objects before the production of such objects.

As opposed to the above method, the classification of reference standards with respect to units of physical prop-

ties makes it possible to develop the reference-standard base ahead of the tested instrument. By studying the re-

quirements of each sphere of measurements it becomes possible to find the tendency in its development; to forecast

its requirements with respect to range, precision, and the condition under which the quantities appear; and to adopt

the necessary measures for a timely production of the required reference standards.

The new standard utilizes the experience gained by the metrological institutes of the USSR and other countries.

It is specified in the standard that units can be reproduced by means of one of the two possible methods, selected on

the basis of their technical and economic advisability, namely, by the centralized reproduction of units with the help

of a single state reference standard for the entire country, or by the decentralized method based on indirect measure-

ments carried out by metrological service agencies with the help of reference means of measurement. The first

method should be used for reproducing all the basic units of the International System (SI) and most of the derived

units. The standard indicates a criterion which should be used in deciding the necessity of producing reference stan-

dards for derived units. The main condition for their production is a wide application of the measuring means gradu-

ated in such units, the technical possibility of direct comparisons with the reference standard, and high testing preci-

sion requiring the availability of special complicated and expensive equipment which it would be inadvisable to pro-

duce and use in several separate locations.

The second method is applicable to derived units whose dimension cannot be determined by direct comparison

with a reference standard, for instance, to the unit of area (square meter), or in the case of indirect measurements

which can be carried out more simply by local metrological service agencies than by direct comparison to a refer-

ence standard, and which nevertheless provide the required precision, as in the case of measures of capacity and vol-

ume (cubic meter). In certain cases the required precision of measurement can be ensured only with the help of spe-

cially designed measuring installations. Therefore, the standard provides a special category of means for reproducing

units, namely, high-precision test installations. Thus, for testing tachometers it is necessary to use a tachometric in-

stallation based on comparing the measured speed of rotation to the frequency of a reference generator incorporated

in the installation; for testing vibrometers it is required to have a vibration rack provided with reference means for

measuring vibration parameters, such as amplitude, velocity, acceleration, and frequency. Installations also exist

for reproducing units of such quantities as the photosensitivity and resolution of photographic materials; the heat con-

duction of solid, liquid, and gaseous substances; the permittivity and loss angle tangent; the losses due to remagnetiza-

tion of magnetic materials; the mean and pulsating velocity of liquid flows; and other quantities. The standard tol-

erates the use of such installations in several metrological service agencies.

The state reference standards are divided by the standard into primary and special ones. The primary stan-

dards consist of the most precise ones for the reproduction of a given unit under the most favorable conditions. Cer-

tain physical quantities, however, have to be measured under different conditions, and in this connection many dif-

derent measuring methods and means have arisen, which are suitable for such conditions. Thus, substances can exist

in a solid, liquid, or gaseous phase; and the means for measuring their properties or parameters of the processes oc-

curring in them should be adapted for these phases. It is necessary to measure not only quantities which are constant

with time, but also variable ones, and in particular periodic or pulsating quantities over a wide frequency range.

Measuring conditions (pressure of a medium, its temperature, etc.) can deviate from the normal ones. In this con-

nection the methods, means, and conditions of testing measuring equipment should reflect all the above peculiarities.

It is thus necessary to have reference standards not only for the normal classical conditions, but also for those

encountered in practical reproduction conditions of units. Therefore, the standard provides for the possible existence

of several state reference standards of the same unit. The standard which provides the greatest precision is the pri-

mary one, whereas those adapted for reproducing units under special conditions are known as special standards.

Special reference standards are produced when a direct transmission of the unit from the primary reference

standard is either technically impossible (owing to different conditions), or leads to a large error and, therefore, it is

better to produce a special reference standard whose application does not entail a transition from one set to another

set of completely different conditions and, therefore, can be carried out with the required precision. The toleration