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METROLOGICAL TECHNICAL SPECIFICATION

OF THE PEOPLE'S REPUBLIC OF CHINA

JJF 1001-2011

General terms in metrology and their definitions

通用计量术语及定义

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General terms in metrology and their definitions

1 Scope

This specification specifies the commonly used terms and their definitions in metrology.

This specification applies to all tasks in the field of metrology. The related fields can also refer to it.

2 Normative references

This specification refers to the following documents:

ISO/IEC 98-3 Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement

ISO/IEC GUIDE 99:2007 International vocabulary of metrology -Basic and general concepts and associated terms (VIM))

ISO/IEC 80000:2006 Quantity and units

For dated reference documents, only the dated version applies to this specification; for undated reference documents, the latest version (including all amendments) applies to this specification.

3 Quantity and unit

3.1 Quantity [VIM1.1]

The property of a phenomenon, object or substance, the size of which can be represented by a number and a reference object.

Note:

- 1 Quantity can refer to a general concept or a specific quantity, as shown in Table 1.
- 2 The reference object can be a measurement unit, measurement procedure, reference material or a combination thereof.

where the index is called the dimensional index, which can be positive, negative or zero.

3.7 Quantity of dimension one [VIM1.8]

Also known as **dimensionless quantity**

In its dimensional expression, the quantity whose exponents of the factors corresponding to the base quantities are all zero.

Note:

- 1 The term "dimensionless quantity" is widely used and has been retained for historical reasons because all exponents in the dimensional symbolic expressions of these quantities are zero. The "quantity of dimension one" reflects the convention of using the symbol 1 as the symbolic expression of the dimensions of these quantities.
- 2 The measurement unit and value of a quantity of dimension one are both numbers, but such a quantity expresses more information than a number.
- 3 Certain quantities of dimension one are defined as the ratio of two homogeneous quantities.

Examples: plane angle, solid angle, refractive index, relative permeability, mass fraction, friction coefficient, Mach number.

- 4 The number of entities is a quantity of dimension one.

Example: the number of turns of the coil, the number of molecules of a given sample, the decline of the energy level of the quantum system.

3.8 Measurement unit [VIM1.9]

Measurement unit, unit of measurement

Referred to as **unit**

According to the agreed definition and adopted scalar quantity, any other similar quantity can be compared with it so that the ratio of the two quantities is represented by a number.

Note:

- 1 The measurement unit has the name and symbol assigned according to the convention.

- 2 Sometimes conventional quantity value is an estimate of the true value.
- 3 The conventional quantity value is generally considered to have a reasonably small (possibly zero) measurement uncertainty.

3.23 Numerical quantity value, numerical value of quantity

[VIM1.20]

Abbreviated as **numerical value**

The value represented by the quantity value, which is not any number of the reference object.

Note:

- 1 For a quantity of dimension one, the reference object is a measurement unit, which is a number, but the number is not part of the value of the quantity.

Example: In the mole fraction equal to 3 mmol/mol, the value of the quantity is 3, the unit is mmol/mol. The unit mmol/mol is equal to the number 0.001, but the number 0.001 is not part of the value of the quantity; the value of the quantity is 3.

- 2 For quantities with measurement units (that is, those quantities that are not sequential quantities), the value of Q $\{Q\}$ is often expressed as $\{Q\} = Q/[Q]$, wherein $[Q]$ represents the measurement unit.

Example: For a quantity value of 5.7 kg, the quantity value is $\{m\} = (5.7 \text{ kg})/\text{kg} = 5.7$. The same value can be expressed as 5700 g, in this case, the value of the amount is $\{m\} = (5700\text{g})/\text{g} = 5700$.

3.24 Quantity equation [VIM1.22]

Giving the mathematical relationship between the quantities in the system of quantities, which has nothing to do with the unit of measurement.

Example:

- 1 $Q_1 = \zeta Q_2 Q_3$, where Q_1 , Q_2 and Q_3 represent different quantities, whilst ζ is a digital factor.
- 2 $T = (1/2) mv^2$, where T is the kinetic energy, m is the mass, v is the velocity of a specific particle.
- 3 $n = It/F$, where n is the amount of substance, I is the current, t is the duration of

Note:

- 1 The measurement is not applicable to the nominal property (see 3.32).
- 2 Measurement means the comparison of quantities and includes the counting of entities.
- 3 The prerequisites for measurement are the description of the quantity suitable for the intended use of the measurement result, the measurement procedure, a calibrated measurement system that operates in accordance with the prescribed measurement procedure (including measurement conditions).

4.2 Metrology

Activities to achieve unified unit, accurate and reliable quantity.

4.3 Metrology [VIM2.2]

The science of measurement and its application.

Note: Metrology covers the theory of measurement and all application fields regardless of its measurement uncertainty.

4.4 Measurement principle [VIM2.4]

A phenomenon used as a basis for measurement.

Example:

- 1 Thermoelectric effect used to measure temperature;
- 2 Energy absorption used to measure the amount-of substance concentration;
- 3 The drop of glucose concentration in the blood of fast-running rabbits is used to measure the insulin concentration during preparation.

Note: The phenomenon can be a physical phenomenon, a chemical phenomenon or a biological phenomenon.

4.5 Measurement method [VIM2.5]

A general description of the logical arrangement of operations used in the measurement process.

4.11 Calibration diagram [VIM4.30]

A diagram showing the relationship between the indicated value and the corresponding measurement result.

Note:

- 1 The calibration diagram is a strip on the plane defined by the indicating axis and the measurement result axis, which shows the relationship between the indicating value and a series of measured values. It gives a one-to-many relationship. For a given indication, the width of the strip provides the measurement uncertainty of the instrument.
- 2 Other ways to express this relationship include a calibration curve with measurement uncertainty, a calibration form, or a set of functions.
- 3 This concept is suitable for calibration when the measurement uncertainty of the instrument (see 7.24) is greater than the measurement uncertainty of the measurement standard.

4.12 Calibration curve [VIM4.31]

A curve representing the relationship between the indicated value and the corresponding measured value.

Note: The calibration curve shows a one-to-one relationship, because it has no information about the measurement uncertainty, it does not provide measurement results.

4.13 Calibration hierarchy [VIM2.40]

The sequence of calibration from the reference object to the final system of measurement. The result of each level of calibration depends on the result of the previous level of calibration.

Note:

- 1 Along the calibration sequence, the measurement uncertainty will inevitably increase step by step.
- 2 The calibration hierarchy is composed of one or more measurement standards and system of measurements operated in accordance with measurement procedures.
- 3 The reference object in this definition can be the definition of the measurement

5.17 Experimental standard deviation

Referred to as **experimental standard deviation**

When performing n measurements on the same measured, the quantity which characterizes the dispersion of measurement results. It is represented by the symbol s .

Note:

- 1 The experimental standard deviation $s(x_k)$ of a single measured value x_k in n measurements can be calculated according to the Bessel formula:

$$s(x_k) = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

Where: x_i - The measured value of the i^{th} measurement;

n - The number of measurements;

$\bar{x}$ - The arithmetic average of a group of measured values obtained from n measurement.

- 2 The experimental standard deviation $s(\bar{x})$ of the arithmetic mean $\bar{x}$ of n measurements is:

$$s(\bar{x}) = s(x_k) / \sqrt{n}$$

5.18 Measurement uncertainty, uncertainty of measurement

[VIM2.26]

Referred to as **uncertainty**

According to the information used, the non-negative parameters that characterizes the dispersion as assigned to the measured quantity value.

Note:

- 1 The measurement uncertainty includes the components caused by the influence of the system, such as the components related to the correction value and the value assigned by the measurement standard as well as the defined uncertainty. Sometimes the estimated system influence is not corrected, but treated as an

6.20 Zero adjustment of a measuring system [VIM3.12]

Referred to as **zero adjustment**

In order to make the system of measurement provide a zero indication corresponding to the zero value being measured, the adjustment of the system of measurement.

7 Property of measuring instruments

7.1 Indication [VIM4.1]

The quantity value given by the measuring instrument or measuring system.

Note:

- 1 The displayed value can be expressed in visual form or sound form; it can also be transmitted to other devices. The indication value is usually given by the position indicated on the analog output display, the number displayed or printed by the digital output, the code pattern of the code output, the assignment of the material measure.
- 2 The indicated value and the corresponding measured value need not be the quantity value of same kinds.

7.2 Blank indication [VIM4.2]

Also known as **background indication**

The indication as obtained from the phenomenon, object or substance similar to the quantity being studied, assuming that the quantity concerned does not exist or does not contribute to the indication.

7.3 Indication interval [VIM4.3]

A set of values within the interval of the limit indications.

Note:

- 1 The indication interval can be expressed in units marked on the display device, for example: 99 V ~ 201 V.
- 2 In some fields, this term is also called "range of indication."

Example:

- 1 The ability of a system of measurement with a mass spectrometer to measure the ion current ratio generated by two specified compounds without being interfered by other specified current sources;
- 2 The ability of the system of measurement to measure the power of a signal component at a given frequency without being interfered by many other signal components or other frequency signals;
- 3 Where there are often frequencies slightly different from the frequency of the desired signal, the ability of receiver to distinguish between the desired signal and the unwanted signal;
- 4 In the presence of accompanying radiation, the ability of the ionizing radiation system of measurement to respond to the given radiation being measured;
- 5 The ability of the measuring system to measure the amount-of-substance concentration of sarcosinuria in plasma using a certain procedure without being affected by glucose, urate, ketones and proteins;
- 6 When the mass spectrometer measures the amount-of-substance of ^{28}Si isotope and ^{30}Si isotope in geological mines, the ability of not being affected by the two or from ^{29}Si isotope.

Note:

- 1 In physics, selectivity means that there is only one measured, the other quantities are the same kind of quantities of the measured, meanwhile they are the input quantities of the system of measurement.
- 2 In chemistry, the quantity to be measured in the system of measurement usually contains different components, meanwhile these quantities do not necessarily belong to the same type.
- 3 In chemistry, the selectivity of the system of measurement is usually obtained by the amount of selected component's concentration within a specified range.
- 4 The "selectivity" used in physics (see Note 1) is conceptually close to the "specificity" sometimes used in chemistry.

7.14 Resolution [VIM4.14]

The smallest change of the measured that causes the corresponding indication to produce a noticeable change.

Note: The resolution may be related to noise (internal or external) or friction, or

A measurement standard recognized by a national authority and used as the basis of other measurement standards for similar quantities in a country or economy.

Note: In China, it is called metrological benchmark or national metrological standard.

8.4 Primary measurement standard [VIM5.4]

Referred to as the **primary standard**

A measurement standard established using a primary reference measurement procedure or a conventional selection of an artifact.

Example:

- 1 The primary measurement standard for the amount-of-substance concentration is prepared by dissolving the chemical components of a known substance in a solution of a known volume.
- 2 The primary measurement standard of pressure is based on the separate measurement of force and area.
- 3 Primary measurement standards for ratio measurement of the amount-of-substance of isotope are prepared by mixing prescribed isotopes of known amount-of-substances.
- 4 The triple point bottle of water is used as the primary measurement standard for thermodynamic temperature.
- 5 The international original kilogram is a man-made article agreed upon.

8.5 Secondary measurement standard [VIM5.5]

Referred to as **secondary standard**

A measurement standard established by calibrating it with the primary measurement standard of the quantities of same kind.

Note:

- 1 This relationship between the secondary measurement standard and the primary measurement standard can be obtained through direct calibration, or the secondary measurement standard can be given measurement results through a media system of measurement as calibrated by the primary measurement standard.

- c) A fishtail paper towel that clarifies the mass fraction of dioxins contained in it is used as a calibrator.

2 Examples of reference materials with nominal property:

- a) One or more color maps of designated colors;
- b) DNA compounds containing specific nucleic acid sequences;
- c) Urine containing 19-androstenedione.

4 Reference materials are sometimes integrated with special devices.

Example:

- 1 The substance with a known triple point in the triple-point bottle;
 - 2 Glass with known optical density placed on the transmission filter holder;
 - 3 Small balls of uniform size placed on the microscope slide.
- 5 The measurement of the value of some standard materials is traceable to a measurement unit outside the SI system. Such materials include vaccines whose value is traceable to the International Unit (IU) designated by the World Health Organization.
- 6 In a particular measurement, the given standard material can only be used for either calibration or quality assurance.
- 7 The description of the standard material shall include the traceability of the material, indicating its source and processing.
- 8 International Organization for Standardization/Standard Substances Committee has a similar definition, but the term "measurement process" means "inspection", which includes both quantity measurement and inspection of nominal property.

8.15 Certified reference material, CRM [VIM5.14]

Reference materials which are attached with documents issued by an authoritative organization, provide one or more characteristic values with uncertainty and traceability obtained using effective procedures.

Example: In the attached certificate, the human serum with the assignment of cholesterol concentration and its measurement uncertainty is used as a calibrator or a substance to control the accuracy of measurement.

Note:

9 Legal metrology and metrological management

9.1 Legal metrology

In order to meet statutory requirements, the measurement activities involving measurement, measurement units, measurement instruments, measurement methods and measurement results carried out by qualified institutions, which are part of metrology.

9.2 Law on metrology

The law that defines legal metrology units, stipulates the tasks of legal metrology and the basic structure of its operation.

9.3 Metrological assurance

All regulations, technical means and necessary activities used to ensure the credibility of measurement results in legal metrology.

9.4 Legal metrological control

All legal measurement activities used for measurement assurance.

Note:

Legal metrological control includes:

- Legal control of measuring instruments;
- Metrological supervision;
- Metrological identification.

9.5 Service of legal metrology

Institutions responsible for implementing laws or regulations in the field of legal metrology.

Note: The service of legal metrology can be a government agency or other agencies authorized by the state. Its main task is to implement legal metrology control.

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