INTERNATIONAL STANDARD

ISO 5725-1

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Accuracy (trueness and precision) of measurement methods and results —

Part 1:
General principles and definitions

Exactitude (justesse et fidélité) des résultats et méthodes de mesure —
Partie 1: Principes généraux et définitions

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5725-1 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 6, *Measurement methods and results*.

ISO 5725 consists of the following parts, under the general title *Accuracy (trueness and precision) of measurement methods and results*:

— *Part 1: General principles and definitions*

— *Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

— *Part 3: Intermediate measures of the precision of a standard measurement method*

— *Part 4: Basic methods for the determination of the trueness of a standard measurement method*

— *Part 5: Alternative methods for the determination of the precision of a standard measurement method*

— *Part 6: Use in practice of accuracy values*

Parts 1 to 6 of ISO 5725 together cancel and replace ISO 5725:1986, which has been extended to cover trueness (in addition to precision) and intermediate precision conditions (in addition to repeatability and reproducibility conditions).

Annexes A and B form an integral part of this part of ISO 5725. Annex C is for information only.

Introduction

0.1 ISO 5725 uses two terms "trueness" and "precision" to describe the accuracy of a measurement method. "Trueness" refers to the closeness of agreement between the arithmetic mean of a large number of test results and the true or accepted reference value. "Precision" refers to the closeness of agreement between test results.

0.2 The need to consider "precision" arises because tests performed on presumably identical materials in presumably identical circumstances do not, in general, yield identical results. This is attributed to unavoidable random errors inherent in every measurement procedure; the factors that influence the outcome of a measurement cannot all be completely controlled. In the practical interpretation of measurement data, this variability has to be taken into account. For instance, the difference between a test result and some specified value may be within the scope of unavoidable random errors, in which case a real deviation from such a specified value has not been established. Similarly, comparing test results from two batches of material will not indicate a fundamental quality difference if the difference between them can be attributed to the inherent variation in the measurement procedure.

0.3 Many different factors (apart from variations between supposedly identical specimens) may contribute to the variability of results from a measurement method, including:

a) the operator;

b) the equipment used;

c) the calibration of the equipment;

d) the environment (temperature, humidity, air pollution, etc.);

e) the time elapsed between measurements.

The variability between measurements performed by different operators and/or with different equipment will usually be greater than the variability between measurements carried out within a short interval of time by a single operator using the same equipment.

0.4 The general term for variability between repeated measurements is precision. Two conditions of precision, termed repeatability and reproducibility conditions, have been found necessary and, for many practical cases, useful for describing the variability of a measurement method. Under repeatability conditions, factors a) to e) listed above are considered

constants and do not contribute to the variability, while under reproducibility conditions they vary and do contribute to the variability of the test results. Thus repeatability and reproducibility are the two extremes of precision, the first describing the minimum and the second the maximum variability in results. Other intermediate conditions between these two extreme conditions of precision are also conceivable, when one or more of factors a) to e) are allowed to vary, and are used in certain specified circumstances. Precision is normally expressed in terms of standard deviations.

0.5 The "trueness" of a measurement method is of interest when it is possible to conceive of a true value for the property being measured. Although, for some measurement methods, the true value cannot be known exactly, it may be possible to have an accepted reference value for the property being measured; for example, if suitable reference materials are available, or if the accepted reference value can be established by reference to another measurement method or by preparation of a known sample. The trueness of the measurement method can be investigated by comparing the accepted reference value with the level of the results given by the measurement method. Trueness is normally expressed in terms of bias. Bias can arise, for example, in chemical analysis if the measurement method fails to extract all of an element, or if the presence of one element interferes with the determination of another.

0.6 The general term accuracy is used in ISO 5725 to refer to both trueness and precision.

The term accuracy was at one time used to cover only the one component now named trueness, but it became clear that to many persons it should imply the total displacement of a result from a reference value, due to random as well as systematic effects.

The term bias has been in use for statistical matters for a very long time, but because it caused certain philosophical objections among members of some professions (such as medical and legal practitioners), the positive aspect has been emphasized by the invention of the term trueness.

Accuracy (trueness and precision) of measurement methods and results —

Part 1:
General principles and definitions

1 Scope

1.1 The purpose of ISO 5725 is as follows:

a) to outline the general principles to be understood when assessing accuracy (trueness and precision) of measurement methods and results, and in applications, and to establish practical estimations of the various measures by experiment (ISO 5725-1);

b) to provide a basic method for estimating the two extreme measures of the precision of measurement methods by experiment (ISO 5725-2);

c) to provide a procedure for obtaining intermediate measures of precision, giving the circumstances in which they apply and methods for estimating them (ISO 5725-3);

d) to provide basic methods for the determination of the trueness of a measurement method (ISO 5725-4);

e) to provide some alternatives to the basic methods, given in ISO 5725-2 and ISO 5725-4, for determining the precision and trueness of measurement methods for use under certain circumstances (ISO 5725-5);

f) to present some practical applications of these measures of trueness and precision (ISO 5725-6).

1.2 This part of ISO 5725 is concerned exclusively with measurement methods which yield measurements on a continuous scale and give a single value as the test result, although this single value may be the outcome of a calculation from a set of observations.

It defines values which describe, in quantitative terms, the ability of a measurement method to give a correct result (trueness) or to replicate a given result (precision). Thus there is an implication that exactly the same thing is being measured, in exactly the same way, and that the measurement process is under control.

This part of ISO 5725 may be applied to a very wide range of materials, including liquids, powders and solid objects, manufactured or naturally occurring, provided that due consideration is given to any heterogeneity of the material.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 5725. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5725 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3534-1:1993, *Statistics — Vocabulary and symbols — Part 1: Probability and general statistical terms.*

ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method.*

ISO 5725-3:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method.*

ISO 5725-4:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 4: Basic methods for the determination of the trueness of a standard measurement method.*

3 Definitions

For the purposes of ISO 5725, the following definitions apply.

Some definitions are taken from ISO 3534-1.

The symbols used in ISO 5725 are given in annex A.

3.1 observed value: The value of a characteristic obtained as the result of a single observation.

[ISO 3534-1]

3.2 test result: The value of a characteristic obtained by carrying out a specified test method.

NOTE 1 The test method should specify that one or a number of individual observations be made, and their average or another appropriate function (such as the median or the standard deviation) be reported as the test result. It may also require standard corrections to be applied, such as correction of gas volumes to standard temperature and pressure. Thus a test result can be a result calculated from several observed values. In the simple case, the test result is the observed value itself.

[ISO 3534-1]

3.3 level of the test in a precision experiment: The general average of the test results from all laboratories for one particular material or specimen tested.

3.4 cell in a precision experiment: The test results at a single level obtained by one laboratory.

3.5 accepted reference value: A value that serves as an agreed-upon reference for comparison, and which is derived as:

a) a theoretical or established value, based on scientific principles;

b) an assigned or certified value, based on experimental work of some national or international organization;

c) a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or engineering group;

d) when a), b) and c) are not available, the expectation of the (measurable) quantity, i.e. the mean of a specified population of measurements.

[ISO 3534-1]

3.6 accuracy: The closeness of agreement between a test result and the accepted reference value.

NOTE 2 The term accuracy, when applied to a set of test results, involves a combination of random components and a common systematic error or bias component.

[ISO 3534-1]

3.7 trueness: The closeness of agreement between the average value obtained from a large series of test results and an accepted reference value.

NOTES

3 The measure of trueness is usually expressed in terms of bias.

4 Trueness has been referred to as "accuracy of the mean". This usage is not recommended.

[ISO 3534-1]

3.8 bias: The difference between the expectation of the test results and an accepted reference value.

NOTE 5 Bias is the total systematic error as contrasted to random error. There may be one or more systematic error components contributing to the bias. A larger systematic difference from the accepted reference value is reflected by a larger bias value.

[ISO 3534-1]

3.9 laboratory bias: The difference between the expectation of the test results from a particular laboratory and an accepted reference value.