

# INTERNATIONAL STANDARD

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

### **Part 4:**

Basic methods for the determination of the  
trueness of a standard measurement method

*Exactitude (justesse et fidélité) des résultats et méthodes de mesure —*

*Partie 4: Méthodes de base pour la détermination de la justesse d'une  
méthode de mesure normalisée*



Reference number  
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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 5725-4 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).

Annex A forms an integral part of this part of ISO 5725. Annexes B, C and D are 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** General consideration of these quantities is given in ISO 5725-1 and so has not been repeated in this part of ISO 5725. ISO 5725-1 should be read in conjunction with all other parts of ISO 5725, including this part, because it gives the underlying definitions and general principles.

**0.3** 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.

**0.4** Two measures of trueness may be of interest and both are considered in this part of ISO 5725.

- a) Bias of the measurement method: where there is a possibility that the measurement method may give rise to a bias, which persists wherever and whenever the measurement is done, then it is of interest to investigate the “bias of the measurement method” (as defined in ISO 5725-1). This requires an experiment involving many laboratories, very much as described in ISO 5725-2.
- b) Laboratory bias: measurements within a single laboratory can reveal the “laboratory bias” (as defined in ISO 5725-1). If it is proposed to undertake an experiment to estimate laboratory bias, then it should be realized that the estimate will be valid only at the time of the experiment. Further regular testing is required to show that the laboratory bias does not vary; the method described in ISO 5725-6 may be used for this.

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

## Part 4:

Basic methods for the determination of the trueness of a standard measurement method

### 1 Scope

**1.1** This part of ISO 5725 provides basic methods for estimating the bias of a measurement method and the laboratory bias when a measurement method is applied.

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

**1.3** In order that the measurements are made in the same way, it is important that the measurement method has been standardized. All measurements are to be carried out according to that standard method.

**1.4** Bias values give quantitative estimates of the ability of a measurement method to give the correct (true) result. When a value for the bias of a measurement method is quoted, together with a test result obtained by that method, there is an implication that the same characteristic is being measured in exactly the same way.

**1.5** This part of ISO 5725 can be applied only if the accepted reference value can be established as a conventional true value, for example by measurement standards or suitable reference materials or by refer-

ring to a reference measurement method or by preparation of a known sample.

Reference materials could be either

- a) certified reference materials;
- b) materials manufactured for the purpose of the experiment with known properties; or
- c) materials whose properties have been established by measurements using an alternative measurement method whose bias is known to be negligible.

**1.6** This part of ISO 5725 considers only those cases where it is sufficient to estimate bias on one level at a time. It is not applicable if the bias in the measurement of one property is affected by the level of a second property (i.e. it does not consider interferences). Comparison of the trueness of two measurement methods is considered in ISO 5725-6.

**NOTE 1** In this part of ISO 5725, bias is considered only at one level at a time. Therefore the index  $j$  for the level has been omitted throughout.

### 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 5725-1:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*.

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*.

### 3 Definitions

For the purposes of this part ISO 5725, the definitions given in ISO 3534-1 and in ISO 5725-1 apply.

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

## 4 Determination of the bias of a standard measurement method by an interlaboratory experiment

### 4.1 The statistical model

In the basic model described in subclause 5.1 of ISO 5725-1:1994, the general mean  $m$  may be replaced by

$$m = \mu + \delta \quad \dots (1)$$

where

$\mu$  is the accepted reference value of the property being measured;

$\delta$  is the bias of the measurement method.

The model becomes

$$y = \mu + \delta + B + e \quad \dots (2)$$

Equation (2) is used when  $\delta$  is of interest. Here  $B$  is the laboratory component of bias, i.e. the component in a test result representing the between-laboratory variation.

The laboratory bias,  $\Delta$ , is given by

$$\Delta = \delta + B \quad \dots (3)$$

so the model may be written

$$y = \mu + \Delta + e \quad \dots (4)$$

Equation (4) is used when  $\Delta$  is of interest.

### 4.2 Reference material requirements

If reference materials are used, the requirements given in 4.2.1 and 4.2.2 shall be satisfied. Reference materials shall be homogeneous.

#### 4.2.1 Choice of reference materials

**4.2.1.1** The reference material shall have known properties at the level appropriate to the level at which the standard measurement method is intended to be applied, e.g. concentration. In some cases it will be important to include, in the assessment experiment, a series of reference materials, each corresponding to a different level of the property, as the bias of the standard measurement method may be different at different levels. The reference material should have a matrix as close as possible to the matrix of the material to be subjected to the standard measurement method, e.g. carbon in coal or carbon in steel.

**4.2.1.2** The quantity of the reference material shall be sufficient for the entire experimental programme, including some in reserve if this is considered necessary.

**4.2.1.3** Wherever possible, the reference material should have stable properties throughout the experiment. There are three cases, as follows.

- The properties are stable: no precautions are necessary.
- The certified value of the property may be influenced by storage conditions. The container should be stored, both before and after its opening, in the way described on the certificate.
- The properties change at a known rate: there is a certificate supplied with the reference value to define the properties at specific times.

**4.2.1.4** The possible difference between the certified value and the true value expressed by the uncertainty of the reference material (see ISO Guide 35) is not taken into account in the methods given here.