BS ISO 5725-4:2020

BSI Standards Publication

Accuracy (trueness and precision) of measurement methods and results

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

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National foreword

This British Standard is the UK implementation of ISO 5725-4:2020. It supersedes BS ISO 5725-4:1994, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee SS/6/-/1, Precision of test methods - Panel 1: Revision of ISO 5725.

A list of organizations represented on this committee can be obtained on request to its secretary.

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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

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Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **2**
4 Symbols ... **2**
5 Determination of the bias of a standard measurement method by an interlaboratory experiment ... **3**
5.1 Experimental design considerations ... 3
5.1.1 Objective ... 3
5.1.2 Layout of the experiment ... 4
5.1.3 Cross-references to ISO 5725-1 and ISO 5725-2 ... 4
5.2 The statistical model ... 4
5.3 Required number of laboratories and measurements ... 4
5.4 Requirements of the accepted reference value ... 6
5.4.1 Approaches to assigning the accepted reference value ... 6
5.4.2 Materials used in the experiment ... 6
5.4.3 Requirements of measurement uncertainty of the accepted reference value ... 7
5.5 Carrying out the experiment ... 8
5.5.1 Evaluation of precision ... 8
5.5.2 Check of precision ... 8
5.5.3 Estimation of the bias of the standard measurement method ... 10
5.5.4 Example ... 10
6 Determination of the laboratory bias of one laboratory using a standard measurement method ... **10**
6.1 Experimental design considerations ... 10
6.1.1 Objective ... 10
6.1.2 Layout of the experiment ... 10
6.1.3 Cross-references to ISO 5725-1 and ISO 5725-2 ... 11
6.2 The statistical model ... 11
6.3 Number of measurement results ... 11
6.4 Requirements of the accepted reference values ... 12
6.5 Carrying out the experiment ... 12
6.5.1 Check of the within-laboratory standard deviation ... 12
6.5.2 Estimation of the laboratory bias ... 13
7 Report to the panel and decisions to be taken by the panel ... **14**
7.1 Cross-reference to ISO 5725-2 ... 14
7.2 Report by the statistical expert ... 14
7.3 Decisions by the panel ... 14
Annex A (informative) **Derivation of formulae** ... **15**
Annex B (informative) **Example of an accuracy experiment** ... **18**
Bibliography ... **26**

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) , see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 69, Subcommittee SC 6, *Measurement methods and results*.

This second edition cancels and replaces the first edition (ISO 5725-4:1994), which has been technically revised.

The main changes compared to the previous edition are as follows:

— clearly recognizing the requirements of the accepted reference values used in bias evaluation experiments and introducing the uncertainties of the accepted reference values,

— changing examples with a currently used measurement method.

A list of all parts in the ISO 5725 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

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 expectation of a measurement result and a true value. "Precision" refers to the closeness of agreement between independent measurement results obtained under stipulated conditions.

General consideration of these quantities is given in ISO 5725-1 and so is not repeated in this document. ISO 5725-1 should be read in conjunction with all other parts of ISO 5725, including this document, because it gives the underlying definitions and general principles.

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 the true value cannot be known exactly, it can be possible to have an accepted reference value for the property being measured; for example, if suitable reference materials or measurement standards 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.

Two measures of trueness are of interest and both are considered in this document.

a) Bias of the measurement method: where there is a possibility that the measurement method can 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”. This requires an experiment involving many laboratories.

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 is valid only at the time of the experiment and at the investigated level(s) for the property. Further regular testing is required to show that the laboratory bias does not vary; the method described in ISO 5725-6 can 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 document

— specifies basic methods for estimating the bias of a measurement method and the laboratory bias when a measurement method is applied;

— provides a practical approach of a basic method for routine use in estimating the bias of measurement methods and laboratory bias;

— provides a brief guidance to all personnel concerned with designing, performing or analysing the results of the measurements for estimating bias.

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

1.3 This document applies when the measurement method has been standardized and all measurements are carried out according to that measurement method.

NOTE In ISO/IEC Guide 99:2007(VIM), "measurement procedure" (2.6) is an analogous term related to the term "measurement method" used in this document.

1.4 This document applies only if an accepted reference value can be established to substitute the true value by using the value, for example:

— of a suitable reference material;

— of a suitable measurement standard;

— referring to a suitable measurement method;

— of a suitable prepared known sample.

1.5 This document applies only to the cases where it is sufficient to estimate bias on one property at a time. It is not applicable if the bias in the measurement of one property is affected by the level of any other property (i.e. it does not consider interferences by any influencing quantity). Comparison of the trueness of two-measurement methods is considered in ISO 5725-6.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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ISO 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

ISO 3534-2, *Statistics — Vocabulary and symbols — Part 2: Applied statistics*

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

ISO 5725-2, *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 Guide 30, *Reference materials — Selected terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3534-1, ISO 3534-2, ISO 5725-1 and ISO Guide 30 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols

A	Factor used to calculate the measurement uncertainty of an estimate
B	Laboratory component of bias
C, C', C''	Test statistics
C_{crit}, C'_{crit}, C''_{crit}	Critical values for statistical tests
e	Random error occurring in every measurement under repeatability conditions
G	Grubbs' test statistic
h	Mandel's between-laboratory consistency test statistic
k	Mandel's within-laboratory consistency test statistic
n	Number of measurement results obtained in one laboratory at one level of the property being measured (i.e. per cell)
p	Number of laboratories participating in the interlaboratory experiment
P	Probability
s	Estimate of a standard deviation
u	Standard measurement uncertainty; quantile of the standard normal distribution
y	Measurement result
$\bar{y}$	Average of the measurement results
$\bar{\bar{y}}$	Grand mean of the measurement results
α	Significance level (α is assumed to be 0,05 in this document)

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β	Type II error probability
Φ	Cumulative distribution function of the standard normal distribution
γ	Ratio of the reproducibility standard deviation to the repeatability standard deviation (σ_R/σ_r)
δ	Bias of the measurement method under investigation
$\hat{\delta}$	Estimate of the bias of the measurement method under investigation
Δ	Laboratory bias
$\hat{\Delta}$	Estimate of the laboratory bias
μ	Accepted reference value of a property being measured
ν	Number of degrees of freedom
σ	True value of a standard deviation
$\chi^2_P(\nu)$	P-quantile of the χ^2-distribution with ν degrees of freedom

Subscripts

i	Identifier for a participating laboratory; identifier for an individual laboratory (inner laboratory)
k	Identifier for a particular measurement result from a laboratory
L	Between-laboratory (interlaboratory)
m	Identifier for detectable bias
P	Probability
r	Repeatability
R	Reproducibility
y	Identifier for the measurement result
0	Identifier for the accepted reference value

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

5.1 Experimental design considerations

5.1.1 Objective

The objective of the experiment is to estimate the value of the bias of the measurement method and to determine when it is statistically significant. When the bias is found to be statistically insignificant, then the objective is to determine the maximum absolute value of bias that can remain, with a certain probability, undetected by the results of the experiment.

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