
**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**

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

*Partie 2: Méthode de base pour la détermination de la répétabilité et
de la reproductibilité d'une méthode de mesure normalisée*



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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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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, *Applications of statistical methods*, Subcommittee SC 6, *Measurement methods and results*.

This second edition cancels and replaces the first edition (ISO 5725-2:1994), which has been technically revised. It also incorporates the Technical Corrigendum ISO 5725-2:1994/Cor 1:2002.

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

- permission is given to use alternative scrutiny and outlier detection tests provided that the performance is similar;
- permission is given to apply modern statistical methods available for calculations of the relevant precision and trueness characteristics;
- guidance on the number of laboratories required for a precision study has been included;
- information on the computation of critical values has been included.

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.

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 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.

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 part, because it gives the underlying definitions and general principles.

This document is concerned solely with estimating the repeatability standard deviation and reproducibility standard deviation based on an interlaboratory design in which each laboratory conducts a number of independent measurements of the same sample under repeatability conditions. There are other designs (such as nested, factorial or split-level experiments) which can be used for the estimation of precision: these are not dealt with in this document but rather are the subject of other parts of ISO 5725. Nor does this document consider any other measures of precision intermediate between the two principal measures; those are the subject of ISO 5725-3.

In certain circumstances, the data obtained from an experiment carried out to estimate precision are used also to estimate trueness and can be used to evaluate measurement uncertainty. The estimation of trueness is not considered in this document; all aspects of the estimation of trueness are the subject of ISO 5725-4. The evaluation of measurement uncertainty, using inter-laboratory estimates of trueness and precision, is the subject of ISO 21748.

[Annex C](#) provides practical examples of estimating the precision of measurement methods by experiment. Worked examples are given to demonstrate balanced uniform sets of test results, although in one example a variable number of replicates per cell were reported (unbalanced design) and in another some data were missing. This is because an experiment designed to be balanced can turn out to be unbalanced. Stragglers and outliers are also considered.

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

1 Scope

1.1 This document

- amplifies the general principles for designing experiments for the numerical estimation of the precision of measurement methods by means of a collaborative interlaboratory experiment;
- provides a detailed practical description of the basic method for routine use in estimating the precision of measurement methods;
- provides guidance to all personnel concerned with designing, performing or analysing the results of the tests for estimating precision.

NOTE Modifications to this basic method for particular purposes are given in other parts of ISO 5725.

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 this single value can be the outcome of a calculation from a set of observations.

1.3 It assumes that in the design and performance of the precision experiment, all the principles as laid down in ISO 5725-1 are observed. The basic method uses the same number of test results in each laboratory, with each laboratory analysing the same levels of test sample; i.e. a balanced uniform-level experiment. The basic method applies to procedures that have been standardized and are in regular use in a number of laboratories.

1.4 The statistical model of ISO 5725-1:1994, Clause 5, is accepted as a suitable basis for the interpretation and analysis of the test results, the distribution of which is approximately normal.

1.5 The basic method, as described in this document, (usually) estimates the precision of a measurement method:

- a) when it is required to determine the repeatability and reproducibility standard deviations as defined in ISO 5725-1;
- b) when the materials to be used are homogeneous, or when the effects of heterogeneity can be included in the precision values; and
- c) when the use of a balanced uniform-level layout is acceptable.

1.6 The same approach can be used to make a preliminary estimate of precision for measurement methods which have not reached standardization or are not in routine use.

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.

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

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

ISO 3534-3, *Statistics — Vocabulary and symbols — Part 3: Design of experiments*

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

3 Terms and definitions

For the purposes of this document, the definitions given in ISO 3534-1, ISO 3534-2, ISO 3534-3, and ISO 5725-1 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

α	Probability associated with a critical value of a test statistic, also referred to as a level of significance
a	Intercept in the relationship $s = a + bm$
a_v	Intercept parameter in the relationship $s_j^2 = a_v^2 + (b_v m)^2$
A	Factor used to calculate the uncertainty of an estimate
b	Slope in the relationship $s = a + bm$
b_v	Slope parameter in the relationship $s_j^2 = a_v^2 + (b_v m)^2$
B	Laboratory component of bias under repeatability conditions
c	Intercept in the relationship $\lg s = c + d \lg m$
C, C', C''	Test statistics
$C_{\text{crit}}, C'_{\text{crit}}, C''_{\text{crit}}$	Critical values for statistical tests
d	Slope in the relationship $\lg s = c + d \lg m$
e	Component in a test result representing the random error occurring in every test result
G	Grubbs' test statistic
h	Mandel's between-laboratory consistency test statistic
k	Mandel's within-laboratory consistency test statistic