MÕÕTMISMEETODITE JA TULEMUSTE MÕÕTETÄPSUS (TÕELINE VÄÄRTUS JA TÄPSUS) Osa 2: Põhimetoodika standardse mõõtemeetodi korratavuse ja reprodutseeritavuse kindlaks määramiseks

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

EESTI STANDARDIKESKUS
ESTONIAN CENTRE FOR STANDARDISATION

EESTI STANDARDI EESSÕNA	NATIONAL FOREWORD
Käesolev Eesti standard EVS-ISO 5725-2:2002 “Mõõtmismeetodite ja tulemuste mõõtetäpsus (tõeline väärtus ja täpsus). Osa 2: Põhimetoodika standardse mõõtemeetodi korratavuse ja reprodutseeritavuse kindlaks määramiseks” sisaldab rahvusvahelise standardi 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” identset ingliskeelset teksti.	This Estonian Standard EVS-ISO 5725-2:2002 consists of the identical English text of the International Standard 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”.
Standard EVS-ISO 5725-2:2002 on kinnitatud Eesti Standardikeskuse 03.05.2002 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.	This standard is ratified with the order of Estonian Centre for Standardisation dated 03.05.2002 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from Estonian Centre for Standardisation.

Käsitlusala	Scope
1.1 Käesolev ISO 5725 osa:	1.1 This part of ISO 5725:
– täiendab üldpõhimõtteid, mida tuleb jälgida, kavandades katseid mõõtemeetodite täpsuse numbriliseks hindamiseks laboritevahelise ringkatse vormis;	- amplifies the general principles to be observed in designing experiments for the numerical estimation of the precision of measurement methods by means of a collaborative interlaboratory experiment;
– kirjeldab detailselt põhimetoodikat mõõtemeetodite kordustäpsuse perioodiliseks hindamiseks;	- provides a detailed description of the basic method for routine use in estimating the precision of measurement methods;
– annab juhised kogu isikkoosseisule, mis tegeleb kordustäpsuse hindamise katsete kavandamise, läbiviimise või katsetulemuste analüüsiga.	- provides guidance to all personnel concerned with designing, performing or analysing the results of the tests for estimating precision.
MÄRKUS 1 Nende põhimeetodite muudatused eri-eesmärkidel on antud ISO 5725 teistes osades.	NOTE 1 Modifications to this basic method for particular purposes are given in other parts of IS0 5725.
Lisas B on mõõtemeetodite kordustäpsuse hindamise katsete praktilised näited.	Annex B provides practical examples of estimating the precision of measurement methods by experiment.
1.2 Käesolev ISO 5725 osa tegeleb ainult mõõtemeetoditega, mis annavad mõõtmisi pideval skaalal ning annavad katse tulemuseks ühe väärtuse, kuigi see võib olla mitmete vaatluste põhjal tehtud arvutuse tulemus.	1.2 This part of IS0 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.
1.3 See eeldab, et kõik täpsuskatse kavandamise ja täitmise põhimõtted, mida tuleb järgida, on sätestatud IS0 5725-l. Põhimeetod kasutab samal arvul katse tulemusi igas laboris, kus iga labor analüüsib samal tasemel katseproove, st tasakaalustatud ühtsel tasemel katse.	1.3 It assumes that in the design and performance of the precision experiment, all the principles as laid down in IS0 5725-l have been 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.

Põhimeetodit kohaldatakse protsessides, mis on standardiseeritud ja regulaarses kasutuses mitmetes laborites.	The basic method applies to procedures that have been standardized and are in regular use in a number of laboratories.
MÄRKUS 2 Väljatöötatud näidete abil selgitatakse tasakaalustatud ühtne testi tulemus, kuigi ühe näite põhjal ilmnes muutuv arv osakesi elemendi kohta (ebaühtlane mudel) ja teises puudusid mõned andmed.	NOTE 2 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.
Seda sellepärast, et katse, mis on kujundatud tasakaalustatuna, võib osutuda ebaühtlaseks. Arvesse võetakse ka muutuvad ja võõrväärtused.	This is because an experiment designed to be balanced can turn out to be unbalanced. Stragglers and outliers are also considered.
1.4 Statistiline mudel IS0 5725-I:I994 punktis 5 on tunnistatud katsetulemuste tõlgendamise ja analüüsi sobivaks aluseks, mille jaotus on ligikaudu normaalne.	1.4 The statistical model of clause 5 of IS0 5725-I:I994 is accepted as a suitable basis for the interpretation and analysis of the test results, the distribution of which is approximately normal.
1.5 Käesolevas IS0 5725 osas kirjeldatud põhimeetod hindab (tavaliselt) täpsusmõõtmist meetodil:	1.5 The basic method, as described in this part of IS0 5725, will (usually) estimate the precision of a measurement method:
a) kui see on vajalik, et määrata kindlaks korratavus ja taastootmise standardhälvet, mis on määratletud IS0 5725-I;	a) when it is required to determine the repeatability and reproducibility standard deviations as defined in IS0 5725-I;
b) kui kasutatavad materjalid on ühesugused või kui eriliigilisuse mõju saab lisada täpsusväärtusele; ja	b) when the materials to be used are homogeneous, or when the effects of heterogeneity can be included in the precision values; and
c) kui tasakaalustatud ühtse taseme paigutuse kasutus on vastuvõetav.	c) when the use of a balanced uniform-level layout is acceptable.
1.6 Sama lähenemist saab kasutada, et anda esialgne täpsushinnang mõõtmismeetoditele mis ei ole standardiseeritud või tavakasutuses.	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.

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Annexes

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 5725-2 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 and C 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 is not 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 This part of ISO 5725 is concerned solely with estimating by means of the repeatability standard deviation and reproducibility standard deviation. Although other types of experiment (such as the split-level experiment) are used in certain circumstances for the estimation of precision, they are not dealt with in this part of ISO 5725 but rather are the subject of ISO 5725-5. Nor does this part of ISO 5725 consider any other measures of precision intermediate between the two principal measures; those are the subject of ISO 5725-3.

0.4 In certain circumstances, the data obtained from an experiment carried out to estimate precision are used also to estimate trueness. The estimation of trueness is not considered in this part of ISO 5725; all aspects of the estimation of trueness are the subject of ISO 5725-4.

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 part of ISO 5725

— amplifies the general principles to be observed in 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 1 Modifications to this basic method for particular purposes are given in other parts of ISO 5725.

Annex B provides practical examples of estimating the precision of measurement methods by experiment.

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.

1.3 It assumes that in the design and performance of the precision experiment, all the principles as laid down in ISO 5725-1 have been 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.

NOTE 2 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.

1.4 The statistical model of clause 5 of ISO 5725-1:1994 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 part of ISO 5725, will (usually) estimate 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 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.*

3 Definitions

For the purposes of this part of 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 Estimates of the parameters in the basic model

4.1 The procedures given in this part of ISO 5725 are based on the statistical model given in clause 5 of ISO 5725-1:1994 and elaborated upon in subclause 1.2 of ISO 5725-1:1994. In particular, these procedures are based on equations (2) to (6) of clause 5 of ISO 5725-1:1994.

The model is

$$y = m + B + e$$

where, for the particular material tested,

m is the general mean (expectation);

B is the laboratory component of bias under repeatability conditions;

e is the random error occurring in every measurement under repeatability conditions.

4.2 Equations (2) to (6) of ISO 5725-1:1994, clause 5 are expressed in terms of the true standard deviations of the populations considered. In practice, the exact values of these standard deviations are not known, and estimates of precision values must be made from a relatively small sample of all the possible laboratories, and within those laboratories from a small sample of all the possible test results.

4.3 In statistical practice, where the true value of a standard deviation, σ, is not known and is replaced by an estimate based upon a sample, then the symbol σ is replaced by s to denote that it is an estimate. This has to be done in each of the equations (2) to (6) of ISO 5725-1:1994, giving:

s_L^2 is the estimate of the between-laboratory variance;

s_W^2 is the estimate of the within-laboratory variance;

s_r^2 is the arithmetic mean of s_W^2 and is the estimate of the repeatability variance; this arithmetic mean is taken over all those laboratories taking part in the accuracy experiment which remain after outliers have been excluded;

s_R^2 is the estimate of the reproducibility variance:

$$s_R^2 = s_L^2 + s_r^2 \qquad \ldots (1)$$

5 Requirements for a precision experiment

5.1 Layout of the experiment

5.1.1 In the layout used in the basic method, samples from q batches of materials, representing q different levels of the test, are sent to p laboratories which each obtain exactly n replicate test results under repeatability conditions at each of the q levels. This type of experiment is called a balanced uniform-level experiment.