
**Accuracy (trueness and precision) of
measurement methods and results —
Practical guidance for the use of
ISO 5725-2:1994 in designing,
implementing and statistically analysing
interlaboratory repeatability and
reproducibility results**

*Exactitude (justesse et fidélité) des résultats et méthodes de mesure —
Lignes directrices pratiques pour l'utilisation de l'ISO 5725-2:1994 pour
la conception, la mise en œuvre et l'analyse statistique des résultats de
répétabilité et de reproductibilité interlaboratoires*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

ISO/TR 22971 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 6, *Measurement methods and results*.

Introduction

ISO 5725 consists of six parts, the general structure of which is shown in Figure 1.

ISO 5725-2 was developed as a guidance document for ISO Technical Committees and other organizations responsible for undertaking inter-laboratory studies for characterizing the variability of standard measurement methods. Two measures of variability, repeatability and reproducibility, are accepted in many disciplines as representative of data encountered in measurement processes.

Repeatability refers to the variability among measurements made on nominally identical samples or materials under identical circumstances. It is recognized that, because of unknown or uncontrollable factors which influence the measurement process, repeated measurements will usually not agree. The extent of this variability can be expressed by a standard deviation, called the repeatability standard deviation, of the results of within-laboratory comparisons.

Reproducibility refers to the variability among measurements made on identical samples or materials under differing conditions by different laboratories following the same standard measurement method. Reproducibility includes effects caused by differences among instruments, reagents, operators, laboratories, and environmental conditions. The variability of results under these conditions may be described by a standard deviation called the reproducibility standard deviation.

This guidance document is divided into four clauses in addition to the Scope (Clause 1):

- Clause 2, Organization of an inter-laboratory programme, deals with the organization of the inter-laboratory test and covers the roles of the executive officer, laboratory personnel, and statistician in preparing for and administering the test; the choice of materials and levels of interest for the test; and the selection of laboratories. It also describes how the number of replicate measurements (to be made on each sample) is to be statistically treated and the manner in which the resulting data are to be reported.
- Clause 3, Critical examination of the data, deals with data using graphical and numerical procedures. Guidance is given as to when data are anomalous, i.e. if they are inconsistent with other data from the study, and for outlier tests that are used to identify the presence or absence of anomalous data.
- Clause 4, Estimation of repeatability and reproducibility standard deviations, deals with the estimation and interpretation of repeatability and reproducibility standard deviations. Also included is a comparison of the relative contributions of the repeatability and reproducibility standard deviations to the total variability of the test method.
- Clause 5, Worked examples using statistical software, deals with worked examples that highlight various techniques that can be used.

It is recommended that this guidance document be read in conjunction with ISO 5725-2 and should not be used as a replacement for ISO 5725-2.

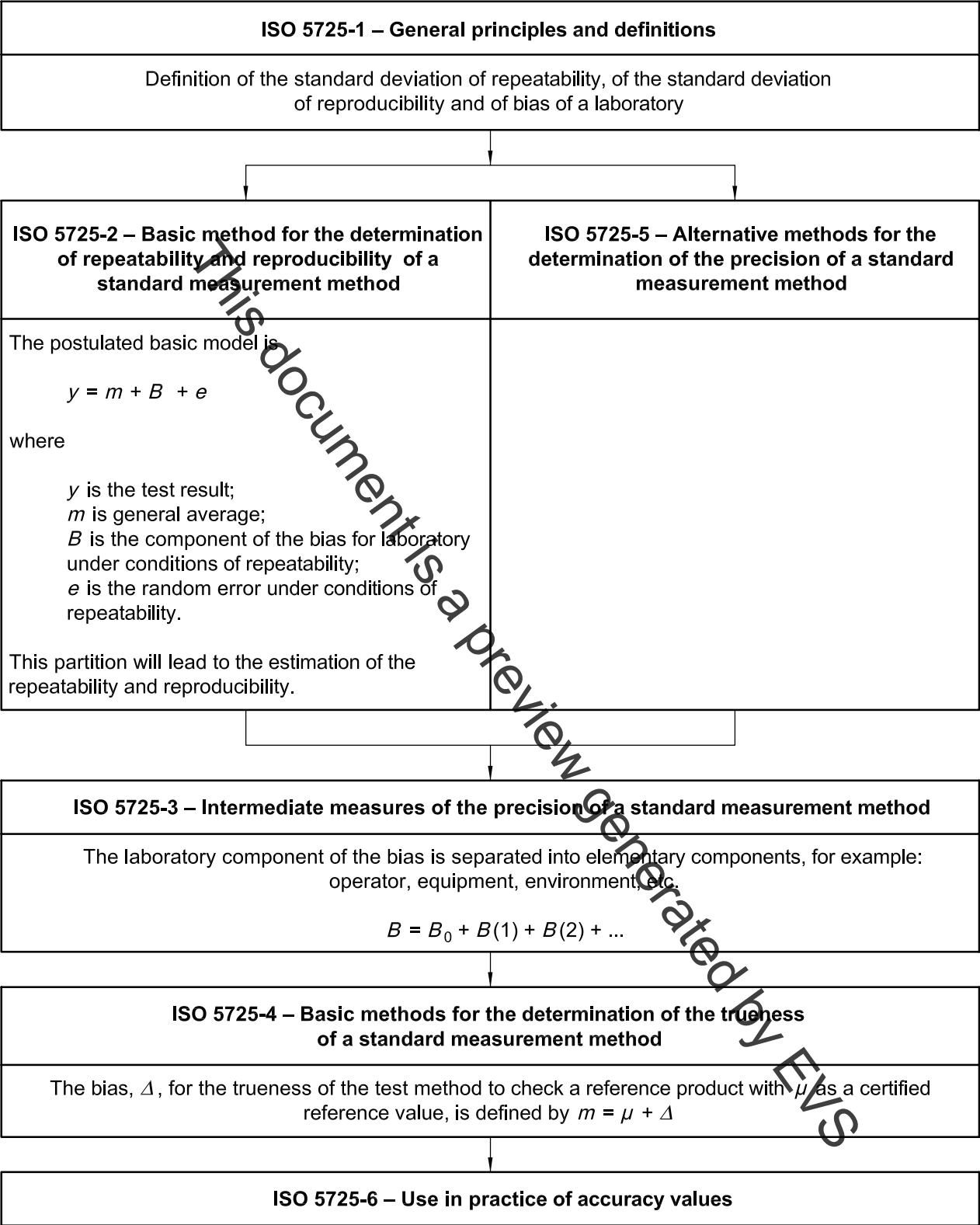


Figure 1 — Structure of ISO 5725 — Application of a standardized test method to the analyses of a sample or product in different laboratories

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1 Scope

This Technical Report provides users with practical guidance to the use of ISO 5725-2:1994 and presents simplified step-by-step procedures for the design, implementation, and statistical analysis of inter-laboratory studies for assessing the variability of a standard measurement method and on the determination of repeatability and reproducibility of data obtained in inter-laboratory testing.

2 Organization of an inter-laboratory programme

2.1 Requirements for a precision experiment

The whole experiment is organized

a) to provide a complete set of results for:

- p_{Lab} number of laboratories demonstrating that the test procedure is well controlled and for quantifying the observed scatter, estimated by the reproducibility;

NOTE The symbol p_{Lab} used in this Technical Report has the same meaning as the symbol p used in ISO 5725-2:1994. The change was made to clearly distinguish this symbol from the symbol, P , used for "probability". The lowercase and uppercase P 's are sometimes difficult to distinguish, particularly as subscripts.

- q number of samples or products representing different levels of results or performance. A minimum value for q is two, but from five to ten is more appropriate for demonstrating that the test procedure is able to discriminate correctly between levels;
- n number of replications cell demonstrating that the test procedure is well controlled within a single laboratory. When the number of laboratories and of levels is sufficient, at least two determinations are required;

b) to analyse statistically (see Clauses 2 and 3) a table of results reported by p_{Lab} laboratories analysing q samples, tested n times under conditions of repeatability.

The table of the results submitted to the executive officer is shown in Table 1 (see ISO 5725-2:1994, 7.2.8).

2.2 The responsibilities of the personnel involved in a precision experiment

2.2.1 General

An inter-laboratory programme is very expensive, both in terms of its co-ordination and its participation. Hence, the performance testing should be well co-ordinated and planned. In any inter-laboratory programme, it is necessary to consider three types of activity as shown in Figure 2.