
**Guidance for the use of repeatability,
reproducibility and trueness estimates in
measurement uncertainty estimation**

*Lignes directrices relatives à l'utilisation d'estimations de la répétabilité,
de la reproductibilité et de la justesse dans l'évaluation de l'incertitude
de mesure*



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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 21748 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 6, *Measurement methods and results*.

This first edition cancels and replaces ISO/TS 21748:2004, which has been technically revised.

Introduction

Knowledge of the uncertainty associated with measurement results is essential to the interpretation of the results. Without quantitative assessments of uncertainty, it is impossible to decide whether observed differences between results reflect more than experimental variability, whether test items comply with specifications, or whether laws based on limits have been broken. Without information on uncertainty, there is a risk of misinterpretation of results. Incorrect decisions taken on such a basis may result in unnecessary expenditure in industry, incorrect prosecution in law, or adverse health or social consequences.

Laboratories operating under ISO/IEC 17025 accreditation and related systems are accordingly required to evaluate measurement uncertainty for measurement and test results and report the uncertainty where relevant. The *Guide to the expression of uncertainty in measurement* (GUM), published by ISO/IEC as ISO/IEC Guide 98-3:2008, is a widely adopted standard approach. However, it applies to situations where a model of the measurement process is available. A very wide range of standard test methods is, however, subjected to collaborative study in accordance with ISO 5725-2:1994. This International Standard provides an appropriate and economic methodology for estimating uncertainty associated with the results of these methods, which complies fully with the relevant principles of the GUM, whilst taking account of method performance data obtained by collaborative study.

The general approach used in this International Standard requires that

- estimates of the repeatability, reproducibility and trueness of the method in use, obtained by collaborative study as described in ISO 5725-2:1994, be available from published information about the test method in use. These provide estimates of the intra- and inter-laboratory components of variance, together with an estimate of uncertainty associated with the trueness of the method;
- the laboratory confirms that its implementation of the test method is consistent with the established performance of the test method by checking its own bias and precision. This confirms that the published data are applicable to the results obtained by the laboratory;
- any influences on the measurement results that were not adequately covered by the collaborative study be identified and the variance associated with the results that could arise from these effects be quantified.

An uncertainty estimate is made by combining the relevant variance estimates in the manner prescribed by the GUM.

The general principle of using reproducibility data in uncertainty evaluation is sometimes called a “top-down” approach.

The dispersion of results obtained in a collaborative study is often also usefully compared with measurement uncertainty estimates obtained using GUM procedures as a test of full understanding of the method. Such comparisons will be more effective given a consistent methodology for estimating the same parameter using collaborative study data.

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Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation

1 Scope

The International Standard gives guidance for

- evaluation of measurement uncertainties using data obtained from studies conducted in accordance with ISO 5725-2:1994;
- comparison of collaborative study results with measurement uncertainty (MU) obtained using formal principles of uncertainty propagation (see Clause 13).

ISO 5725-3:1994 provides additional models for studies of intermediate precision. However, while the same general approach may be applied to the use of such extended models, uncertainty evaluation using these models is not incorporated in the present International Standard.

This International Standard is applicable in all measurement and test fields where an uncertainty associated with a result has to be determined.

This International Standard does not describe the application of repeatability data in the absence of reproducibility data.

This International Standard assumes that recognized, non-negligible systematic effects are corrected, either by applying a numerical correction as part of the method of measurement, or by investigation and removal of the cause of the effect.

The recommendations in this International Standard are primarily for guidance. It is recognized that while the recommendations presented do form a valid approach to the evaluation of uncertainty for many purposes, it is also possible to adopt other suitable approaches.

In general, references to measurement results, methods and processes in this International Standard are normally understood to apply also to testing results, methods and processes.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply. In addition, reference is made to “intermediate precision conditions”, which are discussed in detail in ISO 5725-3:1994.

2.1

bias

difference between the expectation of a test result or measurement result and a true value

NOTE 1 Bias is the total systematic error as contrasted to random error. There may be one or more systematic error components contributing to the bias. A larger systematic difference from the true value is reflected by a larger bias value.

NOTE 2 The bias of a measuring instrument is normally estimated by averaging the error of indication over an appropriate number of repeated measurements. The error of indication is the “indication of a measuring instrument minus a true value of the corresponding input quantity”.

NOTE 3 In practice, the accepted reference value is substituted for the true value.

[ISO 3534-2:2006, definition 3.3.2]