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Radiation protection instrumentation - Determination of uncertainty in measurement

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Radiation protection instrumentation - Determination of uncertainty in measurement

FOREWORD

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IEC TS 62461, which previously was a Technical Report, has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation. It is a Technical Specification.

This first edition of IEC TS 62461 cancels and replaces the second edition of IEC TR 62461 published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) several minor corrections;
b) the addition of an example of the determination of the decision threshold and detection limit in accordance with ISO 11929.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
45B/1115/DTS	45B/1126/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

INTRODUCTION

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)* as well as its Supplement 1:2008, *Propagation of distributions using a Monte Carlo method* (GUM S1), are general guides to assess uncertainty in measurement. Furthermore, ISO 11929 is a general guide to assess the decision threshold and detection limit, as well as coverage interval for measurements of ionizing radiation. This Technical Specification lays emphasis on the application of these documents in the area of radiation protection and serves as a practical introduction to ISO/IEC Guide 98-3:2008 and its Supplement 1:2008 as well as ISO 11929.

The process of determining uncertainty delivers not only a numerical value of uncertainty; in addition, it produces the best estimate of the quantity to be measured, which can differ from the indication of the instrument. Thus, it can also improve the result of the measurement by using information beyond the indicated value of the instrument, e.g., the energy dependence of the instrument. Furthermore, measurement uncertainties and characteristic values, such as the decision threshold, the detection limit and limits of the coverage interval for measurements, as well as the best estimate and its associated standard measurement uncertainty, are of importance in metrology in general and for radiation detection and radiological protection in particular. The quantification of the uncertainty associated with a measurement result provides a basis for the trust an individual can have in a measurement result. Conformity with regulatory limits, constraints or reference values can only be demonstrated by taking into account and quantifying all sources of uncertainty. Characteristic limits provide the basis for deciding if a measurement method is suitable and reliable for the proposed measuring task.

1 Scope

This Technical Specification gives guidelines for the application of the uncertainty analysis according to ISO/IEC Guide 98-3:2008 (GUM describing an analytical method for the uncertainty determination) and its Supplement 1:2008 (GUM S1 describing a Monte Carlo method for the uncertainty determination) for measurements of ionizing radiation. It does not include the uncertainty associated with the concept of the measuring quantity, e.g., the difference between $H_p(10)$ on the ISO water slab phantom and on the person.

This document explains the principles of ISO/IEC Guide 98-3:2008, its Supplement 1:2008 and the special considerations necessary for radiation protection at an example taken from individual dosimetry of external radiation. In the informative annexes, several examples are given for the application on instruments measuring ionizing radiation, for several of which the IEC has developed standards.

This document is intended to assist the understanding of ISO/IEC Guide 98-3:2008, ISO/IEC Guide 98-3-SP1:2008 and other papers on uncertainty analysis. It cannot replace these papers, nor can it provide the background and justification of the arguments leading to the concept of ISO/IEC Guide 98-3:2008 and ISO/IEC Guide 98-3-SP1:2008.

Finally, this document gives a very simple method to judge whether a measured result is significantly different from zero or not based on ISO 11929.

NOTE For a better readability the correct terms are not always used throughout this document. For example, instead of "random variables of a quantity" only the "quantity" itself is stated.

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.

IEC 60050-311:—[1], *International Electrotechnical Vocabulary (IEV) - Part 311: Electrical and electronic measurements - General terms relating to measurements*

IEC 60050-151, *International Electrotechnical Vocabulary (IEV) - Part 151: Electrical and magnetic devices*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 98-3-SP1:2008, *Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995) - Propagation of distributions using a Monte Carlo method*

ISO 11929-1:2019, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation - Fundamentals and application - Part 1: Elementary applications*

ISO 11929-3:2019, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation - Fundamentals and application - Part 3: Applications to unfolding methods*

[1] Under consideration. Stage at the time of publication: IEC/CDV 60050-311:2026.

ISO 11929-4:2022, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation - Fundamentals and application - Part 4: Guidelines to applications*

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