

---

---

**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**

*Détermination des limites caractéristiques (seuil de décision, limite de détection et limites de l'intervalle élargi) pour le mesurage des rayonnements ionisants — Principes fondamentaux et applications —*

*Partie 4: Lignes directrices relatives aux applications*

<https://standards.iteh.ai/catalog/standards/iso/1e6a4a56-c514-4266-b08e-0ac62d612e5c/iso-11929-4-2020>



**iTeh Standards**  
**(<https://standards.iteh.ai>)**  
**Document Preview**

[ISO 11929-4:2020](https://standards.iteh.ai/catalog/standards/iso/fe6a4a56-c314-4266-b0be-0ac62d612e5c/iso-11929-4-2020)

<https://standards.iteh.ai/catalog/standards/iso/fe6a4a56-c314-4266-b0be-0ac62d612e5c/iso-11929-4-2020>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b> .....	<b>vii</b>
<b>Introduction</b> .....	<b>viii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>2</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 Quantities and symbols</b> .....	<b>3</b>
<b>5 Summary of this document</b> .....	<b>5</b>
5.1 Procedures according to ISO 11929 (all parts).....	5
5.2 Survey on the examples.....	5
5.3 General stipulations.....	8
<b>6 Counting measurements with small or moderate uncertainties</b> .....	<b>9</b>
6.1 Definition of the task and general aspects.....	9
6.2 Model of evaluation and standard uncertainty.....	9
6.3 Available information, input data, and specifications.....	9
6.4 Evaluation of the measurement and characteristic limits according to ISO 11929-1.....	10
6.4.1 Background effect.....	10
6.4.2 Primary result and its associated standard uncertainty.....	10
6.4.3 Standard uncertainty as a function of an assumed true value.....	11
6.4.4 Decision threshold.....	11
6.4.5 Detection limit.....	11
6.4.6 Limits of coverage intervals.....	11
6.4.7 The best estimate and its associated standard uncertainty.....	12
6.5 Documentation of the results obtained by ISO 11929-1 and ISO 11929-2.....	12
6.6 Assessment and explanations.....	14
<b>7 Counting measurement with small count numbers</b> .....	<b>14</b>
7.1 Definition of the task and general aspects.....	14
7.2 Model of evaluation and standard uncertainty.....	15
7.3 Available information, input data, and specifications.....	15
7.4 Evaluation of the measurement and characteristic limits according to ISO 11929-1.....	15
7.4.1 Background effect.....	15
7.4.2 Primary result and its associated standard uncertainty.....	16
7.4.3 Standard uncertainty as a function of an assumed true value.....	16
7.4.4 Decision threshold.....	16
7.4.5 Detection limit.....	17
7.4.6 Limits of coverage intervals.....	17
7.4.7 The best estimate and its associated standard uncertainty.....	17
7.5 Documentation of the results obtained by ISO 11929-1 and ISO 11929-2.....	17
7.6 Assessment and explanations.....	19
7.7 An alternative example of a measurement with small count numbers.....	19
7.7.1 General.....	19
7.7.2 Background effect.....	20
7.7.3 Primary result and its associated standard uncertainty.....	20
7.7.4 Standard uncertainty as a function of an assumed true value.....	21
7.7.5 Decision threshold.....	21
7.7.6 Detection limit.....	21
7.7.7 Limits of coverage intervals.....	22
7.7.8 The best estimate and its associated standard uncertainty.....	22
7.8 Documentation of the results obtained by ISO 11929-1 and ISO 11929-2.....	22
7.9 Assessment of the alternative example and explanations.....	23
<b>8 Counting measurements with large uncertainties in the numerator of the calibration factor</b> .....	<b>24</b>

8.1	Definition of the task and general aspects .....	24
8.2	Model of evaluation and standard uncertainty .....	24
8.3	Available information, input data, and specifications .....	25
8.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1 .....	25
8.4.1	Background effect .....	25
8.4.2	Primary result and its associated standard uncertainty .....	26
8.4.3	Standard uncertainty as a function of an assumed true value .....	26
8.4.4	Decision threshold .....	26
8.4.5	Detection limit .....	26
8.4.6	Limits of coverage intervals .....	27
8.4.7	The best estimate and its associated standard uncertainty .....	27
8.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2 .....	27
8.6	Assessment and explanations .....	28
<b>9</b>	<b>Counting measurements with large uncertainties in the denominator of the calibration factor .....</b>	<b>29</b>
9.1	Definition of the task and general aspects .....	29
9.2	Model of evaluation and standard uncertainty .....	29
9.3	Available information, input data, and specifications .....	30
9.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1 .....	31
9.4.1	Background effect .....	31
9.4.2	Primary result and its associated standard uncertainty .....	31
9.4.3	Standard uncertainty as a function of an assumed true value .....	31
9.4.4	Decision threshold .....	31
9.4.5	Detection limit .....	32
9.4.6	Limits of coverage intervals .....	32
9.4.7	The best estimate and its associated standard uncertainty .....	32
9.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2 .....	32
9.6	Assessment and explanations .....	34
<b>10</b>	<b>Counting measurements with shielding of the background .....</b>	<b>34</b>
10.1	Definition of the task and general aspects .....	34
10.2	Model of evaluation and standard uncertainty .....	35
10.3	Available information, input data, and specifications .....	35
10.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1 .....	36
10.4.1	Background effect .....	36
10.4.2	Primary result and its associated standard uncertainty .....	36
10.4.3	Standard uncertainty as a function of an assumed true value .....	36
10.4.4	Decision threshold .....	36
10.4.5	Detection limit .....	36
10.4.6	Limits of coverage intervals .....	37
10.4.7	The best estimate and its associated standard uncertainty .....	37
10.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2 .....	37
10.6	Assessment and explanations .....	38
<b>11</b>	<b>Counting clearance measurement .....</b>	<b>39</b>
11.1	Definition of the task and general aspects .....	39
11.2	Model of evaluation and standard uncertainty .....	40
11.3	Available information, input data, and specifications .....	40
11.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1 .....	41
11.4.1	Background effect .....	41
11.4.2	Primary result and its associated standard uncertainty .....	41
11.4.3	Standard uncertainty as a function of an assumed true value .....	41
11.4.4	Decision threshold .....	42
11.4.5	Detection limit .....	42
11.4.6	Limits of coverage intervals .....	42
11.4.7	The best estimate and its associated standard uncertainty .....	42
11.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2 .....	43
11.6	Assessment and explanations .....	44

<b>12</b>	<b>Gamma-spectrometry of Uranium-235 with interference by Radium-226</b>	<b>45</b>
12.1	Definition of the task and general aspects	45
12.2	Model of evaluation and standard uncertainty	46
12.3	Available information, input data, and specifications	47
12.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1	48
12.4.1	Background effect	48
12.4.2	Primary result and its associated standard uncertainty	48
12.4.3	Standard uncertainty as a function of an assumed true value	49
12.4.4	Decision threshold	50
12.4.5	Detection limit	50
12.4.6	Limits of coverage intervals	50
12.4.7	The best estimate and its associated standard uncertainty	51
12.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2	51
12.6	Assessment and explanations	52
<b>13</b>	<b>Black box measurements</b>	<b>53</b>
13.1	Definition of the task and general aspects	53
13.2	Model of evaluation and standard uncertainty	53
13.3	Available information, input data, and specifications	54
13.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1	54
13.4.1	Background effect	54
13.4.2	Primary result and its associated standard uncertainty	55
13.4.3	Standard uncertainty as a function of an assumed true value	55
13.4.4	Decision threshold	55
13.4.5	Detection limit	56
13.4.6	Limits of coverage intervals	56
13.4.7	The best estimate and its associated standard uncertainty	56
13.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2	56
13.6	Assessment and explanations	58
<b>14</b>	<b>Counting measurements with unknown random influence of sample treatment</b>	<b>58</b>
14.1	Definition of the task and general aspects	58
14.2	Model of evaluation and standard uncertainty	59
14.3	Available information, input data, and specifications	59
14.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1	60
14.4.1	Background effect	60
14.4.2	Primary result and its associated standard uncertainty	60
14.4.3	Standard uncertainty as a function of an assumed true value	61
14.4.4	Decision threshold	61
14.4.5	Detection limit	62
14.4.6	Limits of coverage intervals	62
14.4.7	The best estimate and its associated standard uncertainty	62
14.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2	62
14.6	Assessment and explanations	64
<b>15</b>	<b>Counting measurement with known influence of sample treatment</b>	<b>64</b>
15.1	Definition of the task and general aspects	64
15.2	Model of evaluation and standard uncertainty	65
15.3	Available information, input data, and specifications	66
15.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1	67
15.4.1	Determination of the relative uncertainty of the sample treatment	67
15.4.2	Background effect	67
15.4.3	Primary result and its associated standard uncertainty	67
15.4.4	Standard uncertainty as a function of an assumed true value	68
15.4.5	Decision threshold	68
15.4.6	Detection limit	69
15.4.7	Limits of coverage intervals	69
15.4.8	The best estimate and its associated standard uncertainty	69
15.5	Documentation of the results obtained by ISO 11929-1 and ISO 11929-2	69
15.6	Assessment and explanations	71

<b>16</b>	<b>Dose measurement using an active personal dosimeter</b>	<b>71</b>
16.1	Definition of the task and general aspects	71
16.2	Model of evaluation and standard uncertainty	71
16.3	Available information, input data, and specifications	72
16.4	Evaluation of the measurement and characteristic limits according to ISO 11929-1	73
16.4.1	Background effect	73
16.4.2	Primary result and its associated standard uncertainty	73
16.4.3	Standard uncertainty as a function of an assumed true value	73
16.4.4	Decision threshold	73
16.4.5	Detection limit	74
16.4.6	Limits of coverage intervals	74
16.4.7	The best estimate and its associated standard uncertainty	75
16.5	Assessment and explanations	76
<b>17</b>	<b>Dose rate measurement using a neutron area monitor</b>	<b>77</b>
17.1	Definition of the task and general aspects	77
17.2	Model of evaluation and standard uncertainty	78
17.3	Available information, input data, and specifications	79
17.4	Evaluation of the measurement and characteristic limits	81
17.4.1	Background effect	81
17.4.2	Primary result and its associated standard uncertainty	81
17.4.3	Standard uncertainty as a function of an assumed true value	81
17.4.4	Decision threshold	82
17.4.5	Detection limit	83
17.4.6	Limits of coverage intervals	83
17.4.7	The best estimate and its associated standard uncertainty	84
17.5	Documentation of the results	84
17.6	Assessment and explanations	85
	<b>Annex A (informative) Determination of a calibration factor</b>	<b>86</b>
	<b>Annex B (informative) Calculations according to ISO 11929-2</b>	<b>92</b>
	<b>Bibliography</b>	<b>95</b>

[ISO 11929-4:2020](https://standards.iteh.ai/catalog/standards/iso/fe6a4a56-c314-4266-b0be-0ac62d612e5c/iso-11929-4-2020)

<https://standards.iteh.ai/catalog/standards/iso/fe6a4a56-c314-4266-b0be-0ac62d612e5c/iso-11929-4-2020>

## 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](http://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](http://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 on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

This second edition of ISO 11929-4 together with ISO 11929-1:2019, ISO 11929-2:2019 and ISO 11929-3:2019, cancels and replaces ISO 11929:2010, which has been technically revised, specifically with reference to the type of statistical treatment of the data and extended with respect to the methodology of uncertainty assessment from the ISO/IEC Guide 98-3 and the ISO/IEC Guide 98-3:2008/Suppl.1.

A list of all parts of ISO 11929 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](http://www.iso.org/members.html).