

VEE KVALITEET. INDUKTIIVSIDESTATUD PLASMA  
MASSISPEKTROMEETRIA (ICP-MS) RAKENDAMINE.  
OSA 2: VALITUD ELEMENTIDE, KAASA ARVATUD  
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Water quality - Application of inductively coupled  
plasma mass spectrometry (ICP-MS) - Part 2:  
Determination of selected elements including uranium  
isotopes (ISO 17294-2:2023, **Corrected version**  
**2024-02**)

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

<p>See Eesti standard EVS-EN ISO 17294-2:2023 sisaldab Euroopa standardi EN ISO 17294-2:2023 ingliskeelset teksti.</p> <p>Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.</p> <p>Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 25.10.2023.</p> <p>Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.</p>	<p>This Estonian standard EVS-EN ISO 17294-2:2023 consists of the English text of the European standard EN ISO 17294-2:2023.</p> <p>This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.</p> <p>Date of Availability of the European standard is 25.10.2023.</p> <p>The standard is available from the Estonian Centre for Standardisation and Accreditation.</p>
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English Version

Water quality - Application of inductively coupled plasma  
mass spectrometry (ICP-MS) - Part 2: Determination of  
selected elements including uranium isotopes (ISO 17294-  
2:2023, Corrected version 2024-02)

Qualité de l'eau - Application de la spectrométrie de  
masse avec plasma à couplage inductif (ICP-MS) -  
Partie 2: Dosage des éléments sélectionnés y compris  
les isotopes d'uranium (ISO 17294-2:2023, Version  
corrigée 2024-02)

Wasserbeschaffenheit - Anwendung der induktiv  
gekoppelten Plasma-Massenspektrometrie (ICP-MS) -  
Teil 2: Bestimmung von ausgewählten Elementen  
einschließlich Uran-Isotope (ISO 17294-2:2023,  
korrigierte Fassung 2024-02)

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This European Standard was corrected and reissued by the CEN-CENELEC Management Centre on 13 March 2024.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

## European foreword

This document (EN ISO 17294-2:2023) has been prepared by Technical Committee ISO/TC 147 "Water quality" in collaboration with Technical Committee CEN/TC 230 "Water analysis" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2024, and conflicting national standards shall be withdrawn at the latest by April 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 17294-2:2016.

Any feedback and questions on this document should be directed to the users' national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## Endorsement notice

The text of ISO 17294-2:2023, Corrected version 2024-02 has been approved by CEN as EN ISO 17294-2:2023 without any modification.

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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.

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 document 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)).

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For an explanation of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 2, *Physical, chemical and biochemical methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 230, *Water analysis*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 17294-2:2016), which has been technically revised.

The main changes are as follows:

- with the incorporation of mercury in the previous edition, mercury has now been excluded as a hydrolysable and has now become a non-hydrolysable element because it was not in line with the other existing standards for the determination of mercury;
- the addition of a modifier has been clarified;
- titanium has been added to the scope.

A list of all parts in the ISO 17294 series 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).

This corrected version of ISO 17294-2:2023 incorporates the following corrections:

- Note 1 to entry has been moved from the terminological entry [3.1.26](#) to [3.1.16](#);
- the symbols "*k*", "*α*" and "*β*" have been revised in [3.2](#) and the symbols "*η*" and "*o*" have been revised in [Tables C.3](#) and [C.5](#), respectively;
- [Clause 12 b\)](#) has been editorially revised;
- "<sup>204</sup>Tl" has been changed to "<sup>205</sup>Tl or <sup>193</sup>Ir" in [Clause A.2](#);

- [Formula \(A.3\)](#) has been revised from " $R = r \left( \frac{m_A}{m_B} \right) \beta$ " to " $R = r \left( \frac{m_A}{m_B} \right)^\beta$ ";
- the descriptions of symbols " $l$ ", " $n$ " and " $\bar{\bar{x}}$ " have been revised in Table C.5.

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# Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) —

## Part 2:

## Determination of selected elements including uranium isotopes

**WARNING** — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

**IMPORTANT** — It is absolutely essential that tests, conducted in accordance with this document, be carried out by suitably qualified staff.

### 1 Scope

This document specifies a method for the determination of the elements aluminium, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, caesium, calcium, cerium, chromium, cobalt, copper, dysprosium, erbium, gadolinium, gallium, germanium, gold, hafnium, holmium, indium, iridium, iron, lanthanum, lead, lithium, lutetium, magnesium, manganese, mercury, molybdenum, neodymium, nickel, palladium, phosphorus, platinum, potassium, praseodymium, rubidium, rhenium, rhodium, ruthenium, samarium, scandium, selenium, silver, sodium, strontium, terbium, tellurium, thorium, thallium, thulium, tin, titanium, tungsten, uranium and its isotopes, vanadium, yttrium, ytterbium, zinc and zirconium in water (e.g. drinking water, surface water, ground water, waste water and eluates).

Taking into account the specific and additionally occurring interferences, these elements can be determined in water and digests of water and sludge (e.g. digests of water as described in ISO 15587-1 or ISO 15587-2).

The working range depends on the matrix and the interferences encountered. In drinking water and relatively unpolluted waters, the limit of quantification ( $L_{00}$ ) lies between 0,002 µg/l and 1,0 µg/l for most elements (see [Table 1](#)). The working range typically covers concentrations between several ng/l and mg/l depending on the element and specified requirements.

The quantification limits of most elements are affected by blank contamination and depend predominantly on the laboratory air-handling facilities available on the purity of reagents and the cleanliness of glassware.

The lower limit of quantification is higher in cases where the determination suffers from interferences (see [Clause 5](#)) or memory effects (see ISO 17294-1).

Elements other than those mentioned in the scope can also be determined according to this document provided that the user of the document is able to validate the method appropriately (e.g. interferences, sensitivity, repeatability, recovery).



**Table 1 — Lower limits of quantification for unpolluted water**

Element	Isotope often used	$L_{OQ}^a$ µg/l	Element	Isotope often used	$L_{OQ}^a$ µg/l	Element	Isotope often used	$L_{OQ}^a$ µg/l
Ag	<sup>107</sup> Ag	0,5	Hf	<sup>178</sup> Hf	0,1	Ru	<sup>102</sup> Ru	0,1
	<sup>109</sup> Ag	0,5	Hg	<sup>202</sup> Hg	0,05	Sb	<sup>121</sup> Sb	0,2
Al	<sup>27</sup> Al	1		<sup>201</sup> Hg	0,1		<sup>123</sup> Sb	0,2
As	<sup>75</sup> As <sup>c</sup>	0,1	Ho	<sup>165</sup> Ho	0,1	Sc	<sup>45</sup> Sc	5
Au	<sup>197</sup> Au	0,5	In	<sup>115</sup> In	0,1	Se	<sup>77</sup> Se <sup>c</sup>	1
B	<sup>10</sup> B	1	Ir	<sup>193</sup> Ir	0,1		<sup>78</sup> Se <sup>c</sup>	0,1
	<sup>11</sup> B	1	K	<sup>39</sup> K	5		<sup>82</sup> Se	1
Ba	<sup>137</sup> Ba	3	La	<sup>139</sup> La	0,1	Sm	<sup>147</sup> Sm	0,1
	<sup>138</sup> Ba	0,5		<sup>6</sup> Li	10	Sn	<sup>118</sup> Sn	1
Be	<sup>9</sup> Be	0,1	Li	<sup>7</sup> Li	1		<sup>120</sup> Sn	1
Bi	<sup>209</sup> Bi	0,5	Lu	<sup>175</sup> Lu	0,1	Sr	<sup>86</sup> Sr	0,5
Ca	<sup>43</sup> Ca	100	Mg	<sup>24</sup> Mg	1		<sup>88</sup> Sr	0,3
	<sup>44</sup> Ca	50		<sup>25</sup> Mg	10	Tb	<sup>159</sup> Tb	0,1
	<sup>40</sup> Ca	10	Mn	<sup>55</sup> Mn	0,1	Te	<sup>126</sup> Te	2
Cd	<sup>111</sup> Cd	0,1	Mo	<sup>95</sup> Mo	0,5	Th	<sup>232</sup> Th	0,1
	<sup>114</sup> Cd	0,5		<sup>98</sup> Mo	0,3	Tl	<sup>203</sup> Tl	0,2
Ce	<sup>140</sup> Ce	0,1	Na	<sup>23</sup> Na	10		<sup>205</sup> Tl	0,1
				<sup>146</sup> Nd	0,1	Ti	<sup>47</sup> Ti	10
							<sup>48</sup> Ti	1
							<sup>49</sup> Ti	10
Co	<sup>59</sup> Co	0,2	Ni	<sup>58</sup> Ni <sup>c</sup>	0,1	Tm	<sup>169</sup> Tm	0,1
Cr	<sup>52</sup> Cr <sup>c</sup>	0,1		<sup>60</sup> Ni <sup>c</sup>	0,1	U	<sup>238</sup> U	0,1
	<sup>53</sup> Cr	5	P	<sup>31</sup> P	5		<sup>235</sup> U	1,10 <sup>-4</sup>
Cs	<sup>133</sup> Cs	0,1	Pb	<sup>206</sup> Pb <sup>b</sup>	0,2	V	<sup>234</sup> U	1,10 <sup>-5</sup>
Cu	<sup>63</sup> Cu	0,1		<sup>207</sup> Pb <sup>b</sup>	0,2		<sup>51</sup> V <sup>c</sup>	0,1
	<sup>65</sup> Cu	0,1		<sup>208</sup> Pb <sup>b</sup>	0,1	W	<sup>182</sup> W	0,3
Dy	<sup>163</sup> Dy	0,1	Pd	<sup>108</sup> Pd	0,5		<sup>184</sup> W	0,3
Er	<sup>166</sup> Er	0,1	Pr	<sup>141</sup> Pr	0,1	Y	<sup>89</sup> Y	0,1
Fe	<sup>56</sup> Fe <sup>c</sup>	5	Pt	<sup>195</sup> Pt	0,5	Yb	<sup>172</sup> Yb	0,2
Ga	<sup>69</sup> Ga	0,3	Rb	<sup>85</sup> Rb	0,1		<sup>174</sup> Yb	0,2
	<sup>71</sup> Ga	0,3	Re	<sup>185</sup> Re	0,1	Zn	<sup>64</sup> Zn	1
Gd	<sup>157</sup> Gd	0,1		<sup>187</sup> Re	0,1		<sup>66</sup> Zn	1
	<sup>158</sup> Gd	0,1	Rh	<sup>103</sup> Rh	0,1		<sup>68</sup> Zn	1
Ge	<sup>74</sup> Ge	0,3	Ru	<sup>101</sup> Ru	0,2	Zr	<sup>90</sup> Zr	0,2

<sup>a</sup> Depending on the instrumentation, significantly lower limits can be achieved.

<sup>b</sup> Lead (Pb) is reported as the sum of the signal intensities of <sup>206</sup>Pb, <sup>207</sup>Pb and <sup>208</sup>Pb.

<sup>c</sup> These limits are achieved by the use of a collision/reaction cell.

## 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.

ISO 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

ISO 5667-3, *Water quality — Sampling — Part 3: Preservation and handling of water samples*

ISO 8466-1, *Water quality — Calibration and evaluation of analytical methods — Part 1: Linear calibration function*

ISO 15587-1, *Water quality — Digestion for the determination of selected elements in water — Part 1: Aqua regia digestion*

ISO 15587-2, *Water quality — Digestion for the determination of selected elements in water — Part 2: Nitric acid digestion*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 17294-1:2004, *Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) — Part 1: General guidelines*

### 3 Terms, definitions and symbols

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17294-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

##### 3.1.1

##### **analyte**

element to be determined

##### 3.1.2

##### **background**

$N_0$

counts for a given mass in the blank solution

Note 1 to entry: Background is expressed in Counts.

##### 3.1.3

##### **blank calibration solution**

solution prepared in the same way as the *calibration solution* (3.1.4) but leaving out the *analyte* (3.1.1)

##### 3.1.4

##### **calibration solution**

solution used to calibrate the instrument, prepared from a *stock solution(s)* (3.1.24) or from a certified standard

##### 3.1.5

##### **determination**

entire process from preparing the *test sample solution* (3.1.26) up to and including the measurement and calculation of the final *result* (3.1.22)

##### 3.1.6

##### **expanded uncertainty**

$U$

product of the standard uncertainty,  $u(C)$ , and the coverage factor,  $k$ , with  $k = 1, 2, \dots$ , as follows:  $U = k \cdot u(C)$

Note 1 to entry: Expanded uncertainty is expressed in the unit of the quantity  $C$ .