CERTIFIED REFERENCE MATERIAL

IAEA-443

NATURAL AND ARTIFICIAL RADIONUCLIDES IN SEA WATER FROM THE IRISH SEA

**Certified values for massic activities**

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Certified value [Bq kg⁻¹]</th>
<th>Expanded uncertainty [Bq kg⁻¹] (**)</th>
</tr>
</thead>
<tbody>
<tr>
<td>³⁷H</td>
<td>37.2</td>
<td>0.5</td>
</tr>
<tr>
<td>¹⁹⁰K</td>
<td>11.4</td>
<td>0.4</td>
</tr>
<tr>
<td>⁹⁰Sr</td>
<td>0.110</td>
<td>0.005</td>
</tr>
<tr>
<td>¹³⁷Cs</td>
<td>0.36</td>
<td>0.01</td>
</tr>
<tr>
<td>²³⁴U</td>
<td>0.044</td>
<td>0.002</td>
</tr>
<tr>
<td>²³⁵U</td>
<td>0.00185</td>
<td>0.00010</td>
</tr>
<tr>
<td>²³⁸U</td>
<td>0.039</td>
<td>0.002</td>
</tr>
<tr>
<td>²³⁸Pu</td>
<td>0.0031</td>
<td>0.0001</td>
</tr>
<tr>
<td>²³⁹⁺²⁴⁰Pu</td>
<td>0.0147</td>
<td>0.0002</td>
</tr>
<tr>
<td>²⁴¹Am</td>
<td>0.0197</td>
<td>0.0010</td>
</tr>
</tbody>
</table>

(*) Estimated expanded uncertainty with a coverage factor k=2, corresponding to a level of confidence of approximately 95%, as defined in the Evaluation of measurement data - Guide to the expression of uncertainty in measurement JCGM100:2008 [1].

(**) The values should be corrected for in-growth from ²³⁹Pu.

Reference date for decay correction: 1 January 2007
Information values for massic activities

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Information value [mBq kg(^{-1})]</th>
<th>Combined expanded uncertainty [mBq kg(^{-1})]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{230})Th</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>(^{232})Th</td>
<td>0.19</td>
<td>0.03</td>
</tr>
<tr>
<td>(^{239})Pu</td>
<td>8.2</td>
<td>0.8</td>
</tr>
<tr>
<td>(^{240})Pu</td>
<td>7.0</td>
<td>0.6</td>
</tr>
<tr>
<td>(^{241})Pu</td>
<td>161</td>
<td>19</td>
</tr>
</tbody>
</table>

Reference date for decay correction: 1 January 2007

Origin and preparation of the material

In collaboration with IAEA-MEL, the Federal Maritime and Hydrographic Agency (BSH), Hamburg, Germany, collected about 3600 litres of surface water from the Irish Sea on-board Research Vessel Valdivia on September 7, 1993. Sampling was performed while cruising between two shallow (ca. 20 m water depth) stations located at 54°24.89’ N - 3°33.62’ W and 54°23.2’N - 3°33.45’W. Water was sampled from 5 m water depth, stored in 600 L containers and acidified to pH<1 immediately without prior filtration. A part of the sample was forwarded to IAEA-MEL and was used for the IAEA-381 interlaboratory comparison on anthropogenic and natural radionuclides. The results obtained from 28 laboratories were reported and the IAEA-381 Certified Reference Material was issued [2-3].

In 2005, 1100 L of this sample, stored at the then Risø National Laboratory, Denmark, were provided to IAEA-MEL. The sample was then transferred into a container of 1500 L and mixed for 4 hours using two pumps, aliquoted into 5 L cubitainers and coded as IAEA-443. All units were sterilized according to ISO standards at 25 kGy in an irradiation facility.

Characterization study

The IAEA-443 candidate reference material was characterized in an interlaboratory comparison (ILC) with participation of 28 laboratories, including 10 expert laboratories, from Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Morocco, Netherlands, Norway, Japan, Portugal, Slovakia, Spain, Sweden, U.K., U.S.A and the IAEA Laboratory in Monaco.

Laboratories were requested to determine as many natural and anthropogenic radionuclides as possible by the analytical method of their choice. The following methods were used: gamma-spectrometry, low background gamma-spectrometry, alpha-spectrometry, beta counting and/or mass spectrometry.

Assignment of values - Certification procedure

The assigned property values were established on the basis of results reported by participating laboratories to the IAEA Environment Laboratories in Monaco. The medians for the sets of individual data were chosen as the best estimations of the property values [4-8] and are reported as certified values when:

(i) at least 5 laboratory means were available, reported from at least 3 different laboratories and

(ii) the relative uncertainty of the median did not exceed ±5% for activities higher than 100 Bq kg\(^{-1}\), ±10% for activities from 1 to 100 Bq kg\(^{-1}\) and ±20% for activities lower than 1 Bq kg\(^{-1}\).

An activity value was considered as an information value if at least 5 laboratory means calculated from the results of at least 2 different laboratories were available.
The details concerning all reported results as well as the criteria for certification may be found in the report IAEA/AQ/10,”Interlaboratory comparison: radionuclides in Irish Sea water IAEA-443”[7]. The report can be downloaded free of charge from: http://www-pub.iaea.org/MTCD/publications/PDF/IAEA-AQ-10_web.pdf

Evidence on metrological traceability to the SI Units was provided by all laboratories and is summarized in the final report [7].

Based on the evidence on calibrators used, quality control procedures applied by the participating laboratories and their generally high quality performance in the IAEA interlaboratory comparisons, the Certification Committee decided to accept these assigned values as certified.

**Statement on metrological traceability and uncertainty of assigned values**

The property values assigned to the IAEA-443 reference material are calculated as massic activities of each radionuclide, expressed in the derived SI unit Bq kg\(^{-1}\). The estimated expanded uncertainty was calculated according to the Evaluation of measurement data - Guide to the expression of uncertainty in measurement JCGM100:2008 [1].

**Intended use**

This Certified Reference Material is intended to be used for quality assurance purposes in the determination of radionuclides in sea water samples, including development and validation of analytical procedures, preparation and testing of reference methods, quality control, and training of analysts. This material is not to be used as a calibrator.

**Instructions for use**

The reference material is supplied in 5 L units. The minimum sample volume (mass) laboratories should take when using the IAEA-443 is 60 ml (60 g) for mass spectrometry and 2 kg for radiometric methods (gamma spectrometry, alpha spectrometry and beta counting).

To overcome potential segregation effects due to storage, the material should be re-homogenized before use.

**Homogeneity of the material and recommended minimum test portion**

Sample homogeneity was checked by determination of \(^{137}\)Cs, \(^{40}\)K, \(^{90}\)Sr, \(^{238}\)Pu and \(^{239+240}\)Pu activities (using high-resolution low-background gamma spectrometry, low-level beta proportional counter, and alpha spectrometry) in 2 kg aliquots from 5 cubitainers chosen at random. Homogeneity was tested by using one-way analysis of variance. The coefficient of variation was below 10% for all radionuclides determined. An additional homogeneity test for major and trace elements (P, S, Cl, K, Ca, Fe, Ni, Cu, Zn, As, Br, Sr, I, Ba, Pb) for the sea water sample was done by XRF analysis of 4 g samples. The coefficient of variation was below 10% for XRF determined elements.

Certified values provided in this certificate are based on the minimum sample mass of 2 kg.

**Handling and storage**

The original unopened bottle should be stored securely at ambient temperature in a dark place. Analysts are reminded to take appropriate precautions in order to avoid contamination of the material during handling.

**Issue and expiry date**

The issue date of this reference material is March 2012. The expiry date is March 2022. The IAEA is monitoring the long term stability of the material and customers will be informed in case of any observed change.
Legal disclaimer

The IAEA makes no warranties, expressed or implied, with respect to the data contained in this reference sheet and shall not be liable for any damage that may result from the use of such data.

Compliance with ISO Guide 31:2000

The content of this IAEA Reference Sheet is in compliance with the ISO Guide 31:2000: Reference materials — Content of certificates and labels [9].

Citation of this reference sheet

It is suggested to cite this reference sheet according to the following example, as appropriate to the citation format used: INTERNATIONAL ATOMIC ENERGY AGENCY, Reference Sheet for CRM IAEA-443, ‘Natural and artificial radionuclides in sea water from the Irish Sea’. IAEA, Vienna, 5 pp. (The latest version published applies; see “Note” below).

Note

Certified values as stated in this reference sheet may be updated if more information becomes available. Users of this material should ensure that the reference sheet in their possession is current. The current version can be found in the IAEA’s Reference Materials online catalogue: http://nucleus.iaea.org/rpst/ReferenceProducts/ReferenceMaterials

Further information:

For further information regarding this material, please contact:

Radiometrics Laboratory
International Atomic Energy Agency
Environment Laboratories
4, Quai Antoine 1er
MC 98000 MONACO

Tel.: 377 97 97 72 72
Fax: 377 97 97 72 73
E-mail: NAEI-RML.Contact-Point@iaea.org

REFERENCES