### Reference Material for $\delta^{15}N$

#### REFERENCE SHEET

**IAEA-N-1**

NIST name: RM 8547

Ammonium Sulfate

Reference value of $\delta^{15}N_{\text{AIR}}$ of IAEA-N-1 expressed in per mille (‰) on the AIR scale\(^{(a)}\) and its associated standard uncertainty ($k=1$).

<table>
<thead>
<tr>
<th>Stable isotope ratio</th>
<th>Reference value(^{(b)})</th>
<th>Standard uncertainty with $k=1$(^{(b)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\delta^{15}N_{\text{AIR}}$ (‰)</td>
<td>+0.43</td>
<td>0.07</td>
</tr>
</tbody>
</table>

\(^{(a)}\) AIR refers to atmospheric nitrogen, which is homogeneous, universally constant and has by convention a $\delta^{15}N$ of 0‰ [1, 2].

\(^{(b)}\) Values are calculated as mean and standard deviation, after elimination of outliers [2], from the 12 accepted data sets, each being obtained by different laboratories and different methods of determination.

### Origin and preparation of the material

IAEA-N-1 is a relatively coarse-grained salt of ammonium sulfate [(NH$_4$)$_2$SO$_4$] prepared by E. Salati, CENA (Centro de Energia Nuclear na Agricultura), Brazil, in 1978 [3].

### Homogeneity of the material

IAEA-N-1, when analysed in different laboratories during the characterisation study, was found homogeneous for sample sizes in the range of 1 - 10 mg [2].
Characterization study

A preliminary characterisation was performed in 1983 [4]. The current characterisation was performed in 1993 based on the results of an inter-laboratory comparison test involving 15 laboratories [2]. The $\delta^{15}$N values were measured against Air N$_2$ by isotope ratio mass spectrometry on N$_2$ gas quantitatively obtained off-line using different combustion methods followed by purification steps [2]. The measured results were then normalized against USGS32 using the consensus $\delta^{15}$N value relative to Air N$_2$ of $+$180‰. The assigned value has been confirmed in 2003, when it was used as primary reference material for analysing other inorganic reference materials in two laboratories using both online combustion continuous flow and offline dual-inlet mass spectrometry [5] and at the IAEA using an online combustion continuous flow system in 2021.

Assignment of values

The reference value and uncertainty have been determined by calculating arithmetic mean and standard deviation of the data of the inter-laboratory comparison test, after elimination of values that differ from the means by more than two standard deviations, followed by recalculation and elimination until all values were within two standard deviations.

The details concerning the reported results as well as the calculation may be found in reference [2].

The $\delta^{15}$N value and uncertainty are the values accepted in 2014 by the Commission on Isotopic Abundances and Atomic Weights of the International Union of Pure and Applied Chemistry (IUPAC) [6] and agreed with NIST, as of the date of this report. Moreover, they have been accepted by the Stable isotope experts participating to the Technical Meeting on the Development of IAEA Stable Isotope Reference Materials and Related Products, 30 August – 3 September 2021.

Statement on metrological traceability and uncertainty of assigned values

The value is traceable to the $\delta^{15}$N$_{\text{AIR}}$ scale, normalised by assigning a consensus value of $+$180‰ to USGS32. For calibration against atmospheric N$_2$, different reference materials (air, salts, and tank gases) with $\delta^{15}$N values between approximately $-3$‰ and $+3$‰ were used.

The uncertainty of the assigned value is the standard deviation of the accepted results obtained during the characterisation study [2].

Absolute isotopic abundances

No absolute ratio isotope abundance determination was performed on this material.

Intended use

IAEA-N-1 is considered a primary RM to be used as a scale anchor for samples that need combustion, for obtaining traceability of the data to the $\delta^{15}$N$_{\text{AIR}}$ scale.

Instructions for use, handling and storage

IAEA-N-1 is issued in units of 0.5 g.

As the material is hygroscopic, it is recommended that it is stored in cool and dry place in the tightly closed container in which it was supplied to the user.
Upon opening and taking a portion for analysis, the container must be rapidly and tightly closed.

The recommended minimum sample size to be used for analysis is 1 mg.

**Limit of distribution**

Only one unit per year per laboratory may be ordered. This strategy should ensure that material is available for international use for as long as possible.

**Issue and expiry date**

The issue date of IAEA-N-1 was January 1983, and the current reference value was published in 1995. The issue date of this reference sheet is provided in the footer of this document.

The reference value was confirmed in 2003 and in 2021. Based on this, the expiry date is February 2032, provided the original packages are handled and stored in accordance with the instructions given in this reference sheet (see “Instructions for use, handling and storage”).

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 31:2015**

The content of this IAEA Reference Sheet is in compliance with ISO Guide 31:2015, Reference materials – Contents of certificates, labels and accompanying documentation [7].

**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 IAEA-N-1, IAEA, Vienna, 4 pp. (The latest version published applies, see “Note” below).

**Note**

Reference 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:

https://nucleus.iaea.org/sites/ReferenceMaterials/Pages/Stable-Isotopes.aspx

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