



# Nuclear Reference Material Program

## U.S. Department of Energy



# Certificate of Analysis

## Certified Reference Material 111

### Uranium (U-233) in Nitrate Form Spike Assay and Isotopic Solution Standard

**Description:** Certified Reference Material (CRM) 111 consists of approximately 5 milligrams of uranium dissolved in 10 grams of 0.8 mol L<sup>-1</sup> HNO<sub>3</sub> contained in a sealed glass ampoule. Certified property values for the standard are provided in Table 1.

**Table 1. Certified Property Values and Uncertainties <sup>(a)</sup>**

	<b>μmol g<sup>-1</sup></b>			<b>g mol<sup>-1</sup></b>
Uranium Molality:	2.1023		Uranium Molar Mass:	233.0472
Uncertainty:	0.0011			0.0019
	<i>n</i> ( <sup>233</sup> U)/ <i>n</i> (U)	<i>n</i> ( <sup>234</sup> U)/ <i>n</i> (U)	<i>n</i> ( <sup>235</sup> U)/ <i>n</i> (U)	<i>n</i> ( <sup>238</sup> U)/ <i>n</i> (U)
Isotope-Amount Fraction (•100):	99.9245	0.0181	0.0011	0.0563
Uncertainty:	0.0006	0.0002	0.0002	0.0004

<sup>(a)</sup> The indicated uncertainty for the uranium molality is the tolerance limit for at least 99 % coverage with a probability level of 0.95. In brief, at least 99 % of the measured values on all ampoules should fall within the indicated interval with a probability of 0.95. This statistical approach is necessary due to the concentration variability between ampoules. (See page 14 of "The Role of Standard Reference Materials in Measurement Systems," NBS Monograph 148, 1975, for a more detailed explanation of the tolerance limit concept.) Since isotopic composition shows little variability between ampoules, the indicated uncertainties for the isotopic composition are 95 % confidence limits for the mean.

**Intended use:** This Certified Reference Material (CRM) is intended for use as a spike in the analysis of uranium materials by isotope dilution mass spectrometry (IDMS).

**Storage:** This material should be stored in its original packaging under normal laboratory environmental conditions.

**Period of validity:** When stored in its original, unopened container, the certification of this material is valid indefinitely. The NRMP will notify customers should degradation be detected.

**Minimum sample size:** CRM 111 is considered a pure solution, and thus no minimum sample size is declared.

**Instructions for handling:** The material in the unit is radioactive. This radioactive material should be handled only by qualified individuals. The ampoule should be handled under proper radiologically-controlled conditions at all times. To minimize personnel exposure, appropriate facilities and personal protective equipment should be used. Refer to the SDS for further information.

**Traceability statement:** The certified isotope-amount fractions are traceable to the SI unit of mole. The certified uranium molality and the molar mass are traceable to the SI units mole and kilogram.

**Additional information:** The uranium molality of CRM 111 was determined by IDMS using high-purity spikes prepared from CRM 135,  $^{235}\text{U}$  spike (formerly SRM 993) and CRM 112A, Metal Assay Standard (formerly SRM 960). Analyses were made on a solid-sample thermal ionization mass spectrometer. Corrections for mass discrimination effects were based upon analyses of CRM U500 (formerly SRM U-500).

The  $^{233}\text{U}$  to  $^{238}\text{U}$  measurement was made using a solid-sample thermal ionization mass spectrometer equipped with a Faraday cup detection system.

The  $^{234}\text{U}$  and  $^{235}\text{U}$  abundances were measured with respect to  $^{238}\text{U}$  in the material using a thermal ionization mass spectrometer equipped with a pulse-counting detection system.

This CRM was originally issued in 1980 by the National Bureau of Standards (NBS) as Standard Reference Material (SRM) 995. The measurements made at NBS leading to the certification were performed by J.D. Fassett, J.W. Gramlich, and L.A. Machlan, under the direction of E.L. Garner. In 1987, the technical and administrative transfer of NBS Special Nuclear SRMs to the New Brunswick Laboratory (NBL) CRM Program was coordinated by the NBS Office of Standard Reference Materials and N. M. Trahey. In 2016 NBL transitioned to a program office within the Department of Energy and is now operating within the National Nuclear Security Administration (NNSA) as the Nuclear Reference Material Program (NRMP).

**NOTE:** NBS Special Publication 260-27 presents further details of the measurements made at NBS which provided the basis for the certification and is available from the National Institute of Standards and Technology (NIST) Office of Reference Materials upon request.