



**Nuclear Reference Material Program**  
*U.S. Department of Energy*



**Certificate of Analysis**  
**Certified Reference Material U630 (10 mg)**  
**Uranium (U<sub>3</sub>O<sub>8</sub>), Isotopic Standard 63 % U-235, 10 mg U**

**Description:** Certified Reference Material (CRM) U630 is a uranium isotope-amount ratio standard. Each unit of CRM U630 consists of a 20 mL glass scintillation vial containing approximately 10 milligrams of uranium in the form of high-purity U<sub>3</sub>O<sub>8</sub>. Certified isotope composition values are reported in Table 1. Additional non-certified values are provided in Table 2.

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

Isotope-Amount Ratio:	$n(^{234}\text{U})/n(^{235}\text{U})$	$n(^{236}\text{U})/n(^{235}\text{U})$	$n(^{238}\text{U})/n(^{235}\text{U})$	
Uncertainty:	0.0097698	0.0151895	0.55351	
	0.0000062	0.0000097	0.00049	
Isotope-Amount Fraction	$n(^{234}\text{U})/n(\text{U})$	$n(^{235}\text{U})/n(\text{U})$	$n(^{236}\text{U})/n(\text{U})$	$n(^{238}\text{U})/n(\text{U})$
(•100):	0.61894	63.353	0.96230	35.066
Uncertainty:	0.00043	0.020	0.00067	0.020
Isotope-Mass Fraction	$m(^{234}\text{U})/m(\text{U})$	$m(^{235}\text{U})/m(\text{U})$	$m(^{236}\text{U})/m(\text{U})$	$m(^{238}\text{U})/m(\text{U})$
(•100):	0.61354	63.069	0.96207	35.356
Uncertainty:	0.00043	0.020	0.00067	0.020
	<b>g mol<sup>-1</sup></b>			
Uranium Molar Mass:	236.10175			
Uncertainty:	0.00061			

<sup>(a)</sup> Reported numerical uncertainties for Certified Values are expressed as expanded uncertainties ( $U = k \cdot u_c$ ) at the 95 % level of confidence, where the expanded uncertainty ( $U$ ) is the product of the combined standard uncertainty ( $u_c$ ) and a coverage factor ( $k$ ). The last figure in the reported values and their uncertainties is provided for information purposes and is not intended to convey a significant degree of reliability. To ensure proper uncertainty propagation, it is recommended that isotope-amount ratios and associated uncertainties be used for calculations incorporating CRM U630 values.

**Intended use:** CRM U630 is intended primarily for use as a uranium isotope-amount ratio standard for the analysis of high enriched uranium oxide.

**Storage:** To maintain the integrity of an unused CRM unit, it should remain in the original packaging and should be stored in a dry, temperature-controlled location.

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

**Minimum sample size:** Certification and/or verification measurements for isotope-amount ratios were performed on aliquots as small as 10 mg of U<sub>3</sub>O<sub>8</sub>. Accordingly, the material homogeneity for the attribute values is not certified for samples smaller than 10 mg. Note that CRM U630 has also been characterized for model purification date but certification analyses for this attribute were performed on 100 mg oxide samples. Therefore, 10 mg CRM U630 units

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are only intended as uranium isotope-amount ratio standards. One gram size CRM U630 units are certified for both isotope amount ratios and model purification age.

**Instructions for handling:** CRM U630 is a radioactive material and should be handled and stored under proper radiologically-controlled conditions at all times. This radioactive material should be handled only by qualified individuals. To minimize personnel exposure, appropriate facilities and personal protective equipment should be used. Refer to the Safety Data Sheet for further information.

**Traceability statement:** Certified property values are traceable to the SI units of mole or gram.

**Additional information:** In 2001 to 2002, a detailed thermal ionization mass spectrometry measurement (TIMS) campaign was performed on the U630 to determine uranium isotope-amount ratios and uncertainties. Mass discrimination calibrations were performed on a sample-turret basis using multiple measurements of CRMs U500 and U750 Uranium Isotopic Standards. Metrological traceability to the SI unit of mass for all ratios and abundances was established through the use and incorporation of uncertainties associated with CRMs U500 and U750.

The  $n(^{232}\text{U})/n(^{235}\text{U})$  ratio,  $n(^{233}\text{U})/n(^{235}\text{U})$  ratio, and amount content values for this material are provided as Non-certified values determined in separate studies performed from 2011 to 2013. An NRMP value represents the best estimate of the true value where all known or suspected sources of bias have not been fully investigated. The  $n(^{232}\text{U})/n(^{235}\text{U})$  isotope amount ratio was measured by  $\alpha$ -spectroscopy with  $^{232}\text{U}$  and  $^{234}\text{U}$  converted from  $\alpha$  counts to atoms using half-lives provided in the NNDC Nuclear Wallet Card Database (June 1, 2012). The resulting ratio of isotopes was normalized to  $^{235}\text{U}$  using the previously certified CRM U630  $n(^{234}\text{U})/n(^{235}\text{U})$  isotope amount ratio. Measurement of the  $n(^{233}\text{U})/n(^{235}\text{U})$  ratio was by TIMS using a combined secondary electron multiplier - Faraday Cup method with mass discrimination internally corrected using the previously certified  $n(^{238}\text{U})/n(^{235}\text{U})$  ratio.

**Table 2. Non-Certified Property Values and Uncertainties** <sup>(a)</sup>

	$n(^{232}\text{U})/n(^{235}\text{U})$	$n(^{233}\text{U})/n(^{235}\text{U})$
Isotope-Amount Ratio:	$7.31 \times 10^{-10}$	$2.372 \times 10^{-6}$
Uncertainty:	$0.16 \times 10^{-10}$	$0.055 \times 10^{-6}$

<sup>(a)</sup> The reference date for these values is 19 May 2014.

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).

**Measurement uncertainty:** Uncertainties were determined according to the protocols outlined in JCGM 100:2008 Guide to the expression of uncertainty in measurement. The combined standard uncertainties for certified values were composed of both Type A and Type B evaluated standard uncertainties. The Type A evaluated uncertainties for isotope-amount ratios are the standard deviations associated with the isotope-amount ratios measured for the samples and the  $n(^{235}\text{U})/n(^{238}\text{U})$  ratio of CRMs U500 and U750. Type B evaluated uncertainties are based on the combined standard uncertainties for the  $n(^{235}\text{U})/n(^{238}\text{U})$  ratio of CRMs U500 and U750. Isotope mass fractions incorporated additional Type B evaluated uncertainties associated with the atomic mass for the U isotopes.

**Project support:** Characterization analyses for  $^{232}\text{U}/^{238}\text{U}$  isotope-amount ratio and  $^{233}\text{U}/^{238}\text{U}$  isotope ratio measurements were funded by the Department of Homeland Security, National Technical Nuclear Forensic Center (NTNFC) under Inter-Agency Agreement HSHQDC-10-X-00135.