NBL Program Office

U.S. Department of Energy

Certificate of Analysis

Certified Reference Material C115 (1g)

Uranium (Metal) Assay and Isotopic Standard, 0.2% U-235, 1 gram

Amount Content :	**0.99978**	**g U•g^{-1} metal**		
Uncertainty:	**0.00010**	**g U•g^{-1} metal**		
	$n(^{234}U)/n(^{238}U)$	$n(^{235}U)/n(^{238}U)$	$n(^{236}U)/n(^{238}U)$	
Isotope-Amount Ratio:	**0.000007545**	**0.0020337**	**0.000032213**	
Uncertainty:	**0.000000018**	**0.0000012**	**0.000000084**	
	$n(^{234}U)/n(U)$	$n(^{235}U)/n(U)$	$n(^{236}U)/n(U)$	$n(^{238}U)/n(U)$
Isotope-Amount Fraction (•100):	**0.0007530**	**0.20295**	**0.0032146**	**99.79308**
Uncertainty:	**0.0000018**	**0.00012**	**0.0000084**	**0.00012**
	$m(^{234}U)/m(U)$	$m(^{235}U)/m(U)$	$m(^{236}U)/m(U)$	$m(^{238}U)/m(U)$
Isotope Mass Fraction (•100):	**0.0007403**	**0.20039**	**0.0031876**	**99.79568**
Uncertainty:	**0.0000018**	**0.00012**	**0.0000083**	**0.00012**
Molar Mass:	**238.0445912**	**g•mol^{-1}**		
Uncertainty:	**0.0000055**	**g•mol^{-1}**		

The ^{233}U isotope was not detected in this material. The uranium isotopic ratio for the estimated limit of detection associated with the method used to assess ^{233}U content is $n(^{233}U)/n(^{238}U) = 0 \pm 3.6 \cdot 10^{-9}$.

Notes:

C115 is a radioactive material and should be handled and stored under proper radiologically-controlled conditions at all times.

Certified Reference Material C115 is a uranium amount content and isotope-amount ratio standard intended for use in calibration of and/or quality control for uranium analysis methods. Each unit of C115 consists of a metal piece with a mass of approximately 1.2 grams. This CRM is not certified for absolute quantity of material which may be somewhat greater or less than the nominal mass (between 1.0 g and 1.5 g).

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. The isotope-amount and weight fraction values and uncertainties are provided primarily for information purposes. To assure proper uncertainty propagation, it is recommended that isotope-amount ratios and associated uncertainties be used for calculations incorporating C115 values.

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November 2020

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Expiration of Certificate: C115 units do not have an expiration date.

Stability and 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.

Certification and/or verification measurements for uranium amount content and isotope-amount ratios were performed on a random sampling of metal pieces weighing approximately 1 gram. The homogeneity of uranium amount content or isotopic composition is not certified for metal pieces smaller than 1 gram. Prior to use, surface oxide must be removed to ensure accurate uranium amount content values. A suggested procedure is provided below:

1. Cover the uranium metal sample in 8 M nitric acid for 10-20 minutes to remove all visible surface oxides and impurities.
2. To minimize oxidation of the sample and ensure an accurate determination of uranium metal mass, the following steps should be performed immediately following Step 1.
   2.1 Thoroughly rinse the metal piece with distilled, deionized water.
   2.2 Remove excess water by thoroughly rinsing the metal piece with pure acetone.
   2.3 Allow the acetone to evaporate (30 – 60 seconds is typically sufficient).
   2.4 Perform a weighing of sufficient accuracy and precision for users need.

Description:

Uranium amount content for C115 was originally determined in 1975 by the NBL High Precision Titrimetric method using SRM 136c Potassium Dichromate Oxidimetric Standard as the titrant. Although the originally certified amount content value appears to be accurate within stated uncertainties, a new amount content determination was performed to meet the requirements of international standards for expression of measurement uncertainty. In 2011 the uranium amount content for C115 was re-determined by analyses using SRM 136e Potassium Dichromate Oxidimetric Standard as the titrant. The C112A Uranium Metal Assay and Isotopic Standard was used as a control to verify performance of the measurement system. Traceability of the measurements is primarily established by direct determination of uranium amount content based on the titration of uranium using SRM 136e Potassium Dichromate Oxidimetric Standard provided by the National Institute of Standards and Technology.

In 2011, a detailed thermal ionization mass spectrometry measurement campaign was performed on the C115 material to determine uranium isotope-amount ratios and uncertainties. Mass discrimination calibrations were performed on a sample turret basis using multiple measurements of NBL U030A Uranium Isotopic Standard. Analyses of C112A Uranium Metal Assay and Isotopic Standard were performed to verify that mass spectrometric measurements were in control. Traceability of the isotope-amount ratio measurements for C115 is primarily established by calibration of the mass spectrometer using measurements of U030A Uranium Isotopic Standard that was originally provided by the National Bureau of Standards (now known as the National Institute of Standards and Technology) as SRM U030A Uranium Isotopic Standard.

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 consist of Type A and Type B components. The Type A uncertainty component for amount content is derived from the standard deviation of the titrations. The Type B component is the combined standard uncertainty of the SRM 136e oxidimetric standard. The Type A components for isotope-amount ratios are derived from standard deviations associated with isotopic ratio measurements of the samples and the $n(^{235}U)/n(^{238}U)$ ratio of NBL U030A. Type B components are based on the combined standard uncertainties for the $n(^{235}U)/n(^{238}U)$ ratio of U030A and uncertainty components to account for additional sources of uncertainty associated with background corrections and analytical biases. Isotope mass fractions incorporate an additional Type B component associated with the uncertainty of the atomic mass for the U isotopes. The coverage factor (k) for each expanded uncertainty is the Student's t-factor necessary to provide a 95% level of confidence ($k \approx 2$ for all values cited in this certificate). A more detailed explanation of measurement uncertainty can be obtained upon request from NBL.