



Nuclear Reference Material Program

U.S. Department of Energy



Certificate of Analysis

Certified Reference Material 136 (10 mg)

Plutonium (Dry Sulfate) Isotopic Standard

Description: Certified Reference Material (CRM) 136 is a plutonium isotope standard. Each unit of CRM 136 consists of approximately 10 milligrams of plutonium, in the form of dry plutonium sulfate, contained in a screw-top 30 mL glass bottle. Certified isotope composition values are reported in Table 1.

Table 1. Certified Property Values and Uncertainties ^{(a) (b)}

Isotope-Amount	$n(^{238}\text{Pu})/n(\text{Pu})$	$n(^{239}\text{Pu})/n(\text{Pu})$	$n(^{240}\text{Pu})/n(\text{Pu})$	$n(^{241}\text{Pu})/n(\text{Pu})$	$n(^{242}\text{Pu})/n(\text{Pu})$
Fraction ($\bullet 100$):	0.223	84.988	12.323	1.888	0.578
Uncertainty:	0.007	0.015	0.015	0.005	0.003
Isotope-Mass	$m(^{238}\text{Pu})/m(\text{Pu})$	$m(^{239}\text{Pu})/m(\text{Pu})$	$m(^{240}\text{Pu})/m(\text{Pu})$	$m(^{241}\text{Pu})/m(\text{Pu})$	$m(^{242}\text{Pu})/m(\text{Pu})$
Fraction ($\bullet 100$):	0.222	84.925	12.366	1.902	0.585
Uncertainty:	0.007	0.015	0.015	0.005	0.003

^(a) The indicated uncertainties for the isotopic composition of the CRM are 95 % confidence intervals for a single determination. This term can be defined as an approximate two-sigma limit, where sigma is the standard deviation of the measurements data obtained from the material.

^(b) **Certified values are provided for a reference date of October 1, 1987. Certified plutonium isotope values must be decay-corrected to the date of use.**

Intended use: CRM 136 is primarily intended for use as an isotope standard in the mass spectrometric analysis of plutonium.

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 NRMP will notify customers should degradation be detected.

Minimum Sample Size: No minimum sample size is declared for this material.

Instructions for Handling: The reference material in the unit is radioactive. The container and its contents should be handled under proper radiologically-controlled conditions at all times. The unit bottle is inside two layers of sealed plastic bagging, which are then inside a blue cardboard tube. The outside of the blue cardboard tube is considered contamination-free. **NOTE: Users should consider the inner contents of the blue tube to be contaminated with loose plutonium and handle the contents appropriately.** This radioactive material should be handled only by qualified individuals.

Chemical separation of the plutonium from its uranium and americium daughters prior to use is essential for high accuracy, since these daughters include nuclides that are isobaric with plutonium isotopes.

Traceability Statement: The certified isotope-amount fraction values are traceable to the SI unit mole. The certified isotope-mass fraction values are traceable to the SI unit kilogram.

Additional information: The contents of this CRM were produced in 2008 by dissolving a 250 mg sample of CRM 136, aliquanting subsamples into new bottles, and drying them down in sulfuric acid to form dry plutonium sulfate. Verification measurements utilizing thermal ionization mass spectrometry were performed, along with environmental blanks, to ensure that the material was not contaminated during the re-bottling process. The certified isotope-amount fraction values were determined using solid-sample thermal ionization mass spectrometry. The analyses were corrected for mass discrimination effects relative to uranium isotopic CRMs (issued by NBS as SRMs), since high-purity plutonium separated isotopes were not available for the preparation of the original synthetic calibration mixtures. The measurements made at NBS leading to the certification were performed by E. L. Garner and L. A. Machlan.

This CRM was originally issued in 1970 by the National Bureau of Standards (NBS) as Standard Reference Material (SRM) 946. In 1987, the NBS transferred the technical and administrative operations of special nuclear material SRMs to the NBL CRM Program. In 2016, the New Brunswick Laboratory facility was 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).