



Designation: C1672 – 17

# Standard Test Method for Determination of Uranium or Plutonium Isotopic Composition or Concentration by the Total Evaporation Method Using a Thermal Ionization Mass Spectrometer<sup>1</sup>

This standard is issued under the fixed designation C1672; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This method describes the determination of the isotopic composition, or the concentration, or both, of uranium and plutonium as nitrate solutions by the total evaporation method using a thermal ionization mass spectrometer (TIMS) instrument. Purified uranium or plutonium nitrate solutions are deposited onto a metal filament and placed in the mass spectrometer. Under computer control, ion currents are generated by heating of the filament(s). The ion currents are continually measured until the whole sample is exhausted. The measured ion currents are integrated over the course of the measurement and normalized to a reference isotope ion current to yield isotope ratios.

1.2 In principle, the total evaporation method should yield isotope ratios that do not require mass bias correction. In practice, samples may require this bias correction. Compared to the conventional TIMS method described in Test Method **C1625**, the total evaporation method is approximately two times faster, improves precision of the isotope ratio measurements by a factor of two to four, and utilizes smaller sample sizes. Compared to the **C1625** method, the total evaporation method provides “major” isotope ratios  $^{235}\text{U}/^{238}\text{U}$  and  $^{240}\text{Pu}/^{239}\text{Pu}$  with improved accuracy.

1.3 The total evaporation method is prone to biases in the “minor” isotope ratios ( $^{233}\text{U}/^{238}\text{U}$ ,  $^{234}\text{U}/^{238}\text{U}$ , and  $^{236}\text{U}/^{238}\text{U}$  ratios for uranium materials and  $^{238}\text{Pu}/^{239}\text{Pu}$ ,  $^{241}\text{Pu}/^{239}\text{Pu}$ ,  $^{242}\text{Pu}/^{239}\text{Pu}$ , and  $^{244}\text{Pu}/^{239}\text{Pu}$  ratios for plutonium materials) due to peak tailing from adjacent major isotopes. The magnitude of the absolute bias is dependent on measurement and instrumental characteristics. The relative bias, however, depends on the relative isotopic abundances of the sample. The use of an electron multiplier equipped with an energy filter may eliminate or diminish peak tailing effects. Measurement of the abundance sensitivity of the instrument may be used to ensure

that such biases are negligible, or may be used to bias correct the minor isotope ratios.

1.4 The values stated in SI units are to be regarded as standard. When non-SI units are provided in parentheses, they are for information only.

1.5 *This standard may involve the use of hazardous materials and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- C753** Specification for Nuclear-Grade, Sinterable Uranium Dioxide Powder
- C757** Specification for Nuclear-Grade Plutonium Dioxide Powder for Light Water Reactors
- C776** Specification for Sintered Uranium Dioxide Pellets
- C787** Specification for Uranium Hexafluoride for Enrichment
- C833** Specification for Sintered (Uranium-Plutonium) Dioxide Pellets for Light Water Reactors
- C859** Terminology Relating to Nuclear Materials
- C967** Specification for Uranium Ore Concentrate
- C996** Specification for Uranium Hexafluoride Enriched to Less Than 5 %  $^{235}\text{U}$
- C1008** Specification for Sintered (Uranium-Plutonium) Dioxide Pellets—Fast Reactor Fuel (Withdrawn 2014)<sup>3</sup>
- C1068** Guide for Qualification of Measurement Methods by a Laboratory Within the Nuclear Industry
- C1156** Guide for Establishing Calibration for a Measurement Method Used to Analyze Nuclear Fuel Cycle Materials

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **C26** on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee **C26.05** on Methods of Test.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).