



Standard Test Method for Determination of Impurities in Nuclear Grade Uranium Compounds by Inductively Coupled Plasma Mass Spectrometry¹

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1. Scope

1.1 This test method covers the determination of 67 elements in uranium dioxide samples and nuclear grade uranium compounds and solutions without matrix separation by inductively coupled plasma mass spectrometry (ICP-MS). The elements are listed in Table 1. These elements can also be determined in uranyl nitrate hexahydrate (UNH), uranium hexafluoride (UF₆), triuranium octoxide (U₃O₈) and uranium trioxide (UO₃) if these compounds are treated and converted to the same uranium concentration solution.

1.2 The elements boron, sodium, silicon, phosphorus, potassium, calcium and iron can be determined using different techniques. The analyst's instrumentation will determine which procedure is chosen for the analysis.

1.3 The test method for technetium-99 is given in [Annex A1](#).

1.4 The values stated in SI units are to be regarded as standard.

1.5 *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. **Warning**—The ICP-MS is a source of intense ultra-violet radiation from the radio frequency induced plasma. Protection from radio frequency radiation and UV radiation is provided by the instrument under normal operation.*

2. Referenced Documents

2.1 ASTM Standards:²

¹ 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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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[C753 Specification for Nuclear-Grade, Sinterable Uranium Dioxide Powder](#)

[C776 Specification for Sintered Uranium Dioxide Pellets](#)

[C787 Specification for Uranium Hexafluoride for Enrichment](#)

[C788 Specification for Nuclear-Grade Uranyl Nitrate Solution or Crystals](#)

[C967 Specification for Uranium Ore Concentrate](#)

[C996 Specification for Uranium Hexafluoride Enriched to Less Than 5 % ²³⁵U](#)

[C1346 Practice for Dissolution of UF₆ from P-10 Tubes](#)

[C1347 Practice for Preparation and Dissolution of Uranium Materials for Analysis](#)

[D1193 Specification for Reagent Water](#)

3. Summary of Test Method

3.1 The sample is dissolved in acid if it is not already a solution. A fixed quantity of internal standard is added to monitor and correct for signal instability. The level of impurities in the solution is measured by ICP-MS. Customized software calculates the concentration of each element.

3.2 Uranium-concentration-matched standard solutions are used to calibrate the ICP-MS instrument. The calibration is linear up to at least 0.2 µg/ml (100 µg/g U) for each analyte.^{3,4}

3.3 Microwave dissolution may be used as an alternate dissolution method.

4. Significance and Use

4.1 This test method is capable of measuring the elements listed in [Table 1](#), some of which are required by Specifications [C753](#), [C776](#), [C787](#), [C788](#), [C967](#) and [C996](#).

³ "ICP-MS Versus Conventional Methods for the Analysis of Trace Impurities in Nuclear Fuel," by Allenby, P., Clarkson, A. S., Makinson, P. R., presented at 2nd Surrey Conference on Plasma Source Mass Spectrometry, Guildford, UK, July 1987.

⁴ "Trace Metals in NBL Uranium Standard CRM 124 Using ICP-MS," by Aldridge, A. J., Clarkson, A. S., Makinson, P. R., Dawson, K. W., presented at 1st Durham International Conference on Plasma Source Mass Spectrometry, Durham, UK, September 1988.