



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

This standard is issued under the fixed designation C 1287; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

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 *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.* For a specific warning statement, see Note 1.

NOTE 1—**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.

1.3 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.

1.4 The test method for technetium-99 is given in Annex A1.

2. Referenced Documents

2.1 ASTM Standards:

- C 753 Specification for Nuclear-Grade, Sinterable Uranium Dioxide Powder²
- C 776 Specification for Sintered Uranium Dioxide Pellets²
- C 787 Specification for Uranium Hexafluoride for Enrichment²

C 788 Specification for Nuclear-Grade Uranyl Nitrate Solution²

C 967 Specification for Uranium Ore Concentrate²

C 996 Specification for Uranium Hexafluoride Enriched to Less Than 5 % ²³⁵U²

C 1346 Practice for Dissolution of UF₆ from P-10 Tubes²

D 1193 Specification for Reagent Water³

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.^{4,5}

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 C 753, C 776, C 787, C 788, C 967 and C 996.

5. Apparatus

5.1 ICP-MS, controlled by computer and fitted with the associated software and peripherals. May be fitted with cold plasma option.

5.2 Autosampler, with tube racks and disposable plastic sample tubes compatible with 5.1 (optional).

5.3 Variable Micropipettes:

5.3.1 10 µL to 100 µL capacity.

5.3.2 100 µL to 1000 µL capacity.

³ Annual Book of ASTM Standards, Vol 11.01.

⁴ "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.

⁵ "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.

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.

Current edition approved July 10, 2003. Published August 2003. Originally approved in 1994. Last previous edition approved in 2001 as C 1287 – 95 (2001).

² Annual Book of ASTM Standards, Vol 12.01.