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Standard Specification for Uranium Oxides with a ^{235}U Content of Less Than 5 % for Dissolution Prior to Conversion to Nuclear-Grade Uranium Dioxide[1]

This standard is issued under the fixed designation C1334; 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.

ε[1] NOTE—Editorially updated organization name of referenced document in 2.2 in January 2016.

1. Scope

1.1 This specification covers uranium oxides, including processed byproducts or scrap material (powder, pellets, or pieces), that are intended for dissolution into uranyl nitrate solution meeting the requirements of Specification C788 prior to conversion into nuclear grade UO_2 powder with a ^{235}U content of less than 5 %. This specification defines the impurity and uranium isotope limits for such urania powders that are to be dissolved prior to processing to nuclear grade UO_2 as defined in Specification C753.

1.2 This specification provides the nuclear industry with a general standard for such uranium oxide powders. It recognizes the diversity of conversion processes and the processes to which such powders are subsequently to be subjected (for instance, by solvent extraction). It is therefore anticipated that it may be necessary to include supplementary specification limits by agreement between the buyer and seller.

1.3 The scope of this specification does not comprehensively cover all provisions for preventing criticality accidents, for health and safety, or for shipping. Observance of this specification does not relieve the user of the obligation to conform to all international, national, state and local regulations for processing, shipping, or any other way of using urania powders (see 2.2 and 2.3).

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C696 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Uranium Dioxide Powders and Pellets

C753 Specification for Nuclear-Grade, Sinterable Uranium Dioxide Powder

C788 Specification for Nuclear-Grade Uranyl Nitrate Solution or Crystals

C799 Test Methods for Chemical, Mass Spectrometric, Spectrochemical, Nuclear, and Radiochemical Analysis of Nuclear-Grade Uranyl Nitrate Solutions

C859 Terminology Relating to Nuclear Materials

C996 Specification for Uranium Hexafluoride Enriched to Less Than 5 % ^{235}U

C1233 Practice for Determining Equivalent Boron Contents of Nuclear Materials

E105 Practice for Probability Sampling of Materials

2.2 *ASME Standard:*[3]

ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications

2.3 *U.S. Government Document:*[4]

Federal Regulations Title 10, (Energy) Part 50, Domestic Licensing of Production and Utilization Facilities

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 Terms shall be defined in accordance with Terminology C859, except for the following:

3.1.2 *Commercial Grade Uranium Oxide, n*—any oxide of uranium made from unirradiated uranium. It is recognized some contamination with reprocessed uranium may occur during routine processing; this is acceptable provided that the specification for Commercial Grade Uranium Oxide as set forth in 4.1 is met.

[1] This specification is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.02 on Fuel and Fertile Material Specifications.

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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.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

3.1.3 *scrap, n*—in the nuclear industry, residues that contain sufficient quantities of source or special nuclear material to be worthy of recovery.

4. Isotopic Content

4.1 For Commercial Grade Uranium Oxide with an isotopic content of ^{235}U between that of natural uranium and 5 %, the isotopic and radionuclide limits of Specification C996 shall apply. The specific isotopic and radionuclide measurements required by Specification C996 may be waived, provided that the seller can demonstrate compliance through, for instance, the seller's quality assurance records.

4.2 For commercial uranium oxides not having an assay in the range set forth in 4.1, the isotopic requirements shall be as agreed upon between the buyer and seller.

5. Physical and Chemical Requirements

5.1 *Uranium Content*—The uranium content shall be determined using methods described in Test Methods C696 and C799, or as agreed upon between the buyer and seller. Based on the oxygen-to-uranium ratio, the minimum total uranium content shall also be agreed upon between the buyer and seller.

5.2 *Impurity Content*—The impurity content shall not exceed the individual element limits specified in Table 1. The summation of the contribution of each of the impurity elements listed in Table 1 shall not exceed 1000 µg/gU. The impurity content shall be determined using methods described in Test Methods C696 or as agreed upon between the buyer and seller. If the Table 1 specifications are not met, and processing beyond simple dissolution is anticipated, the concentrations of carbon and toxic elements such as Ag, Cr, Pb, Hg, Se, Sb, and As shall be reported for information. Analysis requirements may be waived provided the seller can characterize the material, for example, through the seller's QA records.

TABLE 1 Impurity Elements and Maximum Concentration Limits

Element	Maximum Concentration Limit (µg/gU)
Aluminum	150
Barium	5
Bismuth	3
Calcium and Magnesium	150
Chlorine	100
Chromium	100
Cobalt	80
Copper	100
Fluorine	100
Iron	150
Lead	40
Manganese	50
Molybdenum	200
Nickel	80
Phosphorus	100
Silicon	200
Sodium	20
Tantalum	200
Thorium	10
Tin	50
Titanium	50
Tungsten	100
Vanadium	10
Zinc	20

5.3 *Equivalent Boron Content*—The total equivalent boron content (EBC) shall not exceed 2.0 µg/gU. The list of elements to be considered in the EBC calculation shall be as recommended in Practice C1233. The method of performing the calculation shall be as indicated in Practice C1233.

5.4 If the concentrations of any of the elements used in the calculations in 5.2 are reported as a less-than value, this less-than value shall be used for any further calculations involving the concentration of this element.

5.5 *Moisture Content*—The moisture content of the uranium oxide shall not exceed 1 % by weight unless otherwise agreed upon by the buyer and seller.

5.6 *Ability to Flow*—The Commercial Grade Uranium Oxide shall be sufficiently free-flowing to permit sampling and powder handling.

5.7 *Particle Size*—Particle size, size distribution and method of determination shall be as agreed upon between the buyer and seller. Packing or agglomeration during shipping, or both, may be a concern.

5.8 *Dissolvability*—At the buyer's request, a dissolvability test shall be performed by a procedure and to a specification as mutually agreed upon between buyer and seller. The test parameters (such as time, temperature, nitric acid molarity) and characteristics to be measured (such as dissolution rate, insolubles, foam generation) shall be defined by agreement between the buyer and seller.

6. Lot Requirements

6.1 A lot is defined as a quantity of Commercial Grade Uranium Oxide powder that is uniform in isotopic, chemical, and flowability characteristics.

6.2 The identity of a lot shall be retained throughout.

6.3 A powder lot shall form the basis for defining sampling plans used to establish conformance to this specification.

6.4 Sampling plans shall be mutually agreed upon by the buyer and seller. A suggested sampling procedure is given in Appendix X1.

7. Testing and Certification

7.1 The material shall be sampled as described in Appendix X1 and tested to ensure conformance of the powder to the requirements as agreed upon between the buyer and the seller.

7.2 The seller, as above, shall provide to the buyer documents certifying that the material meets all the requirements of Sections 4, 5, and 6.

7.3 *Lot Acceptance*—Acceptance testing may be performed by the buyer on either the sample provided by the seller or on a sample taken at the buyer's plant by sampling one or more individual containers with a thief. Practice E105 is referenced as a guide. Acceptance shall be on a lot basis and shall be contingent upon the material properties meeting the requirements of Sections 4, 5, and 6.

7.4 *Referee Method*—The buyer and seller may agree to a third party as a referee in the event of a dispute in analytical results.

8. Packaging and Marking

8.1 Uranium oxide powder shall be packaged in sealed containers to prevent loss of material and undue contamination from air or to the container materials. The exact size and method of packaging shall be as agreed upon between the buyer and seller.

8.2 Each container shall bear, as a minimum, a label on the lid and side with the following information:

8.2.1 Seller's name,
8.2.2 Material in container,
8.2.3 Lot number,
8.2.4 Uranium enrichment,
8.2.5 Gross, tare, net oxide weights,
8.2.6 Uranium weight,
8.2.7 Purchase order number (or equivalent), and
8.2.8 Container ( ) of ( ).

9. Quality Assurance

9.1 Quality assurance requirements shall be as agreed upon between the buyer and seller when specified in the purchase order. Code of Federal Regulations Title 10, Part 50, Appendix B and NQA-1 are referenced as guides.

10. Keywords

10.1 nuclear fuel; uranium oxide; uranium oxide dissolution

APPENDIX

(Nonmandatory Information)

X1. SAMPLING

X1.1 Uranium oxide may be hygroscopic and retain sufficient water after exposure to a moist atmosphere to cause detectable error. Sample, weigh, and handle the sample under conditions that will ensure that the sample is representative of the lot.

X1.2 Take a representative sample of powder from each lot for the purpose of determining chemical properties.

X1.3 A lot sample shall be of sufficient size to perform quality assurance testing at the seller's plant, acceptance testing at the buyer's plant, and referee tests in the event they become necessary.

X1.4 Package the lot sample for acceptance testing at the buyer's plant in a separate container, clearly identify by lot number, and ship with the lot. Clearly identify the referee sample and retain it at the manufacturer's (if someone other than the seller) plant until the lot has been formally accepted by the buyer.

X1.5 Prepare the lot sample by blending and splitting the container samples

X1.6 To obtain a container sample, take specimens with a thief at random locations along a randomly chosen vertical traverse through each container selected at random to be sampled. Then blend the thief samples from the selected containers and split down to the required size.

X1.7 The number of containers so sampled shall be $5 + (n/10)$ where n is the total number of containers per lot rounded to the nearest decade. If there are five or fewer containers per lot, each container shall be so sampled.

X1.8 Alternatively, an auto-sampler can be used to obtain samples during emptying or filling of the container.