



Designation: C1348 – 01(Reapproved 2008)

Standard Specification for Blended Uranium Oxides with ^{235}U Content of Less Than 5 % for Direct Hydrogen Reduction to Nuclear Grade Uranium Dioxide¹

This standard is issued under the fixed designation C1348; 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.

INTRODUCTION

This specification is intended to provide the nuclear industry with a general standard for such uranium oxide powders. It recognizes the diversity of conversion processes and the many special requirements for chemical and physical characterization that may be imposed by the end use of the powder. It is anticipated, therefore, that this specification may be supplemented with additional requirements by agreement between the buyer and the seller.

1. Scope

1.1 This specification covers blended uranium trioxide (UO_3), U_3O_8 , or mixtures of the two, powders that are intended for conversion into a sinterable uranium dioxide (UO_2) powder by means of a direct reduction process. The UO_2 powder product of the reduction process must meet the requirements of Specification C753 and be suitable for subsequent UO_2 pellet fabrication by pressing and sintering methods. This specification applies to uranium oxides with a ^{235}U enrichment less than 5 %.

1.2 This specification includes chemical, physical, and test method requirements for uranium oxide powders as they relate to the suitability of the powder for storage, transportation, and direct reduction to UO_2 powder. This specification is applicable to uranium oxide powders for such use from any source.

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 uranium oxide powders (see 2.2 and 2.3).

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 The following safety hazards caveat pertains only to the test methods portion of the annexes in this specification: *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:²

- B329 Test Method for Apparent Density of Metal Powders and Compounds Using the Scott Volumeter
- 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
- 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
- C1287 Test Method for Determination of Impurities in Nuclear Grade Uranium Compounds by Inductively Coupled Plasma Mass Spectrometry

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.

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E105 Practice for Probability Sampling of Materials

2.2 *ANSI Standard*.³

NQA-1 Quality Assurance Program, Requirements for Nuclear Facilities

2.3 *U.S. Government Document*.⁴

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

3. Terminology

3.1 *Definitions*—Terms shall be defined in accordance with Terminology **C859**, except the following.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *Commercial-Grade Uranium Oxide*—uranium trioxide (UO₃), U₃O₈, or a mixture of the two, made from unirradiated uranium. It is recognized that 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.

4. Isotopic Content

4.1 For Commercial-Grade Uranium Oxide with an isotopic content of ²³⁵U between that of natural uranium and 5 %, the isotopic limits, including the requirements for reporting and measurements of Specification **C996** shall apply, unless otherwise agreed upon between the buyer and seller. The specific isotopic measurements required by Specification **C996** may be waived, provided that the seller can demonstrate compliance with Specification **C996**, for instance, through the seller's quality assurance records. ²³⁶U contents greater than that specified in **C996** for Enriched Commercial Grade UF₆ may be agreed upon between the buyer and seller since it is not a safety concern.

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

5. Physical and Chemical Requirements

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

5.2 *Oxygen-to-Uranium Ratio (O/U)*—The O/U ratio of the Commercial-Grade Uranium Oxide shall be nominally between 2.67 and 3.0. The O/U ratio shall be determined by Test Methods **C696** or by another method as agreed upon by the buyer and the seller.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

5.3 *Impurity Content*—The impurity content of the Commercial-Grade Uranium Oxide shall not exceed the individual element limit specified in **Table 1** on a uranium weight basis. 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 the procedures described in Test Methods **C696** or **C1287**, or both, or as agreed upon between the buyer and the seller.

5.4 *Equivalent Boron Content*—The total equivalent boron content (EBC) of the Commercial-Grade Uranium Oxide shall not exceed 2.0 µg/gU. The list of elements to be considered in the EBC calculation shall be as agreed upon between the buyer and the seller. The method of performing the calculation shall be as indicated in Practice **C1233**.

5.5 If the concentrations of any of the elements used in the calculations in **5.3** are reported as a less-than value, this less-than value shall be used for any further calculations involving the concentration of this element.

5.6 *Bulk Density*—Unless otherwise agreed upon between the buyer and the seller, the bulk density of the Commercial-Grade Uranium Oxide shall be a minimum of 575 kg/m³, as determined by Test Method **B329**, or an alternative agreed upon between the buyer and the seller.

5.7 *Moisture Content*—The moisture content of the Commercial-Grade Uranium Oxide shall not exceed 1 % by weight unless otherwise agreed upon by the buyer and the seller.

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

TABLE 1 Impurity Elements and Maximum Concentration Limits

Element	Maximum Concentration µg/gU	Limit of Uranium, µg/gU
Aluminum	50	
Barium	5	
Beryllium	100	
Bismuth	3	
Calcium + magnesium	100	
Carbon	100	
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	