



Standard Specification for Nuclear-Grade Gadolinium Oxide (Gd_2O_3) Powder¹

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1. Scope

1.1 This specification provides the chemical and physical requirements for nuclear-grade gadolinium oxide powder intended for subsequent processing and use in nuclear fuel applications, for example, as an addition to uranium dioxide.

1.2 This specification does not include requirements for health and safety. Observance of this specification does not relieve the user of the obligation to be aware of and comply with all federal, state, and local regulations pertaining to possessing, shipping, processing, or using this material.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 ASTM Standards:²

B329 Test Method for Apparent Density of Metal Powders and Compounds Using the Scott Volumeter

C493 Test Method for Bulk Density and Porosity of Granular Refractory Materials by Mercury Displacement (Discontinued 2002) (Withdrawn 2002)³

C859 Terminology Relating to Nuclear Materials

C889 Test Methods for Chemical and Mass Spectrometric Analysis of Nuclear-Grade Gadolinium Oxide (Gd_2O_3) Powder

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E105 Practice for Probability Sampling of Materials

¹ This specification is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.03 on Neutron Absorber Materials 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 The last approved version of this historical standard is referenced on www.astm.org.

2.2 ANSI Standard:

ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications⁴

2.3 U.S. Government Document:

Code of Federal Regulations, Title 10, Part 50 Energy (10 CFR 50), Domestic Licensing of Production and Utilization Facilities⁵

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 Terms shall be defined in accordance with Terminology **C859** except as defined herein.

3.1.1.1 *buyer*—the organization issuing the purchase order.

3.1.1.2 *powder lot*—a quantity of gadolinium oxide powder that has been processed in a manner such that samples taken in accordance with the procedures of **8.1** can be considered as representative of the entire powder lot.

3.1.1.3 *seller*—the gadolinium oxide powder supplier.

4. Ordering Information

4.1 The buyer shall specify the following information for all orders where this specification applies:

4.1.1 Powder lot size (allowable range),

4.1.2 Quantity (weight of delivered product),

4.1.3 Nominal particle size range and applicable tolerances in accordance with Specification **E11**,

4.1.4 Density (optional), Scott Volumeter (Test Method **B329**) and Mercury Displacement (Test Method **C493**) are referenced as guides to density measurement techniques,

4.1.5 Shape factor and method of determination (optional),

4.1.6 Sampling requirements,

4.1.7 Crystal structure (optional), and

4.1.8 Quality requirements.

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

⁵ 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>.

5. Chemical Composition

5.1 *Loss-on-Ignition*—The loss-on-ignition as determined after ignition for 2 h at a minimum temperature of 900°C shall not exceed 1.5 weight %.

5.2 *Gadolinium Oxide Concentration*—The minimum Gd_2O_3 concentration shall be 99.8 weight % exclusive of the constituents lost on ignition as determined by Test Methods C889.

5.2.1 *Gadolinium Oxide Isotope Concentration*—The isotopic concentration of the gadolinium shall be that which is found in naturally occurring gadolinium for the following isotopes:

Isotope	Atomic %
^{155}Gd	14.9 ± 1.0
^{157}Gd	15.7 ± 1.0

5.3 Impurity Content:

5.3.1 *Individual Impurity Limits*—Individual impurities exclusive of constituents lost on ignition shall not exceed the following limits:

Element	Maximum Concentration ($\mu g/g Gd_2O_3$)
Boron	5
Cadmium	25
Thorium	30
(Chlorine + fluorine)	100
(Europium + samarium + terbium + ytterbium + dysprosium)	1000
Carbon	600

5.3.2 The buyer may specify individual impurity limits for any elements not listed in 5.3.1. Any identified impurity exceeding 1000 $\mu g/g Gd_2O_3$ shall be reported. The total of all measured impurities shall not exceed 2000 $\mu g/g Gd_2O_3$.

6. Physical Properties

6.1 Physical properties listed in 4.1.3, 4.1.4, 4.1.5, and 4.1.7 shall be in compliance with the buyer's requirements.

7. Cleanliness

7.1 The lot shall be processed and packaged in a manner that precludes contamination by dust, organics, plastics, or other foreign materials.

8. Sampling

8.1 Sampling plans to meet acceptance criteria and inspection and measurement procedures that describe the method of compliance with this specification shall be approved by the buyer. The degree of sampling where not specified in this document varies with the application and therefore should be specified on the purchase order. Recommended Practice E105 is referenced as a guide.

8.2 Each sample taken shall be sufficient to perform the following in the event they are necessary or desired by the buyer:

- 8.2.1 Quality verification tests by the seller,
- 8.2.2 Acceptance tests by the buyer,
- 8.2.3 Referee tests, in the event these become necessary, and
- 8.2.4 Retention of archive samples by the seller.

8.3 Archive samples shall be retained for a period of time specified by the buyer and delivered to the buyer upon request.

9. Inspection and Certification

9.1 The seller shall inspect the material covered by this specification and shall provide the buyer with certificates of tests showing the results of all testing and inspection performed on each lot.

9.2 The seller shall deliver all test certificates to the buyer prior to or concurrent with the shipment of the powder lot.

10. Rejection and Rehearing

10.1 Unless the buyer and seller agree otherwise, rejection and acceptance shall be on a lot basis.

10.2 Powder lots that fail to conform to the requirements of this specification may be rejected by the buyer. The seller may petition the buyer to waive selected requirements for identified out-of-specification lots. The decision to grant such waiver belongs to the buyer. The seller shall obtain the buyer's approval, prior to use, of any remedy proposed to bring rejected lots into specification.

10.3 In the event of disagreement over the results of chemical analyses, samples shall be submitted to a mutually selected referee for resolution.

11. Packaging and Package Marking

11.1 Gadolinium oxide powder shall be packaged in sealed containers to prevent loss, damage, or contamination of the powder from airborne or container materials. The exact size and type of packaging shall be as mutually agreed upon by the buyer and the seller.

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

- 11.2.1 Material in container (gadolinium oxide powder),
- 11.2.2 Specification number,
- 11.2.3 Purchase order number,
- 11.2.4 Powder lot number,
- 11.2.5 Gross, net, and tare weights,
- 11.2.6 Name of seller, and
- 11.2.7 Container, numbered to identify individual container and total quantity of containers in shipment.

12. Quality Assurance

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

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