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Standard Specification for Nuclear-Grade Aluminum Oxide Powder¹

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1. Scope

1.1 This specification provides the chemical and physical requirements for nuclear-grade aluminum oxide powder intended for fabrication into shapes for nuclear applications. Two specific uses for which this powder is intended are Al_2O_3 pellets and $\text{Al}_2\text{O}_3 - \text{B}_4\text{C}$ composite pellets for use as thermal insulator or burnable neutron absorbers, respectively.

1.2 The material described herein shall be particulate in nature.

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

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[C809 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Aluminum Oxide and Aluminum Oxide-Boron Carbide Composite Pellets](#)

[C859 Terminology Relating to Nuclear Materials](#)

[E105 Guide for Probability Sampling of Materials](#)

2.2 *ANSI Standard:*

[ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications](#)³

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 Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

2.3 *U.S. Government Document:*

[Code of Federal Regulations, Title 10, Part 50—Energy \(10CFR 50\), Domestic Licensing of Production and Utilization Facilities](#)⁴

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 *buyer*—organization issuing the purchase order.

3.1.3 *powder lot*—that quantity of aluminum oxide powder made up of powder from one or more sources, blended together and homogenized such that samples taken in accordance with the procedures in Section 8 can be considered as representative of the entire quantity.

3.1.4 *seller*—aluminum oxide manufacturer.

4. Ordering Information

4.1 The buyer shall specify the following information on the order:

4.1.1 Quantity (weight of delivered product),

4.1.2 Lot size (allowable range),

4.1.3 Sample requirements, and

4.1.4 Additional requirements.

5. Chemical Composition

5.1 The powder shall conform to the following chemical requirements (see Methods C809):

Element	Weight %, max
Silicon	2.0
Iron-Chromium-Nickel	0.6
Magnesium	1.0
Sodium	0.2
Calcium	0.3
Hafnium	200 $\mu\text{g/g Al}_2\text{O}_3$
Fluorine	50 $\mu\text{g/g Al}_2\text{O}_3$
Fluorine-Chlorine-Iodine-Bromine	100 $\mu\text{g/g Al}_2\text{O}_3$
Gadolinium	100 $\mu\text{g/g Al}_2\text{O}_3$
Samarium	100 $\mu\text{g/g Al}_2\text{O}_3$
Europium	100 $\mu\text{g/g Al}_2\text{O}_3$
Dysprosium	200 $\mu\text{g/g Al}_2\text{O}_3$

5.2 The impurities listed in 5.1, and any other identified impurity exceeding 1.0 weight % and the total concentration of

⁴ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, D.C., 20401.

all impurities, shall be reported. The total of all measured impurities shall not exceed 4.0 weight %.

5.3 Loss-on-Ignition—The test method and acceptance limits for loss-on-ignition shall be agreed upon between the buyer and the seller.

NOTE 1—The buyer may specify limits for any other elements (for example, neutron absorbing materials, such as boron) not listed in 5.1.

6. Physical Requirements

6.1 The particle size distribution shall have a mean value of 6 µm or less. The particle size distribution will be determined utilizing a method approved by the buyer.

6.2 *Specific Surface Area*—The test method and acceptance limits for specific surface area shall be agreed upon between the buyer and the seller.

7. Cleanliness

7.1 The powder lot shall be handled in a manner to avoid contamination by foreign matter such as dust, cleaning agents and organics, and materials, such as plastics and paper, used in packaging. Cleaning solutions, if used, shall be free of halides and nonvolatile additives and shall be removed from the powder prior to sampling and packaging.

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 specification, varies with the application and for this reason should be specified on the purchase order. Practice E105 is referenced as a guide.

8.2 Each sample taken shall be sufficient for quality control tests, acceptance tests, referee tests, and archive samples as necessary or desired by the buyer.

9. Inspection and Certification

9.1 The seller shall inspect the material covered by this specification and shall furnish the buyer with certificates of test and inspection results performed on each powder lot. The certificates shall include the following:

9.1.1 Identity of the lot,

- 9.1.2 Individual and total impurities,
- 9.1.3 Particle size distribution and mean value,
- 9.1.4 Specific surface area, and
- 9.1.5 A statement that each powder lot is in compliance with the provisions of this specification.

10. Rejection and Rehearing

10.1 Unless the buyer and seller agree otherwise, rejection and acceptance shall be on a powder 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. Decision to grant such waiver belongs to the buyer. The buyer shall approve, prior to use, 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 Aluminum oxide powder shall be packaged in sealed containers to prevent loss or damage or contamination, 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 be clearly marked with the following:

- 11.2.1 Aluminum oxide powder,
- 11.2.2 Purchase order number,
- 11.2.3 Purchase order Specification,
- 11.2.4 Gross, net, and tare weight,
- 11.2.5 Lot number,
- 11.2.6 Name of seller, and
- 11.2.7 Container () of ().

12. Quality Assurance

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

13. Keywords

13.1 aluminum oxide; powder

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