



# Standard Specification for Nuclear-Grade Aluminum Oxide Pellets<sup>1</sup>

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## 1. Scope

1.1 This specification applies to pellets of aluminum oxide that may be ultimately used in a reactor core, for example, as filler or spacers within fuel, burnable poison, or control rods. In order to distinguish between the subject pellets and “burnable poison” pellets, it is established that the subject pellets are not intended to be used as neutron-absorbing material.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

C 559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles

C 809 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Aluminum Oxide and Aluminum Oxide-Boron Carbide Composite Pellets

C 859 Terminology Relating to Nuclear Materials

E 105 Practice for Probability Sampling Of Materials

### 2.2 ANSI Standard:

ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications<sup>3</sup>

### 2.3 U.S. Government Document:

Code of Federal Regulations, Title 10, Part 50, Energy (10CFR50) Domestic Licensing of Production and Utilization Facilities<sup>4</sup>

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

<sup>4</sup> 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. Terminology

3.1 *Definitions*—Terms shall be defined in accordance with Terminology C 859 except for the following:

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *buyer*—organization issuing the purchase order.

3.2.2 *pellet*—fabricated geometric shape of aluminum oxide having a chemical composition as described in Section 4.

3.2.3 *pellet lot*—that quantity of pellets produced from one aluminum oxide powder lot using one set of process parameters whose limits have been agreed upon between the seller and the buyer.

3.2.4 *powder lot*—a specified quantity of aluminum oxide powder made up of powders from one or more sources, blended together such that samples taken in accordance with 7.1 can be considered as representative of the entire specified quantity.

3.2.5 *seller*—aluminum oxide pellet supplier.

## 4. Chemical Composition

4.1 Use analytical chemistry methods in accordance with Methods C 809 or alternate methods agreed upon between the buyer and the seller.

4.2 The finished aluminum oxide pellets shall conform to the following chemical analysis:

B <sub>2</sub> O <sub>3</sub> + boric acid	0.01 weight % max
Si	2.0 weight % max
Fe + Cr + Ni	0.6 weight % max
Mg	1.0 weight % max
Na	0.2 weight % max
Ca	0.3 weight % max
Hf	200 µg/g pellet max
F	50 µg/g pellet max
F + Cl + I + Br	100 µg/g pellet max

Any element impurity not listed in 4.2 shall not exceed 1 weight % as determined by emission spectroscopy. The sum of all impurities shall not exceed 4.0 weight %.

4.2.1 The total equivalent boron content (EBC) of the finished aluminum oxide pellets shall not exceed 400 mg/g on a pellet weight basis. The total EBC is the sum of the individual EBC values. Table 1 is a list of elements to be considered in calculating the total EBC. The EBC of each impurity element shall be calculated individually using the following equation:

$$\text{EBC of impurity} = (\text{EBC factor}) \times (\text{mg of impurity/g pellet}) \quad (1)$$

4.2.2 Should the EBC of additional elements not listed in **Table 1** be of concern, their inclusion in the summation and their respective EBC factors must be mutually agreed upon by the buyer and the seller.

4.2.3 The hydrogen impurity (including moisture) level, detailed procedure for measuring hydrogen, and packaging requirements associated with hydrogen contamination, shall be agreed upon between the buyer and the seller.

## 5. Physical Properties

### 5.1 *Physical Dimensions:*

5.1.1 Dimensional requirements shall be in accordance with applicable drawings and purchase order documents.

5.1.2 Pellet dimensions shall be measured to ensure compliance with the buyer's requirements. Sampling plans to meet acceptance criteria shall be agreed upon between the buyer and the seller to ensure that the pellets represented by the sample are within the required tolerances.

### 5.2 *Density:*

5.2.1 Pellet density limits shall be specified by the buyer.

5.2.2 The method of density measurement shall be Test Method **C 559** or an alternative method approved by the buyer prior to use. Sampling plans to meet acceptance criteria shall be agreed upon between the seller and the buyer. The method of density measurement and the method of compliance with **5.2.1** shall be approved by the buyer prior to use.

5.3 *Mechanical Properties*—Required mechanical properties and test methods shall be mutually agreed upon between the buyer and the seller.

5.4 *Visual Appearance*—Visual examination shall be conducted on finished pellets in accordance with Section 7. The seller and the buyer shall agree on visual standards as representing the requirements of **5.4.1**, **5.4.2**, and **5.4.3**. These standards shall be used as acceptance standards for the visual examination of the pellets. In the event of a dispute, the method of defect measurement shall be submitted by the seller for approval by the buyer. Maximum permissible defects are defined as follows:

5.4.1 *End Chips*—Pellet end surface shall not be chipped beyond 10 % of the end-face surface area and no chip shall exceed 1.0 mm (0.040 in.) in depth.

5.4.2 *Circumferential Chips*—Pellet circumferential surfaces shall not be chipped beyond 5 % of the circumferential surface area. No single chip shall exceed a depth of 1.0 mm (0.040 in.).

5.4.3 *Cracks*—No single crack shall exceed 90° of circumference in length.

5.4.4 Fissures and other defects shall be evaluated with respect to the criteria of **5.4.1**, **5.4.2**, and **5.4.3**.

## 6. Cleanliness

6.1 The finished pellets shall be handled in a manner to avoid contamination by grinding fluids and dust, cleaning agents, and organic materials such as plastics and paper used in packaging. Cleaning solutions, if used, shall be free of halides or nonvolatile additives and shall be removed from the pellets prior to sampling and packaging.

## 7. Sampling

7.1 Sampling plans to meet acceptance criteria and inspection and measurement procedures that describe the method of compliance with this specification shall be established by the seller and shall be approved by the buyer prior to use. The degree of sampling shall be specified in the purchase order. Practice **E 105** is referenced as a guide.

7.2 Each sample taken shall be sufficient for quality verification tests, acceptance tests and archive samples, as needed.

7.3 Archive samples shall be retained and disposed in accordance with the buyer's instructions.

## 8. Inspection and Certification

8.1 The seller shall inspect the material covered by this specification and shall furnish the buyer with certificates of tests showing the results of testing and inspection performed on each pellet lot prior to shipment. The seller shall certify that each pellet lot is in compliance with the provisions of this specification.

## 9. Rejection

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

9.2 Pellet 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 seller may also apply any remedy to bring rejected lots into specification providing the seller can demonstrate to the buyer that such remedy does not impair the function or preclude the certification of the rejected material.

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

## 10. Packaging and Shipping

10.1 The pellets shall be packaged in sealed containers for shipment from the seller to the buyer. The seller shall be responsible for using the shipping container to assure the pellets arrive still in conformance with this specification, and to assure reasonable ease of unpacking.

10.2 Each container shall be clearly marked with the following:

- 10.2.1 Aluminum oxide pellets,
- 10.2.2 Purchase order number,
- 10.2.3 Gross, tare, and net weights,
- 10.2.4 Lot number, and
- 10.2.5 Name of manufacturer.

## 11. Quality Assurance

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

## 12. Keywords

12.1 Al<sub>2</sub>O<sub>3</sub>; aluminum oxide; filler pellets; spacer pellets; spacers

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