



Designation: C 1098 – 93

## Standard Specification for Nuclear-Grade Hafnium Oxide Powder<sup>1</sup>

This standard is issued under the fixed designation C 1098; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification defines the physical and chemical requirements for hafnium oxide powder intended for fabrication into shapes for use in a nuclear reactor core.

1.2 The material described herein shall be particulate in nature.

1.3 The values stated in SI units are to be regarded as the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

C 117 Test Method for Materials Finer Than 75- $\mu\text{m}$  (No. 200) Sieve in Mineral Aggregates by Washing<sup>2</sup>

C 371 Test Method for Wire-Cloth Sieve Analysis of Non-plastic Ceramic Powders<sup>3</sup>

C 859 Terminology Relating to Nuclear Materials<sup>4</sup>

E 11 Specification for Wire-Cloth Sieves for Testing Purposes<sup>5</sup>

E 105 Practice for Probability Sampling of Materials<sup>5</sup>

#### 2.2 ANSI/ASME Standard:

NQA-1 Quality Assurance Program Requirements for Nuclear Facilities<sup>6</sup>

#### 2.3 U.S. Government Standard:

Code of Federal Regulations, Title 10, Part 50, Energy (10 CFR 50), Domestic Licensing of Production and Utilization Facilities<sup>7</sup>

### 3. Terminology

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

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

3.3 *hafnium oxide powder*—hafnium oxide that contains no hard aggregates larger than 20 mesh (840  $\mu\text{m}$ ).

3.4 *phase transformation*—the rearrangement of the atomic ordering of a crystalline lattice as material is cycled through a critical transformation or inversion temperature; the change from one crystalline phase to another may be accompanied by a volume change that could lead to cracks or defects in products fabricated from such materials.<sup>8,9</sup>

3.5 *powder lot*—a specified quantity of hafnium oxide powder (with stabilizing additive, if applicable) blended together such that samples taken in accordance with the procedures of Section 8 can be considered as representative of the entire quantity.

3.6 *seller*—the hafnium oxide powder processor.

3.7 *stabilizing additive*—material which, when added in sufficient concentration to the subject material exhibiting the phase transformation, produces a stabilized crystalline phase that does not undergo a transformation at any temperature within the expected fabrication or usage regime of the manufactured product; the potentially deleterious volume change is therefore avoided.

### 4. Ordering Information

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

4.1.1 Quantity (weight of delivered product).

4.1.2 Nominal particle size, particle size range, and applicable tolerances. Test Method C 371 and Test Method C 117 and Specification E 11 may be applied for particles larger than 37  $\mu\text{m}$ . For particle sizes less than 37  $\mu\text{m}$ , the particle size distribution will be determined using a method agreed upon between the buyer and the seller.

4.1.3 *Stabilizing Additive*—The amount and types of stabilizing additives (if any, including limits).

4.1.4 Lot size.

4.1.5 Sampling requirements.

### 5. Chemical Composition

5.1 A stabilizing additive may be utilized with the hafnium oxide. The recommended stabilizing additive is yttrium oxide

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C-26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.03 on Neutron Absorber Materials Specifications.

Current edition approved April 15, 1993. Published June 1993. Originally published as C 1098 – 88. Last previous edition C 1098 – 88.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 12.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>6</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

<sup>7</sup> Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

<sup>8</sup> Curtis, C. E., Doney, L. M., and Johnson, J. R., "Some Properties of Hafnium Oxide, Hafnium Silicate, Calcium Hafnate, and Hafnium Carbide," *Journal of American Ceramic Society*, Vol 37, 1954, pp. 458–465.

<sup>9</sup> Brown, L. M., and Mazdiyasi, K. S., "Characterization of Alkoxy-Derived Yttria-Stabilized Hafnia," *Journal of American Ceramic Society*, Vol 53, 1970, pp. 590–594.