Designation: C751 – 16

Standard Specification for Nuclear-Grade Boron Carbide Pellets[1]

This standard is issued under the fixed designation C751; 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.

1. Scope

1.1 This specification applies to boron carbide pellets for use as a control material in nuclear reactors.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles

C750 Specification for Nuclear-Grade Boron Carbide Powder

C791 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Boron Carbide

C859 Terminology Relating to Nuclear Materials

E105 Practice for Probability Sampling of Materials

2.2 *ANSI Standard:*

ANSI/ASME NQA-1 Quality Assurance Program Requirements for Nuclear Facilities[3]

2.3 *U.S. Government Document:*

Title 10, CFR, Energy Part 50 (10 CFR 50) Licensing of Domestic Production and Utilization Facilities[4]

3. Terminology

3.1 Terms shall be defined in accordance with Terminology C859 or ASTM Dictionary of Engineering Science and Technology, except for the following:

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

3.3 *pellet lot*—quantity of pellets produced from one boron carbide powder lot using one set of process parameters. The pellet lot size shall be agreed upon between seller and buyer.

3.4 *powder lot*—a fixed quantity of boron carbide powder blended together such that samples taken in accordance with Section 7 on Sampling can be considered as representative of the entire fixed quantity.

3.5 *seller*—boron carbide pellet supplier.

4. Chemical Composition

4.1 The starting boron carbide powder used to produce these pellets shall be in accordance with Specification C750.

4.2 Analytical chemistry methods used to test pellets for conformance with this specification shall be those of Method C791 or demonstrated equivalent methods agreed upon between buyer and seller.

4.3 The ^{10}B concentration (gram ^{10}B per unit volume or grams ^{10}B per unit length) may be specified by the buyer. The buyer should consider the following in specifying the allowable range in ^{10}B concentration:

4.3.1 Variations in chemical composition,

4.3.2 Bulk pellet density,

4.3.3 Boron isotopic composition, and

4.3.4 Pellet dimensions.

4.4 The finished boron carbide pellets shall conform to the chemical analysis in Table 1.

[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, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from U.S. Government Printing Office, Washington, DC 20402.

TABLE 1 Chemical Analysis of Finished Boron Carbide Pellets

Constituent	Limits
Total boron (B)	81.0 % weight, max
	73.0 % weight, min
Nitric acid-soluble boron (B)	0.5 % weight, max
Water-soluble boron (B)	0.2 % weight, max
Calcium (Ca)	0.3 % weight, max
Iron (Fe)	1.0 % weight, max
Total boron + total carbon (B+C)	98.0 % weight, min
Fluoride (F)	25 µg/g, max
Chloride (Cl)	75 µg/g, max
Water	750 µg/g, max[A]

[A]Ultimate usage of the pellets in a control rod may require drying to a lower moisture level.

5. Physical Requirements

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.

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 C559 or an alternative method approved by the buyer. Sampling plans to meet the acceptance criteria shall be agreed upon between the buyer and the seller. The method of density measurement and the method of compliance with 5.2.1 shall be approved by the buyer.

5.3 *Visual Appearance*—Visual examination shall be conducted on finished pellets in accordance with Section 7 on Sampling. As soon as practical after finished pellets are available, the seller and buyer shall jointly select two sets of visual standards for defining the requirements of 5.3.1, 5.3.2, and 5.3.3. One set of standards shall be used each by the seller and buyer as an acceptance standard in the visual examination of the pellets. The method of measurement of defects in case of a dispute shall be approved by the buyer. Maximum permissible defects are defined as follows:

5.3.1 *End Chips*—Pellet end surfaces shall not be chipped beyond 10 % of the end-face surface area, and no chip shall exceed 1.02 mm (0.040 in.) in depth.

5.3.2 *Circumferential Chips*—Pellet circumferential surfaces shall not be chipped beyond 5 % of the circumferential surface area. No single chip shall exceed a depth of 1.02 mm (0.040 in.).

5.3.3 *Cracks*—Individual cracks not exceeding 90° of circumference in length are acceptable provided other requirements of the specification are met. Acceptable number of cracks shall be specified by the buyer.

5.3.4 Fissures and other defects shall be evaluated with respect to the criteria of 5.3.1, 5.3.2, and 5.3.3.

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

6. Cleanliness

6.1 Finished pellets shall be handled in a manner to avoid contamination by grinding fluids and dust, 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 approved by the buyer prior to manufacture of the required pellets. The degree of sampling varies with the application and for this reason should be specified in the purchase order. Practice E105 is referenced as a guide.

7.2 Powder and pellet samples taken shall be sufficient, as necessary, for quality verification tests, acceptance tests, referee tests, and the retention of archive samples.

7.3 Archive samples shall be retained and disposed of 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 and Rehearing

9.1 Unless buyer and 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 buyer shall approve, prior to use, any remedy proposed to bring rejected lots into specification.

9.3 In the event of disagreement over the results of analyses, 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 ensure the pellets arrive still in conformance with this specification.

10.2 Each container shall be clearly marked with the following: Boron carbide pellets, purchase order number, gross, net, and tare weights, lot number, and name of seller.

11. Quality Assurance

11.1 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 ASTME NQA-1 are referenced as guides.

12. Keywords

12.1 Boron carbide pellets; B_4C neutron absorber; control material