Designation: C 750 – 03

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

This standard is issued under the fixed designation C 750; 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 defines the chemical and physical requirements for boron carbide powder intended for a variety of nuclear applications. Because each application has a different need for impurity and boron requirements, three different chemical compositions of powder are specified. In using this specification, it is necessary to dictate which type of powder is intended to be used. In general, the intended applications for the various powder types are as follows:

1.1.1 *Type 1*—For use as particulate material in nuclear reactor core applications.

1.1.2 *Type 2*—Powder that will be further processed into a fabricated shape for use in a nuclear reactor core or used in non-core applications when the powder directly or indirectly may cause adverse effects on structural components, such as halide stress corrosion of stainless steel.

1.1.3 *Type 3*—Powder that will be used for non-core applications or special in-core applications.

2. Referenced Documents

2.1 *ASTM Standards:*

B 329 Test Method for Apparent Density of Powders of Refractory Metals and Compounds by the Scott Volumeter[2]

C 117 Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing[3]

C 371 Test Method for Wire-Cloth Sieve Analysis of Nonplastic Ceramic Powders[4]

C 493 Test Method for Bulk Density and Porosity of Granular Refractory Materials by Mercury Displacement[5]

C 791 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Boron Carbide[6]

C 859 Terminology Relating to Nuclear Materials[6]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[7]

E 105 Practice for Probability Sampling of Materials[7]

2.2 *ANSI Standard:*

ANSI/ASME NQA-1 Quality Assurance Program Requirements for Nuclear Facilities[8]

2.3 *U.S. Government Document:*

Title 10, Code of Federal Regulations, Energy Part 50 (10CFR 50), Domestic Licensing of Production and Utilization Facilities[9]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard*—Terms shall be defined in accordance with Terminology C 859 except for the following:

3.1.1 *buyer*—organization issuing the purchase order.

3.1.2 *powder lot*—that quantity of boron carbide powder blended together such that samples taken in accordance with the procedures of 8.1 can be considered as representative of the entire powder lot.

3.1.3 *seller*—boron carbide powder supplier.

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 tolerance.

4.1.3 Density and method of measurement.

4.1.4 Angular or spherical shape.

4.1.5 Shape factor.

4.1.6 Lot size.

4.1.7 Sampling requirements.

4.1.8 Powder type (1, 2, or 3).

4.1.9 Isotopic content (^{10}B).

5. Chemical Composition

NOTE 1—B_4C powder is hygroscopic and certain applications require low-moisture content.

[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.

Current edition approved July 10, 2003. Published August 2003. Originally approved in 1974. Last previous edition edition approved in 1997 as C 750 – 89(1997).

[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 15.02.

[5] *Annual Book of ASTM Standards*, Vol 15.01.

[6] *Annual Book of ASTM Standards*, Vol 12.01.

[7] *Annual Book of ASTM Standards*, Vol 14.02.

[8] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[9] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

5.1 The material shall conform to the chemical composition requirements prescribed in Table 1 (see Methods C 791).

5.2 When agreed upon between the buyer and the seller, the weight loss of the powder shall not exceed 1 % when heated at 110°C for 1 h in air.

6. Physical Requirements

6.1 The nominal particle size, particle size range, and applicable tolerances shall be agreed upon between the buyer and the seller. Method C 371, Test Method C 117, and Specification E 11 may be applied for particles larger than 37 µm. For particles smaller than 37 µm, the particle size distribution will be determined utilizing a method submitted by the seller for approval by the buyer.

6.2 The density shall be determined when specified. The Scott Volumeter (Test Method B 329) or Mercury Displacement (Test Method C 493) are approved methods. The recommended value to be used for the theoretical density of stoichiometric B_4C of natural isotopic content is 2.52 g/cm^2.

6.3 When specified, the angular or spherical shape shall be determined utilizing a method agreed upon between the buyer and the seller.

6.4 When specified, the shape factor shall be determined utilizing a method agreed upon between the buyer and the seller.

7. Cleanliness

7.1 The lot shall be handled 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 established by the seller and submitted to the buyer for approval. The degree of sampling, where not specified in this specification, varies with the application and for this reason should be specified in the purchase order. Recommended Practice E 105 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 control tests,

8.2.2 Acceptance tests,

8.2.3 Referee tests,and

8.2.4 Retention of archive samples by the seller.

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

TABLE 1 Chemical Requirements

Constituent	Composition, Weight %[A]		
	Type 1	Type 2	Type 3
Total boron[B]	81.0 max 76.5 min	81.0 max 73.0 min	81.0 max 70.0 min
HNO_3-soluble boron	0.5 max	0.6 max	not determined
Water soluble boron	0.2 max	0.2 max	1.0 max
Fluoride	25 µg/g max	25 µg/g max	not determined
Chloride	75 µg/g max	75 µg/g max	not determined
Calcium	0.3 max	0.3 max	not determined
Iron	1.0 max	1.0 max	2.0 max
Total boron plus total carbon	98.0 min	97.0 min	94.0 min

[A] Unless otherwise indicated (percentages based on a dry weight of boron carbide).

[B] Unless otherwise specified, the ^{10}B isotopic content in the boron shall be 19.90 ± 0.3 atom % for Types 1 and 2 and 19.90 ± 0.5 atom % for Type 3.

9. Inspection and Certification

9.1 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 for each powder lot prior to shipment. The seller shall certify that each powder lot is in compliance with the provisions of this specification.

10. Rejection

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 analysis, samples shall be submitted to a mutually selected referee for resolution.

11. Packaging and Package Marking

11.1 The powder shall be packaged in sealed containers for shipment from the seller to the buyer. The seller will be responsible for designing the shipping container to ensure cleanliness, minimize moisture pickup, provide adequate protection against damage during transportation, and ensure reasonable ease of unpackaging.

11.2 Each container shall be clearly marked with the following: boron carbide powder, powder type (1, 2, or 3), purchase order number, purchase order specification, gross net and tare weights, lot number, and name of seller.

12. Quality Assurance

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