Designation: ~~C992 – 11~~ C992 – 16

Standard Specification for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear ~~Spent~~ Fuel Storage Racks in a Pool Environment[1]

This standard is issued under the fixed designation C992; 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 criteria for boron-based neutron absorbing material systems used in racks in a pool environment for storage of nuclear light water reactor (LWR) spent-fuel assemblies or disassembled components to maintain sub-criticality in the storage rack system.

1.2 Boron-based neutron absorbing material systems normally consist of metallic boron or a chemical compound containing boron (for example, boron carbide, B_4C) supported by a matrix of aluminum, steel, or other materials.

1.3 In a boron-based absorber, neutron absorption occurs primarily by the boron-10 isotope that is present in natural boron to the extent of 18.3 ± 0.2 % by weight (depending upon the geological origin of the boron). Boron, enriched in boron-10 could also be used.

1.4 The materials systems described herein shall be functional – that is always be capable to maintain a ~~B10~~boron-10 areal density such that subcriticality ~~Keff <0.95 or Keff <0.98 or Keff < 1.0~~ is maintained depending on the design specification for the service life in the operating environment of a nuclear spent fuel pool.

~~1.5 A number of acceptable boron-based absorbing materials combinations are currently available while others are being developed for use in the future. This specification defines criteria essential and applicable to all materials combinations and identifies parameters a buyer should specify to satisfy a unique or particular requirement.~~

1.5 ~~The scope of this specification does not comprehensively cover all provisions for preventing criticality accidents or requirements for health and safety.~~ Observance of this specification does not relieve the user of the obligation to conform to all applicable international, national, and local regulations.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications~~

~~B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate~~

~~C750 Specification for Nuclear-Grade Boron Carbide Powder~~

C859 Terminology Relating to Nuclear Materials

C1187 Guide for Establishing Surveillance Test Program for Boron-Based Neutron Absorbing Material Systems for Use in Nuclear Fuel Storage Racks In a Pool Environment

E105 Practice for Probability Sampling of Materials

[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 ~~Feb. 1, 2011~~Jan. 15, 2016. Published ~~February 2011~~February 2016. Originally approved in 1983. Last previous edition approved in ~~2006~~2011 as ~~C992 – 06.~~C992 – 11. DOI: ~~10.1520/C0992-11.~~10.1520/C0992-16.

[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.

E2971 Test Method for Determination of Effective Boron-10 Areal Density in Aluminum Neutron Absorbers using Neutron Attenuation Measurements

ASTM Dictionary of Engineering Science and Technology

2.2 *ANSI and ASME Standards:*[3]

ANSI ~~45.2.2~~N45.2.2 Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants

~~ANSI-ASME~~ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Application

2.3 *U. S. Government Documents:*[4]

10CFR50 Title 10, CFR, Energy Part 50 — Licensing of Production and Utilization Facilities

10CFR72 Title 10, CFR, Energy Part 72 — Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)

3. Terminology

3.1 Terms shall be defined in accordance with Terminology C859 or the ASTM Dictionary of Engineering Science and Technology

3.2 *Definitions of Terms Specific to This Standard:*

~~3.1.1 Terms shall be defined in accordance with Terminology C859 or the ASTM Dictionary of Engineering Science and Technology, except as defined as follows:~~

3.2.1 *accelerated testing*—a procedure for investigating the potential for long-term changes in physical properties or chemical composition of a material important to safety, caused by a system operating parameter such as temperature, chemical environment or radiation.

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

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

3.2.1.1 *Discussion*—

The procedure uses a value of the identified parameter that is outside the normal bound of the operating parameter being investigated, in order to (*1*) increase the rate of degradation, if any, (*2*) identify the operating limit for acceptable limit of the parameter, and (*3*) to provide information that might assist in interpreting the degradation mechanism(s) involved. In this manner, the long-term behavior of a material may be simulated in an appreciably shorter period of time.

3.2.2 *areal density*—the boron-10 per unit area of a sheet, which is equivalent to the mass per unit volume of boron-10 in the material multiplied by the thickness of the material in which that isotope is contained.

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

3.2.4 *degradation*—a change in a material property that lessens the original design functionality.

3.2.5 *individual piece*—a discrete section of neutron absorber material whose individual dimensions conform to those in the purchase specification.

3.2.6 *irradiation*—the incidence of neutron, gamma, and beta radiation from spent fuel assemblies on materials in a water-filled spent fuel pool.

3.2.7 *production batch*—a group of neutron-absorbing material pieces produced in a continuous production period, all of which can be shown to have the same chemical composition, physical, and nuclear properties within specification limits.

3.2.8 *seller*—the neutron absorbing system manufacturer.

3.2.9 *service life*—the period of time for which properties of the neutron-absorbing material system are expected to remain in compliance with the contract requirements which relate to ~~chemical and physical integrity.~~material functionality.

3.2.10 *supplier*—any outside source of raw materials and services used by the seller.

4. Ordering Information

4.1 The buyer should specify a material for which there is documented evidence that the neutron absorbing material system is capable of acceptable performance in the following environmental conditions to which the material is expected to be exposed:

4.1.1 Total service life of the neutron absorbing material system,

4.1.2 Maximum integrated irradiation over the total service life of the neutron absorbing material system, and

4.1.3 ~~Chemical and thermal environment of the water in the spent~~ Environment of the fuel pool in which the neutron absorbing material system will be ~~located.~~located, including consideration of normal operation and effects of anticipated operational occurrences.

4.2 The buyer shall specify the following ~~physical and chemical properties~~material properties and applicable tolerances of the neutron absorbing material system; this may include archive or in-service surveillance coupons: