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Standard Practice for Determining Equivalent Boron Contents of Nuclear Materials¹

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1. Scope

1.1 This standard details a recommended practice for the calculation of the Equivalent Boron Content (EBC) for nuclear materials. The EBC is used to provide a measure of the macroscopic neutron absorption cross section of a nuclear material. EBC factors for the natural elements are determined from their atomic masses and thermal neutron absorption cross sections. This practice is illustrated by using EBC factors that are based on thermal neutron (2200 m/s) absorption cross sections. Other EBC factors may be used depending upon the actual neutron energy spectrum.

1.2 The EBC is a characteristic of a homogeneous material. Characterization of inhomogeneous materials and calculation of neutron multiplication factors require techniques that are beyond the scope of this practice.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 ASTM Standards:²

C696 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Uranium Dioxide Powders and Pellets

C698 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Mixed Oxides ((U, Pu)O₂)

C761 Test Methods for Chemical, Mass Spectrometric, Spectrochemical, Nuclear, and Radiochemical Analysis of Uranium Hexafluoride

C799 Test Methods for Chemical, Mass Spectrometric, Spectrochemical, Nuclear, and Radiochemical Analysis of Nuclear-Grade Uranyl Nitrate Solutions

¹ This practice is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.02 on Fuel and Fertile Material 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. Methods For EBC Determination

3.1 Agreement shall be reached between the buyer and seller as to which elements shall be analyzed for calculation of their EBC. It is recommended that B, Cd, Dy, Eu, Sm, and Gd be included in this calculation. Analytical methods for such elements shall be those given in Test Methods C696, C698, C761, and C799 as applicable or as otherwise agreed upon between buyer and seller.

3.2 The individual EBC values are calculated using the EBC factors from Table 1 as follows:

$$EBC \text{ of constituent} = (EBC \text{ factor of constituent})(\mu\text{g of constituent} / \text{g of material})$$

where:

$$EBC \text{ factor of constituent} = (\text{atomic mass of boron})(\sigma_a \text{ of constituent}) / [(\text{atomic mass of constituent})(\sigma_a \text{ of boron})], \text{ and}$$
$$\sigma_a = \text{atomic neutron absorption cross section in barns.}$$

The EBC factors been calculated using a value of 764 barns for the neutron absorption cross section (σ_a) of boron. This value may vary in nature according to the isotopic composition of the elements. If an alternative value is chosen the EBC factors must be recalculated using the chosen value.

3.3 If the concentration of any of the elements used in the calculation is reported as “less than” values, these values shall be used in calculating the EBC.

3.4 A total EBC value, if required, is determined by the summation of individual EBC values.

3.5 Plutonium and uranium have not been included, as they are fissionable elements.

3.6 Table 1 includes elements that may provide a negligible contribution to the total EBC. In particular, elements with both small concentrations and very small EBC factors (less than 2E-4) will generally provide a negligible contribution to the EBC of the material as a whole. Such elements should be excluded from determinations of the total EBC.

4. Keywords

4.1 boron; neutron absorption; nuclear materials; nuclear poisons