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Standard Guide for Evaluation of Nuclear Graphite Surface Area and Porosity by Gas Adsorption Measurements¹

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1. Scope

1.1 The purpose of this Guide is to provide methodologic information specific to highly graphitized, low surface area materials used in the nuclear industry. It applies to nitrogen adsorption measurements at 77 K for the characterization of graphite pore structure, such as: (1) specific surface area; (2) cumulative volume of open pores (for pore sizes less than about 300 nm); and (3) distribution of pore volumes as a function of pore sizes (for pore sizes less than about 30 nm). These properties are related to graphite's reactivity in oxidative environments, graphite's ability to retain fission products, and gas transport through graphite's pore system.

1.2 Characterization of surface area (also known as the Brunauer-Emmett-Teller "BET" method) and porosity in nuclear graphite by gas adsorption is challenged by nuclear graphite's low specific surface area, weak adsorption interactions, and energetic and structural heterogeneity of surface sites in gas-accessible pores. This guide provides recommendations and practical information related to the nitrogen adsorption method, including guidance on specimen preparation, selection of experimental conditions, data processing, and interpretation of results.

1.3 Other porosity characterization methods used for nuclear graphite, such as krypton adsorption at 77 K, argon adsorption at either 77 K or 87 K, helium pycnometry (Test Method B923), and mercury intrusion porosimetry, are not in the scope of this guide.

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

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

¹ This guide is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

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1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

C1274 Test Method for Advanced Ceramic Specific Surface Area by Physical Adsorption

D3663 Test Method for Surface Area of Catalysts and Catalyst Carriers

D4641 Practice for Calculation of Pore Size Distributions of Catalysts and Catalyst Carriers from Nitrogen Desorption Isotherms

D4222 Test Method for Determination of Nitrogen Adsorption and Desorption Isotherms of Catalysts and Catalyst Carriers by Static Volumetric Measurements

D6556 Test Method for Carbon Black—Total and External Surface Area by Nitrogen Adsorption

D6761 Test Method for Determination of the Total Pore Volume of Catalysts and Catalyst Carriers

B923 Test Method for Metal Powder Skeletal Density by Helium or Nitrogen Pycnometry

2.2 ISO Standards:³

ISO 9227 Determination of the specific surface area of solids by gas adsorption – BET method (Second edition)

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *adsorbate, n*—the material retained by adsorption at the interface between a solid and a gas or liquid.

3.1.2 *adsorbent, n*—a solid material able to concentrate measurable quantities of other substances on its accessible surface, either external or in pores.

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 International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.