



Standard Practice for Testing Graphite Materials for Gas-Cooled Nuclear Reactor Components¹

This standard is issued under the fixed designation C781; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This practice covers the application and limitations of test methods for measuring the properties of graphite materials. These properties may be used for the design and evaluation of gas-cooled reactor components.

1.2 The test methods referenced herein are applicable to materials used for replaceable and permanent components as defined in Section 7 and includes fuel elements; removable reflector elements and blocks; permanent side reflector elements and blocks; core support pedestals and elements; control rod, reserve shutdown, and burnable poison compacts; and neutron shield material. Specific aspects with respect to testing of irradiated materials are addressed.

1.3 This practice includes test methods that have been selected from ASTM standards and guides that are specific to the testing of materials listed in 1.2. Comments on individual test methods for graphite components are given in Section 8. The test methods are summarized in Table 1.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered 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.*

1.6 *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.*

¹ This practice 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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2. Referenced Documents

2.1 ASTM Standards:²

- C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles
- C577 Test Method for Permeability of Refractories
- C611 Test Method for Electrical Resistivity of Manufactured Carbon and Graphite Articles at Room Temperature
- C625 Practice for Reporting Irradiation Results on Graphite
- C651 Test Method for Flexural Strength of Manufactured Carbon and Graphite Articles Using Four-Point Loading at Room Temperature
- C695 Test Method for Compressive Strength of Carbon and Graphite
- C747 Test Method for Moduli of Elasticity and Fundamental Frequencies of Carbon and Graphite Materials by Sonic Resonance
- C749 Test Method for Tensile Stress-Strain of Carbon and Graphite
- C769 Test Method for Sonic Velocity in Manufactured Carbon and Graphite Materials for Use in Obtaining an Approximate Value of Young's Modulus
- C816 Test Method for Sulfur Content in Graphite by Combustion-Iodometric Titration Method
- C838 Test Method for Bulk Density of As-Manufactured Carbon and Graphite Shapes
- C1039 Test Methods for Apparent Porosity, Apparent Specific Gravity, and Bulk Density of Graphite Electrodes
- C1179 Test Method for Oxidation Mass Loss of Manufactured Carbon and Graphite Materials in Air
- C1233 Practice for Determining Equivalent Boron Contents of Nuclear Materials
- C1274 Test Method for Advanced Ceramic Specific Surface Area by Physical Adsorption
- D346 Practice for Collection and Preparation of Coke Samples for Laboratory Analysis
- D1193 Specification for Reagent Water
- D2854 Test Method for Apparent Density of Activated Carbon

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.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Summary of Test Methods for Graphite Components

NOTE 1—Graphite Components include: Fuel, Removable Reflector and Core Support Elements; Pebble Bed Reflector, Key and Sleeves and Dowel Pins, Permanent Side Reflector Elements and Dowel Pins, Core Support Pedestals and Dowels.

	Test Method
Fabrication	
As Manufactured Bulk Density	C838
Mechanical Properties	
Compressive Strength	C695
Tensile Properties	C749
Poisson's Ratio	E132, C747
Flexural Strength	C651, D7972
Fracture Toughness	D7779
Modulus of Elasticity	C747, C769
Physical Properties	
Bulk Density—Machined Specimens	C559
Surface Area (BET)	C1274
Permeability	C577 ^{A,B}
Apparent Porosity	C1039
Spectroscopic Analysis	^B
Electrical Resistivity	C611
Thermal Properties	
Linear Thermal Expansion	E228 ^A
Thermal Conductivity	E1461 ^A
Chemical Properties	
Oxidative Mass Loss	C1179, D7542
Sulfur Concentration	C816
Equivalent Boron Content ^C	C1233 ^A

^A Modification of this test method is required. See Section 8 for details.

^B New test methods are required. See Section 8 for details.

^C There is no identified need for determining this property for core support pedestals and dowels.

D2862 Test Method for Particle Size Distribution of Granular Activated Carbon

D3104 Test Method for Softening Point of Pitches (Mettler Softening Point Method)

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4292 Test Method for Determination of Vibrated Bulk Density of Calcined Petroleum Coke

D5600 Test Method for Trace Metals in Petroleum Coke by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

D7219 Specification for Isotropic and Near-isotropic Nuclear Graphites

D7542 Test Method for Air Oxidation of Carbon and Graphite in the Kinetic Regime

D7775 Guide for Measurements on Small Graphite Specimens

D7779 Test Method for Determination of Fracture Toughness of Graphite at Ambient Temperature

D7846 Practice for Reporting Uniaxial Strength Data and Estimating Weibull Distribution Parameters for Advanced Graphites

D7972 Test Method for Flexural Strength of Manufactured Carbon and Graphite Articles Using Three-Point Loading at Room Temperature

D8186 Test Method for Measurement of Impurities in Graphite by Electrothermal Vaporization Inductively Coupled Plasma Optical Emission Spectrometry (ETV-ICP OES)

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E132 Test Method for Poisson's Ratio at Room Temperature

E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer

E261 Practice for Determining Neutron Fluence, Fluence Rate, and Spectra by Radioactivation Techniques

E639 Test Method for Measuring Total-Radiance Temperature of Heated Surfaces Using a Radiation Pyrometer (Withdrawn 2011)³

E1461 Test Method for Thermal Diffusivity by the Flash Method

E1269 Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry

E2716 Test Method for Determining Specific Heat Capacity by Sinusoidal Modulated Temperature Differential Scanning Calorimetry

3. Terminology

3.1 *Definitions*—Terminology D4175 shall be considered as applying to the terms used in this practice.

4. Significance and Use

4.1 Property data obtained with the recommended test methods identified herein may be used for research and development, design, manufacturing control, specifications, performance evaluation, and regulatory statutes pertaining to nuclear reactors that utilize graphite.

4.2 The referenced test methods are applicable primarily to specimens in the non-irradiated and non-oxidized state. Testing irradiated specimens often requires specimen geometries that

³ The last approved version of this historical standard is referenced on www.astm.org.