



Standard Specification for Packing Material, Graphitic, Corrugated Ribbon or Textured Tape, and Die-Formed Ring¹

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1. Scope

1.1 *Scope*—This specification covers various types, classes, and grades of flexible graphite material in which valve media temperatures are limited to a maximum of 966°C. Where this specification is invoked as ASTM F2168, Sections 1 – 18 apply. Where this specification is invoked as ASTM/DoD F2168, Sections 1 – 18 and the Supplementary Requirements apply.

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

1.3 *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

- C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles
- C561 Test Method for Ash in a Graphite Sample
- C816 Test Method for Sulfur Content in Graphite by Combustion-Iodometric Titration Method
- C889 Test Methods for Chemical and Mass Spectrometric Analysis of Nuclear-Grade Gadolinium Oxide (Gd₂O₃) Powder
- D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)
- D512 Test Methods for Chloride Ion In Water
- D1179 Test Methods for Fluoride Ion in Water

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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.

- D1246 Test Method for Bromide Ion in Water
- D3178 Test Methods for Carbon and Hydrogen in the Analysis Sample of Coal and Coke (Withdrawn 2007)³
- D3684 Test Method for Total Mercury in Coal by the Oxygen Bomb Combustion/Atomic Absorption Method (Withdrawn 2014)³
- D3761 Test Method for Total Fluorine in Coal by the Oxygen Bomb Combustion/Ion Selective Electrode Method (Withdrawn 2019)³
- D3951 Practice for Commercial Packaging
- D4239 Test Method for Sulfur in the Analysis Sample of Coal and Coke Using High-Temperature Tube Furnace Combustion

3. Terminology

3.1 Definitions:

3.1.1 *accordion crease, n*—because of the method of construction of die-formed rings, an accordion-like linear indication (crease) appear singularly or in multiple locations around the inside and outside diameter surface.

3.1.2 *corrosion inhibitors, n*—additives to the products to function in a passive or sacrificial manner to reduce galvanic corrosion. These additives are typically embedded zinc powder, phosphorus, or barium molybdate.

3.1.3 *corrugated ribbon, n*—graphite ribbon or tape that is subjected to mechanical pressure in a consistent manner to apply surface indentations to the tape or ribbon.

3.1.4 *density, n*—the mass per unit volume at a specified temperature.

3.1.5 *detrimental materials, n*—abrasive or chemically active constituents such as ash particles (in high ash content foils) or elemental materials that cause galvanic action or corrosion in long-term storage or service environments.

3.1.6 *die-formed ring, n*—a packing ring made by mechanically compacting winds of graphite ribbon or braided packing in a die or fixture.

3.1.7 *lot, n*—all finished packing of one size, type, class, and grade produced in a continuous run or at the same time under essentially the same conditions.

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

TABLE 1 Chemical and Physical Properties

Property	Value	Unit	Test
Density, bulk	as specified	kg/m ³	13.5
Ash	1 % by mass, max		13.3
Graphite purity	99 %, min		13.4

3.1.8 *set, n*—the packing components required to pack one valve.

3.1.9 *size, n*—the physical dimensions of the packing material.

4. Classification

4.1 *Classification*—The material shall be of the following types, classes, and grades as specified (see Section 5).

4.1.1 *Type I*—Corrugated ribbon or textured tape.

4.1.2 *Type II*—Die-formed ring.

4.1.3 *Class 1*—For use where detrimental material content of the packing need not be controlled beyond normal manufacturing limit (commercial grade).

4.1.4 *Class 2*—For use where detrimental material content shall be controlled to the limits specified herein.

4.1.5 *Grade A*—Treated with corrosion inhibitor.

4.1.6 *Grade B*—No corrosion inhibitor.

5. Ordering Information

5.1 Contracts or orders for the units under this specification shall include the following information:

5.1.1 Title, number, and date of this specification.

5.1.2 Type, class, and grade.

5.1.3 Type of corrosion inhibitor (see 6.1.3 and Supplementary Requirements).

5.1.4 Specify density of die-formed rings.

5.1.5 Inspection, testing, and certification of the material shall be agreed upon between the purchaser and the supplier as part of the purchase contract (see Sections 14 and 16).

5.1.6 When die-formed (Type II) packing rings are desired, the ring height, inside diameter, outside diameter, number of cuts, and number of packing rings required per set (see 9.2 and 9.3).

5.1.7 Marking requirements (see Section 17 and Supplementary Requirements).

5.1.8 Packaging requirements (see Section 18 and Supplementary Requirements).

5.1.9 Application data (to include operating pressure, operating temperature, and media).

5.1.10 Specify thickness of Type I.

6. Materials and Manufacture

6.1 *Material*—Requirements specified herein apply to Class 1 and Class 2 and Grade A and Grade B packing, except where noted.

6.1.1 *Type I*—The packing shall be made entirely of flexible graphitic material having no binders and meeting the requirements of Tables 1 and 2.

6.1.2 *Type II*—Die-formed packing rings shall be manufactured from flexible graphitic material conforming to the requirements of Tables 1 and 2.

TABLE 2 Detrimental Materials (Class 2 Only (See 13.6))

Element	Maximum Total Allowable Impurity Levels in Parts per Million (ppm)
Mercury (Hg)	10
Sulfur (S)	750
Total halogens (chlorine, bromine, and fluorine)	500
Chlorine (Cl)	250
Bromine (Br)	250
Fluorine (F)	250

6.1.3 Coating and Corrosion-Inhibiting Treatments:

6.1.3.1 *Grade A*—Grade A packing shall be provided with a powdered zinc active corrosion-inhibiting treatment or a passive inhibiting treatment such as phosphorous or barium molybdate, as specified (see Section 5). When the use of inhibitors is required, both passive and active inhibitors shall be permitted to be used.

6.1.3.2 *Grade B*—Grade B packing shall not contain corrosion-inhibiting additives.

6.1.4 *Mercury Exclusion*—During manufacturing, fabrication, handling, packaging, and packing, the packing material shall not come in contact with mercury or mercury containing compounds.

7. Properties

7.1 *Chemical and Physical Properties*—Unless otherwise specified, the properties of the finished packing shall conform to the requirements of Table 1. Class 2 also requires compliance with Table 2.

7.2 *Prohibited Additions*—There shall be no intentional additions of any of the detrimental materials of Table 2 or antimony (Sb), arsenic (As), bismuth (Bi), cadmium (Cd), gallium (Ga), indium (In), lead (Pb), mercury (Hg), silver (Ag), or tin (Sn) during the manufacturing, fabrication, handling, packaging, and packing of the product.

8. Other Requirements

8.1 No other requirements noted.

9. Dimensions, Mass, and Permissible Variations

9.1 *Type I Ribbon Packing*—Unless otherwise specified (see Section 5), the packing shall be uniformly coiled, spooled, or reeled in accordance with Table 3.

9.2 *Type II Die-Formed Packing*—Unless otherwise specified (see Section 5), the tolerances for Type II packing shall be in accordance with Table 4. The tolerance applies to finished rings before any cutting operations.

9.3 *Split Rings*—The number of cuts (zero, one, or two) shall be as specified (see Section 5). Cuts shall be made at approximately a 45° angle such that an overlapping joint is formed in the compressed state. When two cuts are required (separating the ring into two parts), the resulting parts shall be approximately the same dimension. When the number of cuts is not specified, single-cut rings shall be provided.

TABLE 3 Dimensions for Type I

Width	Length, min
6 ± 0.075 mm	7.62 m
12 ± 0.075 mm	7.62 m
18 ± 0.075 mm	15.24 m
25 ± 0.075 mm	15.24 m

10. Workmanship, Finish, and Appearance

10.1 *Workmanship*—The packing shall be free from extraneous material and visual defects that affect its serviceability, as defined in [Table 5](#).

11. Quality Assurance

11.1 *Quality Systems*—Manufacturers shall be prepared to document use of a quality system such as compliance with an ISO 9000 series program or similar program.

12. Specimen Preparation

12.1 *Specimen Preparation*—Buyer and seller shall agree on specimen preparation.

13. Test Methods

13.1 *Tests*—When tests are required as part of the purchasing requirements (see [5.1.5](#)), tests shall be made in accordance with the following methods or by way of alternate methods of analysis with equal or improved accuracy and precision. The use of an alternate analytical method requires the prior written consent of the purchasing party before acceptance will be allowed. Except for the corrosion-inhibiting treatment exceptions of [13.3](#) and [13.4](#), all testing shall be performed on final product after completion of all processing, including application of any binders and, if required, corrosion inhibitors.

13.2 *Size*—The size determined by measuring each sample selected for visual examination (see [Table 4](#)).

13.3 *Ash Content*—The ash content determined in accordance with Test Method [C561](#) (see [Table 1](#)). For Grade A packing only, the test shall be conducted before the corrosion-inhibiting treatment or the added mass of the corrosion inhibitor shall be determined and subtracted from the base mass of the sample.

13.4 *Graphite Purity*—The sample shall be dried to a constant mass at $149 \pm 3^\circ\text{C}$ before testing. For Grade A packing only, the test shall be conducted before the corrosion-inhibiting treatment or the added mass of the corrosion inhibitor shall be determined and subtracted from the base mass of the sample. The percent carbon shall be based upon mass of the dried sample. This determination shall be made in accordance with Test Methods [D3178](#) or an alternate method of analysis with equal or improved accuracy and precision (see [Table 1](#)).

13.5 *Bulk Density*—The bulk density of the Type I and Type II materials determined in accordance with Test Method [C559](#).

13.6 *Detrimental Material Tests*—For determination of the detrimental materials listed in [Table 2](#) for Class 2 only, the test methods of [Table 6](#) or alternate methods of equal or improved accuracy and precision shall be used.

14. Inspection and Testing

14.1 Inspection and testing of the material shall be agreed upon between the purchaser and the supplier as part of the purchase contract (see [5.1.5](#)).

15. Rejection

15.1 Materials that fail to conform to the requirements of this specification shall be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of testing, the producer shall make claim for a rehearing or provide for third party testing.

16. Certification

16.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

16.2 *Detrimental Materials Control*—For Class 2 material only, the vendor shall provide certification that the limits of [Table 2](#) have been met and that low melting metals (Sb, As, Bi, Cd, Pb, Sn, Ga, In, Ag, Hg and Zn [Zn for Grade B only]) have not been added as intentional constituents. In lieu of specific test results for the lot to be delivered, certifications shall be based on tests of both raw materials and production lots of similar finished packing material over an extended time period (not exceeding three years between tests). Any change to manufacturing processing that affects product composition, including changes to raw material, binders, or inhibitors (Grade A) shall require additional testing to form the basis for future certifications.

17. Product Marking

17.1 *Marking*—For commercial shipment, marking shall be in accordance with accepted industry practices or as required in the purchase contract (see [5.1.1](#)). Marking shall include type of corrosion inhibitor, if any.

18. Packaging

18.1 *Commercial Packaging*—Commercial packaging shall be in accordance with Practice [D3951](#) or as required in the purchase contract (see [5.1.1](#)).

19. Keywords

19.1 flexible graphite material; packing material