Designation: F 2168 – 02

An American National Standard

Standard Specification for Packing Material, Graphitic, Corrugated Ribbon or Textured Tape, and Die-Formed Ring[1]

This standard is issued under the fixed designation F 2168; 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 *Scope*—This specification covers various types, classes, and grades of flexible graphite material in which valve media temperatures are limited to a maximum of 1050°F (966°C). Where this specification is invoked as ASTM F 2168, Sections 1-18 apply. Where this specification is invoked as ASTM/DoD F 2168, Sections 1-18 and the Supplementary Requirements are applicable.

1.2 The values stated in SI units are to be regarded as standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles[2]

C 561 Test Method for Ash in a Graphite Sample[2]

C 816 Test Method for Sulfur in Graphite by Combustion-Iodometric Titration Method[2]

C 889 Test Methods for Chemical and Mass Spectrographic Analysis of Nuclear-Grade Gadolinium Oxide (Gd_2O_3) Powder[3]

D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)[4]

D 512 Test Methods for Chloride Ion in Water[5]

D 1179 Test Methods for Fluoride Ion in Water[5]

D 1246 Test Method for Bromide Ion in Water[5]

D 3178 Test Methods for Carbon and Hydrogen in the Analysis Sample of Coal and Coke[6]

D 3684 Test Method for Total Mercury in Coal by the Oxygen Bomb Combustion/Atomic Absorption Method[6]

D 3761 Test Method for Total Fluorine in Coal by the Oxygen Bomb Combustion/Ion Selective Electrode Method[6]

D 3951 Practice for Commercial Packaging[7]

D 4239 Test Methods for Sulfur in the Analysis Sample of Coal and Coke Using High Temperature Tube Furnace Combustion Methods[6]

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) may 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 can 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.

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

3.1.9 *size*, *n*—refers to 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.

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.02 on Insulation Systems.

Current edition approved Feb. 10, 2002. Published April 2002.

[2] *Annual Book of ASTM Standards*, Vol 15.01.

[3] *Annual Book of ASTM Standards*, Vol 12.01.

[4] *Annual Book of ASTM Standards*, Vol 10.03.

[5] *Annual Book of ASTM Standards*, Vol 11.01.

[6] *Annual Book of ASTM Standards*, Vol 05.06.

[7] *Annual Book of ASTM Standards*, Vol 15.09.

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 must 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 should 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.

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). If 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.

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

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

6.1.4 *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. If the number of cuts is not specified, single-cut rings shall be provided.

10. Workmanship, Finish and Appearance

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

TABLE 3 Dimensions for Type I

Width	Length, min
0.25 ± 0.030 in (6 ± 0.075 mm)	25 ft (7.62 m)
0.50 ± 0.030 in (12 ± 0.075 mm)	25 ft (7.62 m)
0.75 ± 0.030 in (18 ± 0.075 mm)	50 ft (15.24 m)
1.00 ± 0.030 in (25 ± 0.075 mm)	50 ft (15.24 m)

TABLE 4 Tolerances for Type II Packing

	Inside Diameter (i.d.)	Outside Diameter (o.d.)	Thickness
to 1 in. (25 mm) o.d.	+0.010 in. (0.25 mm) -0.000 in. (0.000 mm)	+0.000 in. (0.000 mm) -0.010 in. (0.25 mm)	±0.020 in. (0.50 mm)
1 in. (25 mm) and above o.d.	+0.015 in. (0.38 mm) -0.000 in. (0.000 mm)	+0.000 in. (0.000 mm) -0.015 in. (0.38 mm)	±0.030 in. (0.75 mm)

TABLE 5 Classification of Visual Defects

Item	Category—Major
Type I corrugated ribbon or textured tape	Void. Rip or tear in ribbon. Particulate or extraneous matter on surface that is not easily removed without damaging the packing. Noncontinuous length (no joints). Lack of corrugation or textured surface area. Creasing or crimping.
Type II die-formed rings	Holes or voids. Particulate or extraneous matter on surface that is not easily removed without damaging the packing. Delaminations (laminated rings). Gouges (minor indentations less than 0.005 in. in depth resulting from normal production and handling are acceptable). Split rings not cut cleanly. Lack of corrosion inhibitor (Grade A only). Wrong corrosion inhibitor (Grade A only). Presence of corrosion inhibitor (Grade B only). Cracking (crevices of no appreciable width associated with folds (accordion creases), ply terminations, or plies of die molded ribbon packing rings are acceptable.)

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*—In the event tests are required as part of the purchasing requirements (see 5.1.5), tests shall be made in accordance with the following tests or by way of alternate methods of analysis with equal to 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 shall be determined by measuring each sample selected for visual examination (see Table 4).

13.3 *Ash Content*—The ash content shall be determined in accordance with Test Method C 561 (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 300 ± 5°F (149 ± 3°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 D 3178 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 shall be determined in accordance with Test Method C 559.

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 should 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.

TABLE 6 Detrimental Materials Tests

Element	Preparation/Analysis Test Methods
Chlorine (Cl), bromine (Br)	(l) pyrohydrolysis (C 889)/ion chromatographic analysis (2) D 129/D 512 (3) D 1246 (for bromine)
Fluorine (F)	(l) pyrohydrolysis (C 889)/selective ion electrode or ion chromatographic analysis (2) D 129/D 1179 (3) D 3761 (sample preparation and analysis)
Sulfur (S)	(1) high temperature combustion in 100 % oxygen/ nondispersive infrared analysis or ion chromatographic analysis (2) C 816 (sample preparation and analysis) (3) D 4239 Method 3 (sample preparation and analysis)
Mercury (Hg)	(1) direct analysis of volatile elements (Hg) by emission spectrographic method (2) direct analysis of volatile elements by atomic absorption per D 3684