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Standard Specification for Epoxy / Cotton Raw Materials for the Use in Bearing Cages¹

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1. Scope

1.1 This specification covers basic characteristics required for porous laminated Epoxy materials intended for use as instrument and thin-section ball-bearing retainers (cages) and the methods of determining these characteristics.

1.2 *Forms*—Sheets and Rolled Tubes are recommended forms of laminated material covered by this specification.

1.3 *Intended Use*—Materials produced to this specification are intended for use as ball bearing retainers (cages). Temperature range is limited to 284°F (140°C) and below

1.4 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

- 2.1 *ASTM Standards*:²
- D618 Practice for Conditioning Plastics for Testing
 - D229 Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
 - D570 Test Method for Water Absorption of Plastics
 - D695 Test Method for Compressive Properties of Rigid Plastics
 - D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

¹ This specification is under the jurisdiction of ASTM Committee F34 on Rolling Element Bearings and is the direct responsibility of Subcommittee F34.06 on Aerospace.

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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.

- D2257 Test Method for Extractable Matter in Textiles
- E1640 Test Method for Assignment of the Glass Transition Temperature By Dynamic Mechanical Analysis
- 2.2 *ANSI/ASQC Standards*:³
- ANSI/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes
- 2.3 *Federal Standard*:⁴
- MIL-STD-129 Military Making for Shipment and Storage

3. Material and Test Conditioning

3.1 *Material Conditioning Prior to Tests*: (designation as follows)

3.1.1 A number indicating in degrees Celsius the conditioning temperature, or

3.1.2 A number indicating relative humidity, whenever humidity is controlled, or a word to indicate immersion in liquid.

3.2 The numbers shall be separated from each other by a slant mark. A sequence of conditions shall be denoted by use of a plus (+) sign between successive conditions. "Des" shall be used to indicate desiccation over anhydrous calcium chloride. A capital letter "T" (test condition) following the prior material conditioning designation shall be separated by a colon, with the testing condition noted in the same format as the material conditioning. Temperature and relative humidity tolerances shall be in accordance with Practice D618 Section 7, unless otherwise specified.

3.2.1 *EXAMPLES*:

3.2.1.1 *C-96/35/90*— Humidity conditioning – 96 h at 95°F, (35°C) and 90% relative humidity.

3.2.1.2 *E-48/50*—Temperature conditioning - 48 h at 122°F, (50°C).

3.2.1.3 *D1-24/23*—Immersion conditioning - 24 h in distilled water at 73.4°F, (23°C), followed by E-1/105 - temperature conditioning - 1 h at 221°F, (105°C).

3.3 *Standard Procedures*:

3.3.1 *Procedure A*:

3.3.1.1 *Condition A*—40/23/50 for thickness equal or less than 0.250 in., (7mm) or Condition A-88/23/50 for thickness

³ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

⁴ DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 <http://quicksearch.dla.mil/>

greater than 0.250 in., (7mm) Standard Laboratory atmosphere for a minimum of either 40 h or 88 h, dependent on thickness, at 73.4°F (23°C) and 50% relative humidity.

3.3.2 Procedure D:

3.3.2.1 Condition D₁—24/23 See example above.

3.3.2.2 Condition D—24/23 – Immersion conditioning - 24 h at 73.4°F, (23°C).

3.3.2.3 Condition D—48/50 – Immersion conditioning - 48 h at 122°F, (50°C).

3.3.3 Procedure E:

3.3.3.1 Condition E-1/150: T-150 – Temperature conditioning - 1 h at 302°F, (150°C) - immediately followed with Test at 302°F, (150°C).

3.3.3.2 Condition E—48/50 See example above.

3.3.3.3 Condition E—168/185 – Temperature conditioning – 168 h at 365°F, (185°C).

4. Classification

4.1 The material shall be furnished in the following types and forms as specified:

Type	Description
FB	Rolled tube made from cotton fabric weighing 4 oz/yd ² (0.14 kg/m ²) or less, with a nominal thread count of 80 by 80 threads per in. (31.5 by 31.5 cm). Thread tolerance of ± 5%.
FBFW	Rolled tube made from cotton fabric weighing 4 oz/yd ² (0.14 kg/m ²) or less, with a nominal thread count of 100 by 100 threads per in. (39.4 by 39.4 cm). Thread tolerance of ± 5%.
FBEFW	Rolled tube made from cotton fabric weighing 3 oz/yd ² (0.1 kg/m ²) or less, with a nominal thread count of 130 by 130 threads per in. (51.2 cm). Thread tolerance of ± 5%.

5. Ordering Information

5.1 Procurement documents should specify the following:

5.1.1 Title, designation, and date of this specification;

5.1.2 Type required (see Section 4);

5.1.3 Dimensions required; and

5.1.4 Special marking required (see 10.2).

5.2 Required test data shall be requested at the time the purchase order is submitted and listed on the purchase order.

6. Order of Precedence

6.1 In the event of a conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification,

however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

7. Performance Requirement

7.1 Tube—Performance requirements for tube laminated materials specified in Table 1.

7.2 Sheet—Performance requirements for sheet laminated materials, specified in Table 2.

7.3 Construction—Tubes and Sheets shall consist of cotton base material (reinforcement) as described in 4.1, impregnated and bonded with a non-plasticized Epoxy resin. Tubes will be made by passing the impregnated material over heated rolls and winding the heated material onto a mandrel while applying pressure to the material/mandrel. The overwrapped mandrel is then placed in an oven to cure the tube. Sheets will be made by stacking pre-cut impregnated material between steel plates and loaded into a press applying heat and pressure to cure the sheet.

7.4 Base Materials:

7.4.1 Cotton Fabric Construction—Material shall consist of a woven cotton fabric substrate impregnated and bonded with an Epoxy resin matrix and processed to meet the requirements of this specification, (see 4.1). Finished fabric shall be de-sized, washed, and bleached, with remaining impurities per Test Method D2257 Extractable Matter, not greater than 1.5 % after finishing.

7.5 Property Values—Tubes shall conform to the property values shown in Table 1, when tested in accordance with Section 8. The property value requirements for special sizes of tubes shall be as specified in the purchase order (see Section 5). Sheets shall conform to the property values shown in Table 2, when tested in accordance with Section 8. The property value requirements for special sizes of sheets shall be as specified in the purchase order (see Section 5).

7.6 Dimensional:

7.6.1 Diameter of Tubes Rolled Round (TRR)—Range of sizes for tubes rolled round shall be as specified in Table 3. The inside diameter and outside diameter shall be included in the part number. An example of a part number for a rolled tube with an inside diameter of 0.188 in., (0.478 cm) and an outside diameter of 0.250 in., (0.635 cm) is TRR-00.188/00.250. The wall thickness tolerances for finished outside diameter shall be as specified in Table 4.

TABLE 1 Performance Requirements for Tubes

	Condition	ASTM Test Method	Unit	FB	FBFW	FBEFW	
Compressive Strength Axial ^A	A	D695	Min. psi	27 000	27 000	27 000	
Compressive Strength Axial ^A Modulus	A	D695	Min. kpsi	255	255	285	
Density ^A (Range)	A	D792	gm/cc	1.24 – 1.34	1.28 – 1.38	1.30 – 1.38	
Tg by DMA	A	E1640	Min. °C	150	150	150	
Water Absorption (ID range of 0.25 in. (0.635 cm.) – 8.0 in. (20.3 cm.))	D ₁ – 24/23	D570	Max. %	Wall < 0.062 in. (0.16 cm.) 1.5	Wall < 0.125 in. (0.32 cm.) 1.0	Wall <0.250 in. (0.63 cm.) 0.75	Wall <0.5 in. (1.27 cm.) 0.5

^APounds per square inches (psi). 1 psi = 6.8948 kPa. Test is limited to tubes 0.250 in. (0.635 cm) and greater ID. One specimen to be taken from center of sample tube. The other two specimens to be taken 1 in. (2.54 cm) from each end of the sample tube.

TABLE 2 Performance Requirements for FB Sheets

	Condition	ASTM Test Method	Unit	Thickness (in.) ^A												
				0.031	0.062	0.094	0.125	0.188	0.250	0.500	0.750	1.000	1.001 – Max.			
Flexural strength																
Lengthwise:	A	D790	Min. psi	19 000	19 000	19 000	19 000	19 000	19 000	19 000	19 000	19 000	18 000	18 000	16 500	16 000
Crosswise:			Min. psi	16 000	16 000	16 000	16 000	16 000	16 000	16 000	16 000	16 000	15 000	15 000	12 500	12 500
Flexural strength	A	D790	Min. kpsi	...	900	900	900	900	900	900	900	900	900	900	900	900
Modulus	...	...	Min. kpsi	...	750	750	750	750	750	750	750	750	750	750	750	750
Tg by DMA	A	E1640	Min. °C	150	150	150	150	150	150	150	150	150	150	150	150	150
Bonding strength	A	D229	Min. lbs.	...	...	...	...	...	...	...	...	...	...	...	...	...
Water absorption	D1 – 24/23	D570	Max. %	1.50	1.25	1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.50	0.50	0.25	0.25
Silicone content	E-168/185	Customer Specific	Max. ppm	50	50	50	50	50	50	50	50	50	50	50	50	50

^A 1 in. = 2.54 cm. 1 lb = 0.45 kg. 1 psi = 6.8948 kPa

^B Maximum thickness tested shall be 2.000 in. (5.08 cm).