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Standard Specification for Phenolic Raw Materials for the Use in Bearing Cages[1]

This standard is issued under the fixed designation F2953; 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 This specification covers basic characteristics required for porous laminated phenolic materials intended for use as instrument and thin-section ball-bearing retainers (cages) and the methods of determining these characteristics.

1.2 *Forms*—Sheets, rolled tubes, molded tubes, and rods 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 250°F (117°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

D695 Test Method for Compressive Properties of Rigid Plastics

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 *ANSI/ASQC Standard:*[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. Classification

3.1 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 inch (31.5 by 31.5 cm).
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 inch (39.4 by 39.4 cm).
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 inch (51.2 by 51.2 cm).

4. Ordering Information

4.1 Procurement documents should specify the following:

4.1.1 Title, designation, and date of this specification;

4.1.2 Type required (see Section 3); Property values for tubes (see Table 1);

4.1.3 Dimensions required; and

4.1.4 Special marking required (see 9.2).

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

5. Order of Precedence

5.1 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.

6. Performance Requirements

6.1 Performance requirements for sheet laminated materials shall be as specified in Table 2.

6.2 *Tubes*—The tubes shall consist of base material (reinforcement) as described in 6.3 impregnated and bonded with a non-plasticized phenolic resin. Tubes will be made by passing the impregnated material over heated rolls and winding the

[1] This test method 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.

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

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

TABLE 1 Performance Requirements for Tubes

ASTM Test Method D348	PB	FB	FBFW	FBEFW
Acetone extraction (Maximum %)	1.5	1.5	1.5	1.5
Compressive strength axial[A] (Minimum psi)	18 000	28 000	28 000	28 000
Specific gravity[A] (Range gm/cc)	1.24-1.34	1.24-1.34	1.28-1.38	1.28-1.38

[A] Pounds 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.

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.

6.3 *Base Materials:*

6.3.1 *Cotton Fabric Construction*—The material shall consist of a woven cotton fabric substrate impregnated and bonded with a phenolic resin matrix and processed to meet the requirements of this specification (see Table 3). Finished fabric shall be de-sized, washed, and bleached, with remaining impurities per acetone extraction, not greater than 1.5 % after finishing. See 8.5 for method of test.

6.3.2 *Paper*—Type PB tubes shall be made from a saturating grade of paper. The caliper of the paper shall be between 2 and 6 mils (0.05 and 0.15 mm). The paper shall be bleached.

6.4 *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 4).

6.4.1 *Diameter of Rolled Round Tubes*—The range of sizes for rolled round tubes shall be as specified in Table 4. 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-0.188/0.250. The wall thickness tolerances for finished outside diameter shall be as specified in Table 5.

6.4.2 *Diameter of Molded Round Tubes*—The range of sizes of molded round tubes shall be as specified in Table 4. The inside diameter and outside diameter shall be included in the part number. An example of a part number for a molded round tube with an inside diameter of 0.125 in. (0.318 cm) and an outside diameter of 0.188 in. (0.478 cm) is TMR-0.125/0.188. The wall thickness tolerances for finished outside diameter shall be as specified in Table 5.

6.4.3 *Diameter of Rods*—The range of sizes and tolerances for rods shall be as specified in Table 4. The outside diameter of the rod shall be included in the part number.

6.4.4 *Thickness of Sheets*—The thickness of laminated sheets, permissible variations, and the applicable part number shall be as specified in Table 7.

6.5 *Prepreg*—The prepreg shall be used within six months when stored at 68 ± 5.4°F (20 ± -14.7°C) and 50 % maximum relative humidity.

6.6 *Resin*—Shall be used and stored within the manufacturer's requirements.

6.7 *Surface Defects*—Finished OD diameters shall be free from blisters, loose layers, resin pockets, voids and wrinkles. Finished walls shall show no checks or cracks between the laminations on machined or sawed edges. As an option, a buyer may request an unfinished OD or trimmed length or both.

6.8 *Warpage*—The warpage of material furnished in the tube form, as delivered, shall not be greater than the following (see 8.4):

Tubes and Rod Outside Diameter (OD) and Sheet Thickness Inch	Permissible Warp Maximum Percent	
	Sheets	Tubes / Rod
0.031 up to 0.063	5.0	(---)
0.063 up to 0.126	2.5	(---)
0.126 up to 0.251	1.0	2.0
0.251 up to 0.750	0.5	1.0
0.750 to Max.	0.25	0.5

NOTE 1—Percentage of warp is specified in terms of 36-in. (91-cm) material lengths.

6.9 *Color*—The natural color of the tubes may vary and is not a cause for rejection.

6.10 *Tolerances:*

6.10.1 *Lengths*—Unless otherwise specified (see Section 4), tubes shall be furnished in manufacturer's standards lengths.

6.10.2 *Diameters and Wall Thickness:*

6.10.2.1 *Sizes*—The ID, OD, and wall thickness of the tubes shall be specified by any two, but only two, dimensions (see Section 4).

6.10.2.2 *Tolerances on Diameters*—Unless otherwise specified (see Section 4), ID and OD for tubes shall conform to the specified dimensions for nominal ID or OD within the tolerances shown in Table 4.

6.10.2.3 *Tolerances on Wall Thickness*—Unless otherwise specified (see Section 4), tubes shall conform to the specified dimensions for nominal ID and OD, but variations in wall thickness shall not be greater than the tolerances shown in Table 5.

6.11 *Surface Finish*—Tubes shall be finished to meet the customer requirements.

6.12 *Degree of Cure*—Acetone extractable matter shall be not greater than 1.5 % (see 8.5).

7. Verification

7.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the customer. The customer reserves the right to perform any of the inspections set forth in this specification when such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

7.2 *Conformance Inspection:*

7.2.1 *Sampling for Conformance Inspection*—Sampling for conformance inspection shall be performed in accordance with

TABLE 2 Performance Requirements for FB Sheets

Requirement	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.
Impact strength[B]			Min.										
Lengthwise:	E-48/50	D229	ft-lbs				1.25	1.25	1.25	1.25	1.25	1.25	1.25
Crosswise:			per inch				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Flexural strength													
Lengthwise:	A	D229	Min.	16 000	16 000	16 000	16 000	16 000	16 000	15 000	15 000	14 500	14 500
Crosswise:			psi	14 000	14 000	14 000	14 000	14 000	14 000	13 500	13 500	13 000	13 000
Thermal endurance Flexural strength:		D2304	Min. psi										
Bonding strength[B]	A	D229	Min.							1600	1600	1600	1600
	D-48/50		pounds							1500	1500	1500	1500
Water absorption	D_1 – 24/23	D229	Max. percent	4.00	1.95	1.55	1.30	1.00	0.95	0.70	0.60	0.55	0.55
Silicone content	E-168/185		Max. ppm	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).

TABLE 3 Cotton Fabrics

FB	FBFW	FBEFW
80 × 80 Tolerance of ±5 %	100 × 100 Tolerance of ±5 %	130 × 130 Tolerance of ±5 %

ASQC-Z1.4 unless otherwise specified. For purpose of sampling, an inspection lot for examination and tests shall consist of all materials of the same type dimensions, resin, and base material from one impregnation run.

7.2.2 *Examination of Material*—Examination of material shall be made in accordance with 7.4. The lot size for determining the sample size in accordance with ASQC-Z1.4 shall be expressed in units of tubes.

7.3 *Appearance and Workmanship*—The sample unit for the following examination shall be tubes of the specified lot. The inspection level shall be per ASQC-Z1.4, Level II with acceptance quality levels (AQLs) as follows: 1.5 for major defects and 6.5 for minor defects. Classifications of defects are listed in Table 6.

7.4 *Testing*—Tubes shall be tested for applicable characteristics as indicated in Table 1 on each lot presented for inspection. The inspection level for determining the sample size shall be S-1 per ASQC-Z1.4 except that not less than two sample units shall be randomly selected from a lot. The lot size shall be expressed in units of tubes. The AQL shall be 6.5. Describe all failures and report all values on which test results are based.

8. Test Methods

8.1 *Measurements*—Tube shall be examined and dimensions other than length recorded to the nearest 0.001 in. (0.002 54 cm). Length shall be measured to the nearest; 0.0625 in. (0.1588 cm) for less than 1-in. (2.5-cm) OD diameter, 0.125 in. (0.3175 cm) for less than 2-in. (5-cm) OD diameter, 0.250 in. (0.635 cm) for less than 4-in. (10-cm) OD diameter, and 1.0 in. (2.54 cm) for OD diameters greater than or equal to 4 in. (10 cm).

8.2 *Axial Compressive Strength:*

8.2.1 The axial compressive strength shall be determined by Table 1 and Test Method D695, except that the specimen length shall be 1 in. (2.54 cm) for tubes to 2-in. (5-cm) OD or less with wall thickness of 0.0625 in. (0.1588 cm) or over.

8.2.2 The axial compressive strength requirement and test method for tubes over 2 in. (5 cm) in OD or with walls less than 0.0625 in. (0.1588 cm) will be as specified in the purchase order.

8.3 *Specific Gravity*—The specific gravity shall be as determined by Test Methods D792.

8.4 *Warpage*—The warpage of material furnished in the tube form, as delivered, shall be not greater than the following (8.4.1 – 8.4.3):

8.4.1 *Apparatus*—A horizontal flat surface and rigid bar with a vertical plane surface firmly fixed at right angles to the flat surface shall be at least as long as the specimen to be tested. The height of the bar shall exceed by one half the outside diameter of the tube. Feeler gauges shall also be required.

8.4.2 *Procedure*—The specimen shall be placed on the horizontal flat surface and rotated against the vertical plane surface of the rigid bar. The bar shall be firmly fastened to the horizontal flat surface. The maximum separation between the tube and the vertical plane surface shall be measured to the nearest 0.001 in. (0.0025 cm).

8.4.3 *Report and Calculation*—Warp or lack of bearing straightness shall be reported as the maximum separation or any part of the tube from a straight edge which contacts the ends of the specimen. The maximum length tested for warpage shall be 18 in. (46 cm). The warpage shall then be calculated as follows:

$$W = \left[(36 \quad D)/L^2 \right] \times 100 \tag{1}$$

where:

W = percentage of warp, calculated to a 36-in. (91-cm) length,
D = maximum deviation of tube from straight edge in inches (centimetres), and
L = length of tube in inches (centimetres).