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INCH-POUND

WW-L-2887
20 July 1998

FEDERAL SPECIFICATION

TUBE, PHENOLIC, POROUS RETAINER FOR USE IN INSTRUMENT BEARINGS

The General Services Administration has authorized the use of this Federal Specification by all Federal agencies.

1. SCOPE

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

1.2 Classification. The materials will be furnished in the following types and forms as specified (see 6.2)

TYPE	DESCRIPTION
FBFW	Rolled tube made from cotton fabric weighting 4 ounces/square yard or less with a total thread count of 130 to 176 threads per inch.
FBEFW	Rolled tube made from cotton fabric weighing 3 ounces/square yard or less with a total thread count of 177 to 300 threads per inch.
PB	Rolled tube made from paper 2 to 6 mils (0.002 - 0.006 inch) thick.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to : Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 9330

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2. APPLICABLE DOCUMENTS

2.1 Government publications. The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-129 - Marking for Shipment and Storage

(Unless otherwise indicated, copies of the above standard is available from the Standardization Documents Ordering Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues are cited in the solicitation documents.

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

ASQC Z1.4 - Sampling Procedures and Tables for Inspection by Attributes

(Application for copies should be addressed to American Society for Quality Control, 611 West Wisconsin Avenue, Milwaukee, WI 53201-3005.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-D618 - Plastics Conditioning and Electrical Insulating Materials for Testing (DoD Adopted)
ASTM-D695 - Properties of Compressive Rigid Plastics (DoD Adopted)
ASTM-D792 - Density and Specific Gravity (Relative Density) of Plastics by Displacement (DoD Adopted)
ASTM-E11 - Sieves, Wire Cloth, for Testing Purposes (DoD Adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. REQUIREMENTS

3.1 Tubes. The tubes shall consist of base material (reinforcement) as described in 3.3 impregnated and bonded with a non-plasticized phenolic resin. Tubes will be made by passing the impregnated material over heated rolls and winding the 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.

3.2 Base materials.

3.2.1 Cotton fabric.

FBFW tubing. FBFW tubing shall be made from cotton fabric weighing 3 to 4 ounces/square yard. Finished fabric shall be desized, washed and/or bleached, and remaining extractables shall be not greater than 2 percent after finishing. Total thread count (warp plus fill) shall be 130 to 176 threads per inch where 80 by 80 = 160 total thread count.

FBEFW tubing. FBEFW tubing shall be made from cotton fabric weighing 1.5 to 3 ounces/square yard. Finished fabric shall be desized, washed and/or bleached and remaining extractables shall be not greater than 2 percent after finishing. Total thread count (warp plus fill) shall be 177 to 300 threads per inch where 88 by 100 = 188 total thread count.

3.2.2 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.

3.3 Property values. Tubes shall conform to the property values shown in table 1, when tested in accordance with section 4. The property value requirements for special sizes of tubes shall be as specified in the purchase order (see 6.2).

3.4 Specific gravity. The specific gravity range required will be specified in the purchase order (low, medium or high) (see table 1).

3.5 Machineability. Material shall be machineable with standard tools.

3.6 Surface defects. Tubes shall be free from blisters, pronounced mandrel scores, loose layers, resin pockets, voids and wrinkles. Tubes shall show no checks or cracks between the laminations on machined or sawed edges.

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TABLE I. Property values.

	Compressive Strength Axial (psi) 1/	Specific Gravity (grams/cm$^{3)}$
Test Paragraph	4.5.2	4.5.3
Condition	A	A
Number of Specimens/Tube 2/	3	3
Test/Specimen	1	1
Limit	Minimum	Range
Wall Thickness Range (Inch)	0.0625 & Over	All Sizes
Type PB (0.093 to 9.000 inches ID)	10,000	1.080 - 1.130 (low) 1.131 - 1.160 (med) 1.161 - 1.240 (high)
Types FBFW, FBEFW (0.375 to 9.000 inches ID)	12,000	1.190 - 1.239 (low) 1.240 - 1.285 (med) 1.286 - 1.370 (high)

1/ Pounds per square inches (psi). Test is limited to tubes 0.250 inch and greater inside diameter (ID).

2/ One specimen to be taken from center of sample tube. The other two specimens to be taken one inch from each end of the sample tube.

3.7 Warpage. The warpage of material furnished in the tube form, as delivered, shall be not greater than the following (see 4.5.4):

Outside Diameter (OD) Inch	Permissible Warpage, Maximum Percent
0.125 to 0.250, inclusive	2.0
over 0.250 to 0.750	1.0
over 0.750	0.5

NOTE: Percentage of warpage is specified in terms of 36 inch material lengths.

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

3.9 Tolerances.

3.9.1 Lengths. Unless otherwise specified (see 6.2), tubes shall be furnished in manufacturer's standard lengths with a tolerance of ± 0.1 inch.

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3.9.2 Diameters and wall thickness.

3.9.2.1 Sizes. The ID, OD and wall thickness of the tubes shall be specified by any two, but only two, dimensions (see 6.2).

3.9.2.2 Tolerances on diameters. Unless otherwise specified (see 6.2), ID and OD for tubes shall conform to the specified dimensions for nominal ID and OD within the tolerances shown in table II.

TABLE II. Tolerances on diameters of tubes.

Nominal Diameters Inches	Tolerances (±)	
	Inside Dia (ID)	Outside Dia (OD)
0.090 - 0.750, inclusive	0.003	0.003
0.751 - 2.000, inclusive	0.004	0.003
2.001 - 4.000, inclusive	0.008	0.004
4.001 - 9.000, inclusive	0.010	0.015

3.9.2.3 Tolerances on wall thickness. Unless otherwise specified (see 6.2), tubes shall conform to the specified dimensions for nominal ID and OD, but variations in wall thickness shall be not greater than the tolerances shown in table III.

3.9.3 Surface finish. Tubes with ODs 9.000 inches or less inclusive shall have a smooth ground or turned finish. Tubes with ODs over 9.000 inches may be supplied unmachined.

3.10 Degree of cure. Acetone extractable matter shall be not greater than 4 percent (see 4.5.5).

4. VERIFICATION

4.1 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 Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

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TABLE III. Tolerances on wall thickness of tubes.

Wall Thickness 1/	Thickness Tolerances (±) from Average Wall Thickness of Individual Tube		
	Type PB	Type FBFW, FBEFW ID ≤ 0.500 / ID > 0.500	
0.010 up to 0.0156	0.003	--	--
0.0156 up to 0.03125	0.005	--	--
0.03125 up to 0.0625	0.006	0.010	0.008
0.0625 up to 0.125	0.007	0.011	0.009
0.125 up to 0.250	0.009	0.013	0.011
0.250 up to 0.500	0.011	0.015	0.013

1/ The term "up to" means "up to but not including."

4.2 Conformance inspection.

4.2.1 Sampling for conformance inspection. Sampling for conformance inspection shall be performed in accordance with ASQC Z1.4 unless otherwise specified. For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type dimensions, resin, and base material from one impregnation run.

4.2.2 Examination of material. Examination of material shall be made in accordance with 4.4. The lot size for determining the sample size in accordance with ASQC Z1.4 shall be expressed in units of tubes.

4.3 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. Classification of defects are listed in table IV

4.4 Testing. Tubes shall be tested for the applicable characteristics as indicated in table V on each lot presented for inspection. The sample unit shall be one tube. 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.

4.5 Test methods.

4.5.1 Measurements. Tubes shall be examined and dimensions other than length recorded to the nearest 0.001 inch. Length shall be measured to the nearest 0.0625 inch.

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TABLE IV. Classification of defects.

Examination	Defect	Classification Major	Classification Minor
Appearance and Workmanship	Not uniform in texture and finish.		X
	Presence of foreign matter, grit, or abrasives	X	
	Any crack, break, bulge, blisters, wrinkles, scratches, dents, voids or resin pockets.	X	
	Any separation of laminations.	X	
	Laminations not as specified. Ragged or rough edges or sides.	X	
	Fabric not continuous.	X	

4.5.2 Axial compressive strength.

a. The axial compressive strength shall be determined by table I and ASTM D-695, except that the specimen length shall be 1 inch for tubes to 2 inch OD or less with wall thickness of 0.0625 inch or over.

b. The axial compressive strength requirement and test method for tubes over 2 inches in OD or with walls less than 0.0625 inch will be as specified in the purchase order.

4.5.3 Specific gravity. The specific gravity shall be as determined by table I and ASTM D-792.

TABLE V. Instruction for testing.

Characteristics	Specification Reference		Requirements Applicable To		Results Reported As	
	Requirement	Test Method	Individual	Lot Average	Pass or Fail	Numerically to Nearest
Property Values	Table I					
Compressive Strength (Axially)		4.5.2	--	X	--	psi
Specific Gravity		4.5.3	--	X	--	0.001

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4.5.4 Warpage.

a. 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.

b. 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 inch.

c. 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 inches. The warpage shall then be calculated as follows:

$$W = \frac{(36\ D)}{L^2} \times 100$$

Where:

W = Percentage of warp, calculated to a 36 inch length

D = Maximum deviation of tube from straight edge in inches.

L = Length of tube in inches.

4.5.5 Degree of cure. Acetone extraction shall be used to determine amount of acetone soluble matter in laminated phenolic products.

4.5.5.1 Apparatus.

4.5.5.1.1 Sieves. The set of sieves used shall consist of numbers 40 (425 µm) and 140 (106 µm), with a cover and receiving pan, conforming to the requirements of ASTM-E11 for wire cloth sieves for testing purposes.

4.5.5.1.2 Extraction apparatus. The apparatus may be of the type shown in figure 1, or a Wiley-Richardson type, as shown in figure 2. The former type is better for use with small electric hot plates, while the latter controls the temperature so that the rate of extraction can be regulated accurately.

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4.5.5.1.3 Drying dishes. The drying dishes shall be lightweight dishes, approximately 63.5mm (2.5 inches) in diameter and 38.1 mm (1.5 inches) in height.

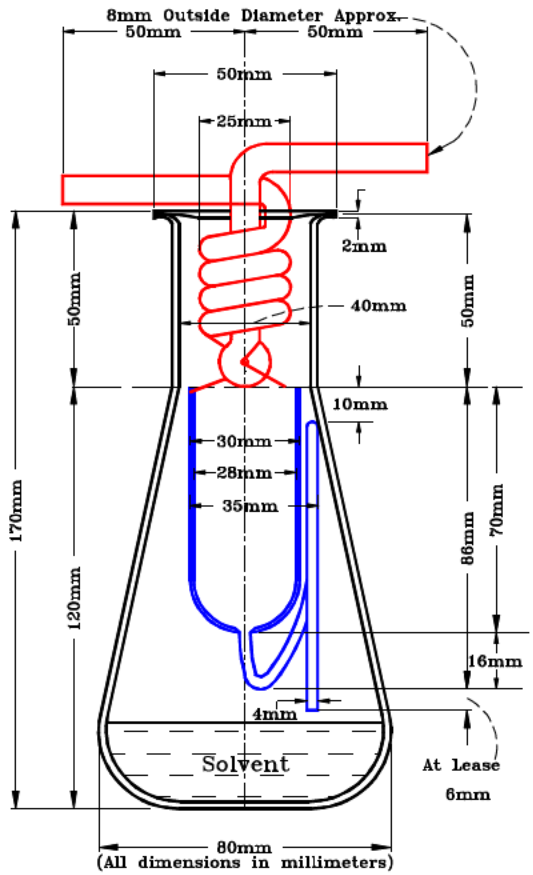

FIGURE 1. Extraction apparatus.

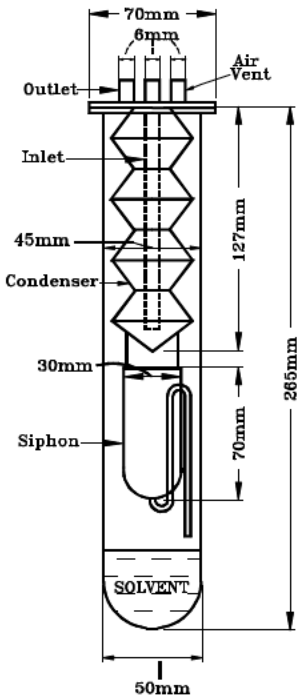

FIGURE 2. Wiley-Richardson type extraction apparatus.

4.5.5.2 Preparation of sample.

4.5.5.2.1 Precautions. Extreme care shall be taken during the preparation of the sample for extraction. The sample shall be drillings if possible; however, if not possible, other means of producing particles equivalent to drillings may be used. Drillings taken from a large tube shall be representative of all sections of the tube in equal proportions. The drills for sampling shall be kept sharp so no extreme heating of the material shall occur during drilling, which will tend to pre-cure the material.

4.5.5.2.2 Obtaining samples. If impracticable to obtain samples by drilling, the parts may be broken up with a lathe, planer, milling machine, or grinder. A mortar and pestle or a pebble mill is considered a grinder, provided no perceptible heating occurs during the grinding procedure. A sharp file or rasp may be used for procuring the sample where the size or shape of the part is such that there is no other method.

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4.5.5.2.3 Particle size. The particles of the sample shall pass through the No. 40 sieve with minimum reworking or grinding. When preparing the sample, the smallest volume shall be obtained for a unit weight of material.

4.5.5.2.4 Sample sieving. The sample shall be sieved through a No. 40 sieve and the particles not passing through shall be re-ground and blended with the original material passing through the sieve. After assembling the Nos. 40 and 140 sieves and the receiving pan, the sample shall be placed in the top sieve, covered, and the entire sample shall be re-sieved either by a mechanical sieve shaker or hand sieving. If the hand sieving method is used, the sieve shall be rotated with slight tapping, the period of rotation being 5 minutes.

4.5.5.2.5 Post sieving. After sieving, the sample (that portion which has passed through the No. 40 sieve and has been retained on the No. 140 sieve) shall be placed immediately in an airtight container to prevent absorption of moisture by the powder and any consequent error as a result.

4.5.5.3 Conditioning. Condition the test specimens at 23 ± 2°C (73 ± 4°F) and 50 ± 5 percent relative humidity for not less than 40 hours prior to testing in accordance with Procedure A of ASTM D618 for those tests where conditioning is required.

4.5.5.3.1 Test conditions. Conduct tests in a standard laboratory atmosphere of 23 ± 2°C ((73 ± 4°F) and 50 ± 5 percent relative humidity, unless otherwise specified in the test methods or in this specification.

4.5.5.4 Procedure.

4.5.5.4.1 Extraction. The extraction procedure shall be carried out in triplicate. Weigh a 3.000-gm portion of the powered sample into a tared, acid-hardened, open-texture quantitative filter paper, 12.5 to 15 cm in diameter, or into a standard, single-thickness extraction thimble, 80 by 22 mm, trimmed if necessary. After folding over, the thimble or filter paper desiccator is ready to insert in the siphon.

4.5.5.4.2 Siphoning. Press the filter paper or thimble containing the weighed sample into the siphon such that the outlet at the bottom is not plugged. Place the condenser and the siphon in the extraction tube and add 50 ml of cp acetone. Start the water through the condenser and adjust the heat (If an oil water bath is used for heating, the height of the liquid in the bath should not come above 2.5 cm (1 inch) below the highest level of the acetone in the siphon before the siphon starts to discharge.) so that the siphon fills and empties between 15 and 20 times/hour. This rate shall be carefully maintained, and the sample shall be extracted for 4 hours. After the siphon empties, remove the flask and pour the contents into an individually weighed dish. Wash the flask three times with the smallest possible quantity of acetone, using a wash bottle, and add the washings to the extracted liquid in the dish.

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4.5.5.4.3 Drying. Place the dish in a well-ventilated drying chamber, maintained at 50 ± 2°C (It is very important that the specified temperature be maintained, otherwise consistent results cannot be obtained between different laboratories. An electrically heated oven should not be used unless it is exceedingly well ventilated, as the acetone fumes are likely to come in contact with the heated coils and cause an explosion.), and dry the sample to constant weight. Between dryings, all dishes containing the residue shall be kept in a desiccator to prevent the absorption of moisture.

4.5.5.5 Calculation and report.

4.5.5.5.1 Calculation. Calculate the percentage of acetone-extractable matter in the specimen as follows:

Acetone-extractable matter, percent = [(W - D)/S] X 100

Where:

W = weight of the dish and extract (gm)
D = weight of the dish (gm) and
S = weight of the original sample (gm)

4.5.5.5.2 Report. The report shall include the percentage of acetone-extractable matter for each sample, and the average percentage of acetone-extractable matter for the three samples.

5. PACKAGING

5.1 Packaging. Material to be packaged per vendor's accepted standard practice unless detailed requirements are specified in the contract.

5.2 Marking. Shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

INFORMATION FOR GUIDANCE ONLY. This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.

6.1 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.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.

b. Type required (see 1.2).

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c. Specific gravity (see 3.4).

d. Property values for special size tubes (see table I).

e. Dimensions required.

f. Special marking required (see 5.2).

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

6.3 Subject Term (key word) listing.

Laminated
Plastic, Fabricated

CONCLUDING MATERIAL

MILITARY INTEREST

Custodians
Army - MI
Navy - AS
Air Force - 84

Review Activities:
Army - AT, AV
Navy - CH

CIVIL AGENCY
COORDINATING ACTIVITIES:

GSA-FSS

Preparing Activity:
Navy - AS
(DoD Project 9330-0003)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.
   NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER WW-L-2887	2. DOCUMENT DATE (*YYMMDD*) 20 July 1998

3. DOCUMENT TITLE
TUBE, PHENOLIC, POROUS RETAINER FOR USE IN INSTRUMENT BEARINGS

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (*Last, First, Middle Initial*)	b. ORGANIZATION	
c. ADDRESS (*Include Zip Code*)	d. TELEPHONE (*Include Area Code*) (1) Commercial: (2) DSN: (*If Applicable*)	7. DATE SUBMITTED (*YYMMDD*)

8. PREPARING ACTIVITY

a. NAME COMMANDER NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION	b. TELEPHONE NUMBER (*Include Area Code*) (1) Commercial (732) 323-2947 (2) DSN 624-2947
c. ADDRESS (*Include Zip Code*) CODE 414100B120-3 HIGHWAY 547 LAKEHURST, NJ 08733-5100	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT Defense Logistics Agency (DLSC-LM), Attn Carla Jenkins/John Tascher 8725 John J. Kingman Road, Ste 2533 Fort Belvoir, VA 22060-6221 Telephone (703) 767-6874