

TP 1324 (E)
MATERIAL SPECIFICATION FOR
COATED FABRICS
USED IN THE MANUFACTURE OF
INFLATABLE LIFERAFTS
(February 1992)

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**MATERIAL SPECIFICATION FOR COATED FABRICS USED IN THE
MANUFACTURE OF INFLATABLE LIFERAFTS TO BE USED AS
ITEMS OF LIFE SAVING EQUIPMENT ON SHIPS**

1. **SCOPE**

1.1 This specification covers the requirements of rubber coated synthetic textiles suitable in the manufacture of buoyancy tubes, inflatable supports for canopies, boarding ramps, floors and canopies of inflatable liferafts.

1.2 The manufacturer or supplier of the coated fabrics shall supply the following information:

Date of manufacture
Type of coating material
Type of textile polymer
Manufacturer identification
Quality control system of the manufacturer.

Manufacturer identification shall consist of a suitable serial number and shall give the date of manufacture, type of coating material, type of textile polymer and the applied test specification. This identification mark shall be applied on one face adjacent to alternate edges of proofed fabric at intervals of about 1 meter. The method of marking shall be agreed between the manufacturer of the proofed fabric and the manufacturer of the liferaft.

2. **APPLICABLE DOCUMENTS**

2.1 The following documents, of the issue in effect on the date of submission for approval, shall form part of this specification to the extent specified herein. Where there is a variation between this specification and documents listed below, this specification shall govern.

International Standard Organization:

ISO 139	Textiles - Standard Atmospheres for Conditioning and Testing.
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ISO 105-B02	Tests for Color Fastness of Textiles
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ISO 34	Determination of Tear Strength of Vulcanized Natural and Synthetic Rubbers (Crescent, trouser and angle test pieces).
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ISO 36	Determination of Adhesion Strength of Vulcanized Rubbers to Textile Fabrics.
ISO 132	Vulcanized Rubbers - Determination of Flex Cracking (De Mattia).
ISO 1421	Determination of Breaking Strength and Elongation at Break of Fabrics Coated with Rubber or Plastics.
ISO 1431	Vulcanized Rubber - Determination of Resistance to Ozone Cracking under Static Condition.
ISO 2231	Fabric coated with Rubber or Plastics - Standard Atmospheres for Conditioning and Testing.
ISO 2411	Fabrics Coated with Rubber or Plastics - Determination of the Coating Adhesion.
ISO 3011	Fabrics Coated with Rubber or Plastics - Determination of Resistance to Ozone Cracking under Static Conditions.

Federal Test Method

Standard No.: 101B.
Method 2065. Puncture Resistance and Elongation Test.

American Society for Testing Materials

Designation: D1776.
Conditioning Textiles and Textile Products for Testing.

Designation: D2136.
Low Temperature Bend Test for Fabrics Coated with Rubber and Rubber-Like Materials.

Designation: D471.
Standard Test Method for Rubber Property. - Effect of Liquids.

Designation: D1141.
Standard Specification for Substitute Ocean Water.

Designation: D1149.
Accelerated Ozone Cracking of Vulcanized Rubber.

Designation: D1171.
Weather Resistance Exposure of Automotive Rubber Compounds.

Designation: D750.
Operating Light- and Weather-Exposure Apparatus (Carbon-Arc Type) for Artificial Weather Testing of Rubber Compounds.

Designation: G26.
Recommended Practice for Operating Light Exposure Apparatus

American Association of Textile Chemists and Colorists:

AATCC Test Method 16E.
Water-Cooled Xenon-Arc Lamp, Continuous Light.

U.S. Military Specification:

Mil-C-20696.
Cloth, Coated, Nylon, Waterproof.

Mil-C-17415.
Cloth, Coated, and Webbing, Inflatable Boat and Miscellaneous Use.

Mil-L-19496.
Lifeboat, CO₂ Inflatable, Mark 5, Mod 1, 15-person Capacity.

U.S. Coast Guard, Washington:

Subpart 160.051.
Specification for Inflatable Liferaft Test Series.

USA Documents:

American Association of Textile Chemist and Colorists.
AATCC Technical Manual.

UK Documents:

British Standard 3224.
Method of Tests for Coated Fabrics.

British Standard 2F.100.
Inspection and Testing Procedure for Textiles.

MS 3/14/0446. - Department of Trade and Industry. Requirements for Proofed Fabrics for Inflatable Liferrafts.

Danish Documents:

Direktoratet for Statens Skibstilsyn, Kobenhavn, Danmark. - The Direktoratet of the Danish Government, Ship Inspection Service. Specification for Proofed Fabrics Used for Buoyancy Chambers, Floors and Canopies of Inflatable Liferrafts and Requirements for Adhesion.

(August 1, 1975. J.nr. R20-402.)

German Documents:

See-Berufsgenossenschaft, Schiffssicherheitsabteilung, Hamburg, Germany. Aufblasbare Rettungsflosse (1967). - Inflatable Liferrafts (1967).

French Documents:

Secretariat d'Etat aux Transports, Secrétariat Général de la Marine Marchande, Paris, Republique Francaise. A l'arreté fixant les conditions d'approbation et de contrôle des radeaux de sauvetage des navires francais de commerce et de pêche et des navires de plaisance de longueur égale ou supérieure à 25 mètres. Conditions for the approval and inspection of liferafts for merchant and fishing craft and pleasure craft of a length of 25 metres or more.

Dutch Documents:

Ministerie van Verkeer en Waterstaat, Directoraat - Generaal van Scheepvaart, Scheepvaartinspectie, 's-Gravenhage, The Hague, Holland. Materialen voor het vervaardigen van automatisch opblaasbare reddingvloten (1972). - Materials for the Manufacture of Inflatable Liferrafts (1972).

3. **REQUIREMENTS**

3.1 **Material** - All basic fabrics used for inflatable liferafts shall be made of standard polyamid, polyester or any other suitable synthetic materials and coated with suitable rubber. Different materials may be used for differing end uses. The four (4) areas of use are as follows:

- (a) Buoyancy Tubes, Inflatable Supports for Canopies and Boarding Ramps:

- (1) Coated Both Sides or Sandwich-Type Construction;
- (2) Coated Single Side.

(b) Floor, Single and Double layer:

- (1) Coated Both Sides or Sandwich-Type Construction;
- (2) Coated Single Side (for double layer floor only).

(c) Outer Canopies:

- (1) Coated Both Sides;
- (2) Coated Single Side.

(d) Inner Canopies:

- (1) Uncoated;
- (2) Coated Single side.

3.1.1 Fabric samples shall undergo the full testing procedure and no part shall be renewed or modified between tests.

3.1.2 Fabrics which have been modified or removed from the test facility and resubmitted shall be considered as a new fabric and shall be subject to the full test procedures.

3.1.3 Each approval test shall be conducted in accordance with the requirements of these Standards.

3.1.4 The applicant shall ensure that an independent laboratory is recognized by the Approval Authority by contacting them for written affirmation before making test arrangements.

3.1.5 To be an independent laboratory, a laboratory shall:

- (a) be engaged in testing marine materials and equipment;
- (b) not be owned or controlled, by the fabric manufacturer or vendor or the fabric, or by a supplier of components to the manufacturer; and

- (c) be recognized by Ship Safety Branch, Canadian Coast Guard, Ottawa, Ontario.

3.2 Material Requirements for Buoyancy Tubes, Inflatable Supports for Canopies, Boarding Ramps and Floors

3.2.1 Weight

- (a) Coated Both Sides or Sandwich-Type Construction.

The weight of the coated fabric shall not be more than 655 g/m
The total weight shall be tested in accordance with paragraph 4.2.
The variation of weight of coated fabric shall not be greater than 10%.

- (b) Coated Single Side

The weight of the coated fabric shall not be more than 530 g/M²
The total weight shall be tested in accordance with paragraph 4.2.
The variation of weight of the coated fabric shall not be greater than 10%.

3.2.2 Breaking Strength (All Material Types)

When tested in accordance with paragraph 4.3, the minimum breaking strength of the coated fabric shall be 2400 N/50 mm of width in the warp direction and 2000 N/50 mm of width in the weft direction.

3.2.3 Elongation at Break (All Material Types)

When tested in accordance with paragraph 4.3, the maximum elongation at break of the coated fabric in warp and weft directions shall be 35% over a 200 mm gauge length. The material shall be tested in accordance with paragraph 4.3.

3.2.4 Tear Strength - Wound Test Method (All Material Types)

When tested in accordance with paragraph 4.4, the minimum tear strength of the coated fabric shall be 1000 N in the warp direction and 900 N in the weft direction.

3.2.5 Puncture Resistance (All Material Types)

When tested in accordance with paragraph 4.5, the minimum puncture resistance of the coated fabric shall be 700 N.

3.2.6 Adhesion (All Material Types)

When tested in accordance with paragraph 4.6, the minimum adhesion strength between the coating and basic fabric, or between 2 plies in the case of sandwich-type material, shall be 28 N/10mm of width in both warp and weft directions.

3.2.7 Porosity (All material Types)

When each side of the reversible fabrics is tested at 30 kPa, the leakage rate of air shall not exceed a total of 15 bubbles in 5 minutes from not more than 5 sites. In the case of non-reversible fabrics only the air holding side shall be tested. The test specimens shall be prepared and tested in accordance with paragraph 4.7.

3.2.8 Flex Cracking (All Material Types)

The flex cracking test shall be performed on a De Mattia-Type machine. After 200,000 flexes, no cracking or delamination shall be visible when inspected under magnification of 5X. In the case of sandwich-type material, after 200,000 flexes each side of the reversible fabric shall be tested independently for porosity. At 30 Kpa the leakage rate of air shall not exceed a total of 2 bubbles in 10 minutes. The test specimens shall be tested in accordance with paragraph 4.8.

3.2.9 Low Temperature Flexing (All Material Types)

After being tested at -50°C +/- 2°C the material shall show no visible cracks, when inspected under a magnification of 5X. In the case of sandwich-type material, after the low temperature flexing test, each side of the reversible fabric shall be tested for porosity. At 30 kPa the leakage rate of air shall not exceed a total of 2 bubbles in 10 minutes. The test specimens shall be tested in accordance with paragraph 4.9. The test also must be independently applied to each face of the coated fabric.

3.2.10 Oil Resistance (except Sandwich-Type Material)

After the outer surface of the coated material has been exposed to ASTM No. 1 oil for two hours at 20°C +/-2°C, there shall be no separation of proofing from the textile. There shall also be no residual tackiness when the two exposed faces are pressed together, and the proofing shall not smear when rubbed with a single pass of the finger. The test specimens shall be tested in accordance with paragraph 4.10.

3.2.11 Dimensional Stability (All Material Types)

The dimensional stability of the coated material shall be determined by exposing specimens to a temperature of 70°C +/- 1°C for 7 days. After conditioning, the change in dimension of the specimens shall be not more than +/-2%. The dimensional stability test shall be performed in accordance with paragraph 4.11.

3.2.12 Ocean Water Resistance (All Material Types)

The coated fabric shall be resistant to ocean water (salinity between 32 and 36 grams/kilogram) after being immersed for 30 days at a temperature of 20°C +/- 2°C. After the immersion period the test specimens shall be free from separation of proofing from fabric, and from cracks and tackiness. In the case of sandwich-type material, after the immersion period each side of the reversible fabric shall be tested for porosity. At 30 Kpa the leakage rate of air shall not exceed a total of 2 bubbles in 10 minutes. The test shall be performed in accordance with paragraph 4.12.

3.2.13 State of Cure (except Sandwich-Type Material)

The state of cure of the rubber coating shall be determined in accordance with paragraph 4.13. In the case of sandwich-type material this test shall be omitted.

3.2.14 Ozone Resistance (All Material Types)

The coated fabric specimens shall be exposed for 8 hours in an ozone chamber to an ozone concentration of 50 ppm (parts per hundred million) at a temperature of 20°C +/- 2°C. After the exposure period the test specimens shall show no significant cracking when examined by the unaided eye. In the case of sandwich-type material, after the ozone exposure period each side of the reversible fabric shall be tested for porosity. At 30 Kpa the leakage rate of air shall not exceed a total of 2 bubbles in 10 minutes. The ozone resistance test shall be performed in accordance with paragraph 4.14.

3.2.15 Freeze/Thaw Cycling (All Material Types)

(a) Coated Both Sides or Sandwich-Type Construction.

After exposure to the freeze/thaw cycle and conditioning period described in paragraph 4.17, the coated fabric shall be tested as follows:

- (1) After being subjected to the folding test described in paragraph 4.18, the coated fabric shall show no evidence of cracking, separations, stickiness or brittleness;
- (2) When tested in accordance with paragraph 4.3, the breaking strength in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;
- (3) When tested in accordance with paragraph 4.3, the elongation at break in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;
- (4) When tested in accordance with paragraph 4.4, the tear strength in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;
- (5) When tested in accordance with paragraph 4.6, the adhesion between the fabric and proofing in both the warp and weft directions shall be at least 90% of that obtained on the "as received" fabric;
- (6) When tested for porosity in accordance with paragraph 4.7, the coated fabric shall emit a maximum of 15 bubbles in 5 minutes from a maximum of 5 sites at a pressure of 30 Kpa.

(b) Coated Single Side

After exposure to the freeze/thaw cycle and conditioning period described in paragraph 4.17, the coated fabric shall be tested as follows:

- (1) After being subjected to the folding test described in paragraph 4.18, the coated fabric shall show no evidence of cracking, separations, stickiness or brittleness;
- (2) When tested in accordance with paragraph 4.3, the breaking strength in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;
- (3) When tested in accordance with paragraph 4.3, the elongation at break in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;

- (4) When tested in accordance with paragraph 4.4, the tear strength in both the warp and weft directions shall vary by no more than 10% from that obtained on the "as received" fabric;
- (5) When tested in accordance with paragraph 4.6, the adhesion between the fabric and proofing in both the warp and weft directions shall be at least 90% of that obtained on the "as received" fabric;
- (6) When tested for porosity in accordance with paragraph 4.7, the coated fabric shall emit a maximum of 15 bubbles in 5 minutes from a maximum of 5 sites at a pressure of 30 Kpa.

3.3 Material Requirements for Outer Canopies

3.3.1 Weight

(a) Coated Both Sides

When tested in accordance with paragraph 4.2, the weight of the coated fabric shall not be more than 275 g/m^2 . The variation in weight shall be not greater than 10%.

(b) Coated Single Side

When tested in accordance with paragraph 4.2, the weight of the coated fabric shall not be more than 200 g/m^2 . The variation in weight shall be not greater than 10%.

3.3.2 Breaking Strength (All Material Types)

The minimum breaking strength of the outer canopy material in warp and in weft directions shall be 950 N/50 mm of width. The material shall be tested in accordance with paragraph 4.3.

3.3.3 Elongation at Break (All Material Types)

The maximum elongation at break of the outer canopy material in the warp and weft directions shall be 35% over a 200 mm gauge length. The material shall be tested in accordance with paragraph 4.3.

3.3.4 Tear Strength - Wound Test Method (All Material Types)

The minimum tear strength of the outer canopy material shall be 400N in the warp and weft directions. The material shall be tested in accordance with paragraph 4.4.

3.3.5 Adhesion (All Material Types)

The minimum adhesion between proofing and basic fabric of the outer canopy material shall be 10N/10 mm of width in both warp and weft directions when tested by the method described in paragraph 4.6.

3.3.6 Low Temperature Flexing

After being tested at $-50^{\circ}\text{C} \pm 2^{\circ}\text{C}$ the material shall show no visible cracks when inspected under a magnification of 5X. The test specimens shall be tested in accordance with paragraph 4.9.

Note: The test must be independently applied to each face of the coated fabric if both sides are coated. If only one side is coated, then only the coated side shall be tested.

3.3.7 Freeze/Thaw Cycling (All Material Types)

As specified in paragraph 3.2.15 for buoyancy tubes and inflatable support for canopies. The porosity test shall be omitted.

3.3.8 Waterproofness (All Material Types)

The material of the outer canopy shall be tested for waterproofness in accordance with the method described in paragraph 4.15. No water shall pass through within 30 minutes. The coated fabric shall not contain any material that is known to be injurious to a survivor drinking rain water collected from the canopy.

3.3.9 Colourfastness to Light (All Material Types)

The outer surface of the outer canopy shall be a high visibility colour such as Fluorescent Flame Orange with good colour fastness. The material shall be exposed to continuous Xenon-Arc radiation to the corresponding AATCC Fading Units of an AATCC Blue Wool Standard L6. The material shall then be rated on the American Association of Textile Chemists and Colourists (AATCC) Grey Scale for evaluating change in colour (ISO International Standard ISO 105-B02). The maximum allowed colour change after the exposure period shall be a Grey Scale rating of 3.0. The test specimens shall be tested in accordance with paragraph 4.16.

3.4 Material Requirements for Inner Canopies

3.4.1 Weight (All Material Types)

As the inner canopy serves as a barrier to provide a static layer of air, it shall either be of a close weave construction or have a low porosity to air. If the fabric is a proofed product, the weight of the coated fabric shall not be more than 145 g/m². The total weight shall be tested in accordance with paragraph 4.2. The variation of weight of the coated fabric shall be not greater than 10%.

3.4.2 Breaking Strength (All Material Types)

The minimum breaking strength of the inner canopy material shall be 500 N/50 mm of width in the warp and weft directions. The material shall be tested in accordance with paragraph 4.3.

3.4.3 Elongation at Break (All Material Types)

The maximum elongation at break of the inner canopy material in the warp and weft directions shall be 35% over a 200 mm gauge length. The material shall be tested in accordance with paragraph 4.3.

3.4.4 Tear Strength - Wound Test Method (All Material Types)

The minimum tear strength of the inner canopy shall be 140 N in the warp and weft directions. The material shall be tested in accordance with paragraph 4.4.

3.4.5 Adhesion (All Material Types)

If proofed fabric is used the minimum adhesion between proofing and basic fabric of the inner canopy material shall be 10N/10mm of width in both warp and weft directions when tested by the method described in paragraph 4.6.

3.4.6 Colour (All Material Types)

The material shall be a relatively light shade of neutral colour, such as light grey, that shall not enhance glare within the raft.

4. **TEST METHODS**

4.1 Conditioning of Test specimens

Test specimens in the "as received" state shall be conditioned in 65 +/- 2% relative humidity at a temperature of 20°C +/- 2°C for a minimum of 16 hours prior to testing.

4.2 Weight

Cut from the sample 3 test specimens, each measuring 50 mm x 50 mm, from positions spaced evenly across the sample but not within 50 mm of a selvage. Other shapes and sizes of test specimen may be used provided that the area of each specimen is not less than 2500 mm² and that the calculations are suitably adjusted. Dry the test specimens to constant mass in an atmosphere with a relative humidity not higher than 10% at a temperature not exceeding 70°C for a minimum period of 3 hours. Remove specimens and allow to cool to 20° +/- 2°C in a desiccator for a period not exceeding 1 hour. Determine their masses to the nearest 0.01 g and their areas using a ruler with an accuracy of 0.5 mm. Report the mean value of the results obtained from the three specimens as the total mass per unit area of the material under test in g/m².

4.3 Breaking Strength and Elongation at Break

Cut from the test sample 10 rectangular specimens each measuring 50 mm wide and 300/400 mm long, 5 each with the longer side parallel to the directions of the warp and weft threads. Space the selection of specimens across the full width of the test sample but not within 50 mm of a selvage. Condition the test specimens as described in paragraph 4.1 and test the samples for breaking strength and elongation at break.

The breaking strength and elongation at break tests shall be performed on a power-driven constant-rate-of-extension machine (1) equipped with a suitable load weighing mechanism and recording system for measuring the applied force within +/- 1%. The tester shall have two grips, preferably rubber coated and compressed air operated, one of which shall be connected to the load weighing system and the other to a mechanism for separating the grips at a uniform rate of 50 +/- 2mm/min. for a distance of at least 500 mm.

Grip the specimen securely and evenly in the grips, using a 200 mm gauge length, so that the specimen length is in the direction of the pull. The clamping surface of the jaw shall be a minimum of 75 mm wide. The separation of the jaws shall continue until the specimen breaks. The breaking strength and the elongation at break shall be recorded and the mean value of the 5 specimens from each of the warp and weft directions reported.

Note (1): The constant-rate-of-extension machine: a testing machine in which one end of the specimen is held by a virtually stationary clamp and the other end is gripped in a clamp that is driven at a constant speed. A suitable system for detecting and recording the force is provided.

4.4 Tear Strength - Wound Test Method

From the test sample, cut 10 rectangular specimens 75 mm wide and 300/400 mm long, 5 each with the longer side parallel to the direction of the warp and weft threads. Space the specimens across the full width of the test sample, but not within 50 mm of a selvage. Make a 12mm cut across the middle of each specimen at right angles to the length. Condition the specimens as described in paragraph 4.1.

The tear strength shall be performed on a power-driven constant-rate-of-extension machine (1) equipped with a suitable load weighing mechanism and recording system for measuring the applied force within 1%. The tester shall have two grips, preferably rubber coated and compressed air operated, one of which shall be connected to the load recording system and the other to a mechanism for separating the grips at a uniform rate of 50 +/-2mm/min. for a distance of at least 500 mm.

Clamp the specimen in the grips using a 200 mm gauge length and so that the specimen length is in the pull direction. The clamping surface of the jaw shall be a minimum of 75mm wide. As the load is applied the specimen yields by tearing outward from both ends of the 12 mm cut and in the case of 2 ply fabric, by separation of the plies. The test is completed when the specimen has been completely ruptured. The maximum load obtained shall be recorded as the Wound Tearing Strength and the mean value of 5 specimens from each of the warp and weft directions reported.

4.5 Puncture Resistance

Cut from the test sample 5 rectangular specimens, each measuring 50 mm by 50 mm. Space the specimens evenly across the sample but not within 50 mm of a selvage. Condition the test pieces as described in paragraph 4.1.

The puncture resistance test shall be performed on a power-driven constant-rate-of-extension machine (1) equipped with a load weighing mechanism and recording system capable of measuring the applied force within +/- 1%. The test jig (Figure 1) shall consist of a probe connected to the load weighing mechanism of the test machine, and a specimen holder in the shape of a cage mounted on the movable crosshead of the test machine. The crosshead shall be capable of moving at a uniform rate of 50 +/- 2mm/min.

The probe should be fabricated from a steel rod, measuring 12.5 +/- 0.5 mm in diameter by approximately 125 mm in length with one end tapered to a 3 +/- 0.1 mm radius. The length of the taper should be 50 +/- 2.0 mm. The untapered end of the probe should be attached to a circular metal plate, measuring approximately 145 mm in diameter. Two holes are drilled in the plate for attaching the probe assembly to the compression table of the mechanism. The specimen cage (see Figure 1) is fabricated from four threaded bolts and three aluminum plates, measuring approximately 85 x 85 x 3 mm, with holes drilled at each corner. The cage is assembled by inserting the bolts in the holes of one plate and anchoring them with a locking washer and nut. A hole is cut in the centre of this plate to allow for attachment to the crosshead of the tester by suitable means. The remaining plates are anchored to the opposite ends of the bolts. A 25 +/- 0.2 mm diameter hole is cut in the centre of these plates and two sheets of carborundum paper, with corresponding holes in the centre and with rough surfaces facing each other, are inserted between the two lower plates to hold the specimen during testing.

Install the specimen cage assembly on the tester crosshead and the probe plate on the compression load weighing mechanism of the test machine.

Insert the test specimen into the centre of the specimen cage between the carborundum papers. Position the probe tip to touch the test specimen, energize the crosshead of the machine and puncture the specimen.

Record the maximum force required to puncture each specimen. The mean value of 5 test specimens shall be reported.

4.6 Adhesion

Cut from the test sample 4 rectangular pieces, each measuring 150 mm in width and 200 mm in length, 2 each with the longer side parallel to the direction of the warp and weft threads. Space the selection of the test pieces across the full width of the sample but not within 50 mm of a selvage. Condition the test pieces as described in paragraph 4.1.

Each pair of corresponding test pieces shall be adhered to each other, using a suitable adhesive, such that a higher adhesion strength is created between the proofing surfaces than the inherent adhesion strength between the proofing and underlying fabric. Prior to the application of the adhesive, lightly abrade the contact surfaces with a light abrasive paper and wipe surfaces with methyl ethyl ketone or toluene. Allow the surfaces to air dry until no solvent smell is detectable. After degreasing, apply a 25 mm wide strip of aluminum foil along one edge of each contact surface, parallel to the 200 mm direction, in order to leave an unadhered area for gripping in the test machine clamps. Make a light cut through one layer of coating, parallel to and at least 5 mm from the foil line on one of the corresponding test pieces.

Apply the adhesive as directed by the manufacturer and place the coated surfaces of the two pairs of test specimens together, taking care to eliminate any entrapped air pockets. This may be achieved by passing a roller weighing approximately 1 kg along the outer surfaces of each bonded test unit.

Cut 6 test specimens, each having dimensions of 25 mm in width and 150 mm in length, from each of the 2 bonded test units. The specimens shall be cut in such a way that the 150 mm dimension is parallel to the 150 mm dimensions of the bonded test unit. The 6 specimens shall be taken from the middle area of the test unit, discarding a 25 mm wide strip along each of the two sides. In the case of sandwich-type material, cut from the test sample 12 rectangular pieces, each measuring 25 mm in width and 150 mm in length, 6 each with the longer side parallel to the direction of the warp and weft threads. Space the direction of the test pieces across the full width of the sample but not within 50 mm of a selvage. At one end of each test piece separate the fabric from the proofing to a depth of 25 mm. Condition the test pieces as described in paragraph 4.1.

The adhesion tests between proofing and underlying fabric shall be performed on a power-driven constant-rate-of-extension machine (1) equipped with a suitable load weighing mechanism and recording system for measuring the applied force within +/- 1%. The tester shall have two grips, preferably rubber coated and compressed air operated, one of which shall be connected to the load weighing system and the other to a mechanism for separating the grips at a uniform rate of 50 +/- 2 mm/min for a distance of at least 500 mm.

Clamp the unadhered tabs of each test specimen securely and evenly in the grips of the test machine. Separate the grips at the test speed and record the force required to peel the proofing from the fabric. The load value for each specimen shall be the mean value of 10 consecutive peak values recorded within an approximate 75 mm peel distance. The mean value of 5 specimens, expressed as newtons per 10 mm of width, from each of the warp and weft directions, shall be reported.

Note: A suitable adhesive may be obtained from "MAX Splicing and Supply" 139 Milliwick Drive, Weston, Ontario, Canada M9L 1Y7, by ordering "SC-2000" two component liquid adhesive.

4.7

Porosity

Cut a specimen measuring 425 mm in the warp direction and 500 mm in the weft direction. Dust the outer face with talc powder and roll the specimen in the warp direction around a mandrel measuring approximately 20 mm in diameter and 525 mm in length, with the powdered face next to the mandrel. Wind a string, tape or wire helically around the rolled specimen and withdraw the mandrel. Grip approximately 40 mm of each end of the specimen in suitable clamps, remove the winding, and suspend the specimen from a fixed support so that the upper end is held stationary. From the lower clamp suspend a mass of approximately 23 kg and, after a period of one minute, rotate the lower clamp through 4 turns at an approximate rate of one turn in 5 seconds. Allow the roll to untwist at about the same rate and rotate 4 turns in the opposite direction. Again allow the roll to untwist at the same rate, remove the load, release the fabric from the clamps, and unroll and smooth out the specimens by hand.

Cut a circular specimen, 330 mm in diameter, from the previously twisted sample and seal the edges by dipping in molten wax (a mixture of 3-1/2 parts petroleum jelly and 2 part beeswax) to leave a wax-free central test area approximately 300 mm in diameter. When the wax is set, clamp the specimen, with the outer face uppermost, firmly in the apparatus shown in Figure 2. Apply and maintain on the inner face of the fabric an air pressure of 30 +/- 2 Kpa. Between 10 and 15 minutes after the pressure has become steady, flood the outer face of the fabric with water so that the crown of the bulge is immersed to a depth of approximately 10 mm. After a period of one minute, brush the entire surface with a soft brush. After a further period of five minutes, record zero time and count the number of bubbles breaking the surface of the water in the required time. Disregard any test specimen containing an obvious pinhole. The test shall be carried out at a temperature of 20°C ± 2°C.

4.8

Flex Cracking - Using a De Mattia-Type machine

Cut three rectangular specimens, 38.0 mm in width and 125 mm in length (in the case of sandwich-type material, 120 mm in width and 150 mm in length), with the length parallel to the warp direction, and an additional three specimens, of the same dimensions, with the length parallel to the weft direction. Space the selection of specimens across the full width of the test sample, but not within 50 mm of a selvage. Condition the specimens as described in paragraph 4.1.

The De Mattia-Type flex testing machine consists of pairs of flat grips, one grip of each pair being positioned vertically above the other. One of the grips of each pair is capable of a reciprocating motion in a vertical plane, with a stroke length of 58.0 +/- 3 mm and a speed of 300 +/- 10 cycles per minute. The pairs of grips are 70.0 +/- 3 mm apart when in the "open" position and 12.0 +/- 0.5 mm when in the "closed" position. In the De Mattia test, the specimens are subjected to repeated bending through an angle of approximately 180 degrees.

Fold each test specimen with the outer surface facing outwards along lines 12 mm from, and parallel to, each of the longer edges. In the case of sandwich-type material fold each test specimen along lines 30 mm from, and parallel to, each of the longer edges. Mount each folded test specimen between a pair of grips of the flexing apparatus so that the centre section will be subjected to an outward fold. Care should be taken that the specimens are suitably spaced so as not to come in contact with each other at any point in the flex cycle. Mount the specimens slightly taut while the grips are in the open position. Move the grips together by hand and guide each specimen into a fold at approximately its midpoint. Start the test. At the completion of 200,000 cycles, move the grips by hand to the closed position and examine the specimens for cracks in the coating. Failure in any test specimen shall be deemed to have occurred when one or more cracks, not less than 1.5 mm in length and extending through the coating to the basecloth, are present at the completion of the test. In the case of sandwich-type material, the specimens shall be evaluated by the porosity test. The flexing test shall be carried out at a temperature of 20°C +/- 2°C.

To perform the porosity test, cut a circular specimen 100 mm in diameter, from the middle of the flexed sample and seal the edges by dipping in molten wax (a mixture of 3-1/2 parts petroleum jelly and 1 part beeswax) to leave a wax-free central test area approximately 75 mm in diameter. When the wax is set, clamp the specimen firmly in the apparatus with the smaller dimensions shown in Figure 2 and complete the test as described in paragraph 4.7.

4.9 Low temperature Flexing

Cut 6 rectangular specimens 25 mm in width (in the case of sandwich-type material 100 mm in width) and 110 mm in length, 3 each with the longer side parallel to the direction of the warp and weft threads. Space the selection of the specimens across the full width of the test sample, but not within 50 mm of a selvage. Condition the specimens as described in paragraph 4.1.

Place the test specimens between glass plates, with dimensions of approximately 125 mm by 175 mm, to eliminate curling or bending. The thickness of the glass plates shall be such as to permit ease of handling. Place the glass plates with the specimens in a cold chamber for a minimum period of 4 hours at the specified temperature.

The cold chamber in which the test specimens are exposed shall be sufficient in size to contain the bending fixture used for testing the specimens, and to permit the operation of the fixture without removal from the chamber. The chamber shall also have sufficient work space to permit the conditioning of the test specimens. It shall be capable of maintaining a uniform atmosphere of dry air at the specified temperature within a tolerance of +/- 2°C. The basic requirements for the test jig required for bending the specimens are shown in Figures 3 and 4. Weight tolerances and dimensions shall be as specified in Figure 4.

At the termination of the exposure period, and while still in the test chamber, remove the specimens from between the glass plates and place them one at a time into the test jig with the flexing plate held in the open position by the trigger pin. Face the side to be evaluated away from the mandrel. Gloves must be worn at all times when handling specimens prior to making the bend test. Before using, the gloves shall be cooled in the cold chamber.

As soon as the specimen is in position in the test jig, release the trigger and permit the flexing plate to make a free fall. After all specimens have been tested, remove them from the cold chamber and examine each under 5X magnification while wrapped 180° around a mandrel measuring approximately 3 mm in diameter.

In the case of sandwich-type material, the specimens shall be evaluated by the porosity test. To perform this test, cut a circular test specimen, 100 mm in diameter, from each specimen so that the flexing line passes through the centre of the specimen. Seal the edge of the specimen and perform the test as described in the last section of paragraph 4.8.

Report the results of the test as "passed" or "failed".

Note:

Detailed drawings of the bending jig to perform the low temperature bend test for fabrics coated with rubber and rubber-like materials are available at a nominal cost from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA., USA., 19103. Request adjunct No. 12-421360-00.

4.10

Oil Resistance

Cut two circular test specimens each measuring 70 mm in diameter. Condition the specimens as described in paragraph 4.1 and test them for oil resistance not less than 16 hours nor more than 6 months after vulcanization or curing of the proofing.

The apparatus required to perform the test shall consist of a base-plate and an open-ended cylindrical chamber which is held tightly against the test specimen by wing nuts mounted on bolts (see Figure 5). A hole measuring approximately 30 mm in diameter may be made in the base-plate for the examination of the surface not in contact with the fluid. During the test the opening in the top of the chamber is closed by a close fitting plug.

The exposure test shall be performed at a temperature of 20°C +/- 2°C for a 3 hour period on the outer surface of the test specimen. The test liquid shall be ASTM Reference Oil No. 1. The properties of this oil are described in ASTM method D471.

The test specimen shall be placed in the apparatus as shown in Figure 5. The chamber of the apparatus is then filled with the test liquid to a depth of approximately 15 mm and the plug inserted. The apparatus is maintained at the required temperature for the duration of the liquid contact. At the end of the contact period, the test liquid is removed and the test piece released. Any surplus liquid is removed from the surface of the test piece by blotting with filter paper or a textile fabric which does not deposit lint. The specimen shall be folded over so that the surfaces, which were in contact with the test liquid, are pressed together to check for residual tackiness. With the specimen opened out, a single pass of the finger over the exposed surface shall not produce smearing.

4.11

Dimensional Stability

Prepare two specimens as shown in Figure 6. Condition the test specimens as described in paragraph 4.1 and measure the distance between the marks in the warp and weft directions. Freely suspend one specimen in an oven for 7 days at 70°C +/- 1°C and suspend the other specimen over water in a loosely closed vessel for the same period of time at 70°C +/- 1°C. After the exposure period remove the test specimens, condition them as described in paragraph 4.1 and measure the distance between marks in the warp and weft directions. Calculate and report the percent dimensional changes based on the distance between marks noted after conditioning.

4.12

Ocean Water Resistance

Cut 3 rectangular specimens, each measuring 50 mm in width and 150 mm in length, (in the case of sandwich-type material, each measuring 125 mm in width and 150 mm in length) from positions spaced evenly across the sample. Immerse the test specimens for 7 days at 20°C +/- 2°C in substitute ocean water, which shall be prepared according to ASTM D1141, Section 7.

The test specimens should be completely immersed by suspension in the prepared solution, in a suitable non-metallic container. They should not contact each other or the sides or bottom of the container.

After the immersion period, the test specimens shall be free from separation of proofing from fabric, and shall be free from cracks and tackiness.

In the case of sandwich-type material, the specimens shall be evaluated by the porosity test. To perform this test, cut from each specimen a circular specimen, measuring 100 mm in diameter. Seal the edge of the specimen and perform the test as described in the last section of paragraph 4.8.

4.13

State of Cure

Apply 3 or 4 drops of xylene to an area of approximately 4 cm² of the rubber proofing or interply rubber proofing in multiple fabric. Let stand for 1 minute. If the liquid spreads rapidly and is quickly absorbed, leaving a velvety surface, and the proofing does not become tacky to a finger pressed on it, then the proofing is cured. If the xylene spreads slowly, is not rapidly absorbed by the rubber, and the proofing becomes locally swollen, soft, and tacky to the touch, and will stick to a finger under light pressure, then the rubber proofing is undercured or uncured.

This test may be applied to any part of a sample or roll not to be used for another test.

4.14

Ozone Resistance

Cut 6 rectangular specimens, 25 mm in width and 100 mm in length (in the case of sandwich-type material, 125 mm in width and 130 mm in length), 3 each with the longer side parallel to the direction of the warp and weft threads. Space the selection of the specimens across the full width of the test sample, but not within 50 mm of a selvage. Condition the specimens as described in paragraph 4.1.

The test specimens shall be folded, with the exterior surface facing outwards, through 180° around a mandrel with a diameter measuring six times the material thickness. After folding, the trailing ends of each specimen shall be clamped together by a suitable clamp located immediately adjacent to the mandrel in such a manner that the folded portion is held firmly around the mandrel circumference. The folded specimens shall be exposed for a period of 8 hours in an ozone cabinet to an ozone concentration of 50 pphm (parts per hundred million) for buoyancy tubes and inflatable supports for canopy materials, and 25 pphm for floor materials at a temperature of 20°C +/- 2°C. After the exposure period, the exterior surfaces of the test specimens shall show no significant cracks.

In the case of sandwich-type material, both sides of the sample shall be evaluated by the porosity test. To perform this test cut from each of the 12 specimens a circular specimen measuring 100 mm in diameter. Seal the edges of the specimen and perform the test as described in the last section of paragraph 4.8.

4.15

Waterproofness

In the selection of specimen for the water penetration test, the sample shall initially be examined by background light in a darkened room for isolated pinholes. The presence of suspended pinholes detected by this method must be confirmed by the water penetration test and reported.

From a pinhole free sample, cut a square specimen 300 mm in length and 300 mm in width. Fold the specimen twice at right angles and open it out into the form of a cone, with the exterior surface facing inwards. Secure the cone with a paper clip, insert it into a suitable sized funnel with its point facing downwards and support the funnel over a beaker. Pour 500 ml of distilled water at a temperature of 20° C +/- 2°C carefully into the cone. Monitor the penetration or seepage of water through the cone over a period of 30 minutes. Any passage of water through the material over the test period shall be recorded.

4.16 Colourfastness to Light

Condition the 6 specimens as described in paragraph 4.1 and place them in the specimen holders of an Xenon-Arc lamp apparatus. The dimensions of the specimens will be controlled by the dimension of the specimen holders. Place the filled specimen holders on the specimen rack of the apparatus with the holders supported at both the top and bottom in vertical alignment. Fill empty spaces in the specimen rack with holders containing white cardboard or dummy specimens. Adjust the controls of the apparatus for a black panel temperature of 63°C +/- 1°C and a relative humidity of 30 +/- 5% (ISO 105-B02, Method 3). Expose the specimens, along with AATCC Blue Wool Standard L6, to continuous light radiation for the corresponding AATCC Fading Units. After exposure let the specimens condition in the dark at room temperature for 24 hours before assessing the colour fastness. Assessment in numerical ratings shall be performed as per ISO 105-302 using the AATCC 9-step Grey Scale for evaluating change in colour.

4.17 Freeze-Thaw Cycling

The freeze-thaw cycle shall consist of seven (7) continuous 24 hour periods during which the sample is held alternately at -40° C and +70° C (+/-2°C). The cycle shall commence with a 24 hour period at -40°C.

Immediately following the freeze/thaw cycle, the sample shall be conditioned for a period of at least 1 hour at a room temperature of +20°C +/-2°C and a relative humidity of 65+/-2%, after which time the specimen shall be cut from the sample and tested as per paragraph 3.2.15.

4.18 Folding Test

One specimen, measuring 300 mm x 300 mm, shall be folded consecutively in two directions, parallel to the edges and at right angles to each other, so as to reduce the exposed area of the specimen to one quarter of its original size. The specimen shall then be completely unfolded and refolded along the same creases, but with each fold reversed in direction. After each folding, press the fold by rubbing fingers and thumb along it. Inspect the specimen for cracks, separation, stickiness or brittleness. A 2x magnification shall be used to inspect for cracking or brittleness.

5. **TESTS TO BE CARRIED OUT ON PRODUCTION PROOFED FABRIC**

5.1 **Buoyancy Tubes and Floor Fabric**

One sample from each 10 rolls or 1000 meters of buoyancy tube, inflatable support for canopies, and floor fabric shall be tested for the following properties:

- 5.1.1 Variation of weight across width, as described in paragraph 3.2.1;
- 5.1.2 Adhesion, as described in paragraph 3.2.6;
- 5.1.3 Porosity, as described in paragraph 3.2.7;
- 5.1.4 State of Cure, as described in paragraph 3.2.13;
- 5.1.5 Breaking Strength and Elongation at Break as described in paragraphs 3.2.2 and 3.2.3;
- 5.1.6 Tear Strength, as described in paragraph 3.2.4;
- 5.1.7 Dimensional Stability, as described in paragraph 3.2.11;
- 5.1.8 Low Temperature Flexing, as described in paragraph 3.2.9;
- 5.1.9 Oil Resistance, as described in paragraph 3.2.10.

5.2 **Outer Canopy Fabric**

One sample from each 10 rolls or 1000 meters of outer canopy fabric shall be tested for the following properties:

- 5.2.1 Variation of weight across width, as described in paragraph 3.3.1;
- 5.2.2 Adhesion, as described in paragraph 3.3.5;
- 5.2.3 Waterproofness, as described in paragraph 3.3.8;
- 5.2.4 Breaking Strength and Elongation at Break as described in paragraphs 3.3.2 and 3.3. 3.
- 5.2.5 Tear Strength, as described in paragraph 3.3.4;
- 5.2.6 Dimensional Stability, as described in paragraph 3.2.11.

5.3 Inner Canopy Fabric

One sample from each 1000 meters or 10 rolls of inner canopy fabric shall be tested for the following properties:

5.3.1 Variation of weight across width, as described in paragraph 3.4.1;

5.3.2 Breaking Strength and Elongation at break, as described in paragraphs 3.4.2 and 3.4.3.

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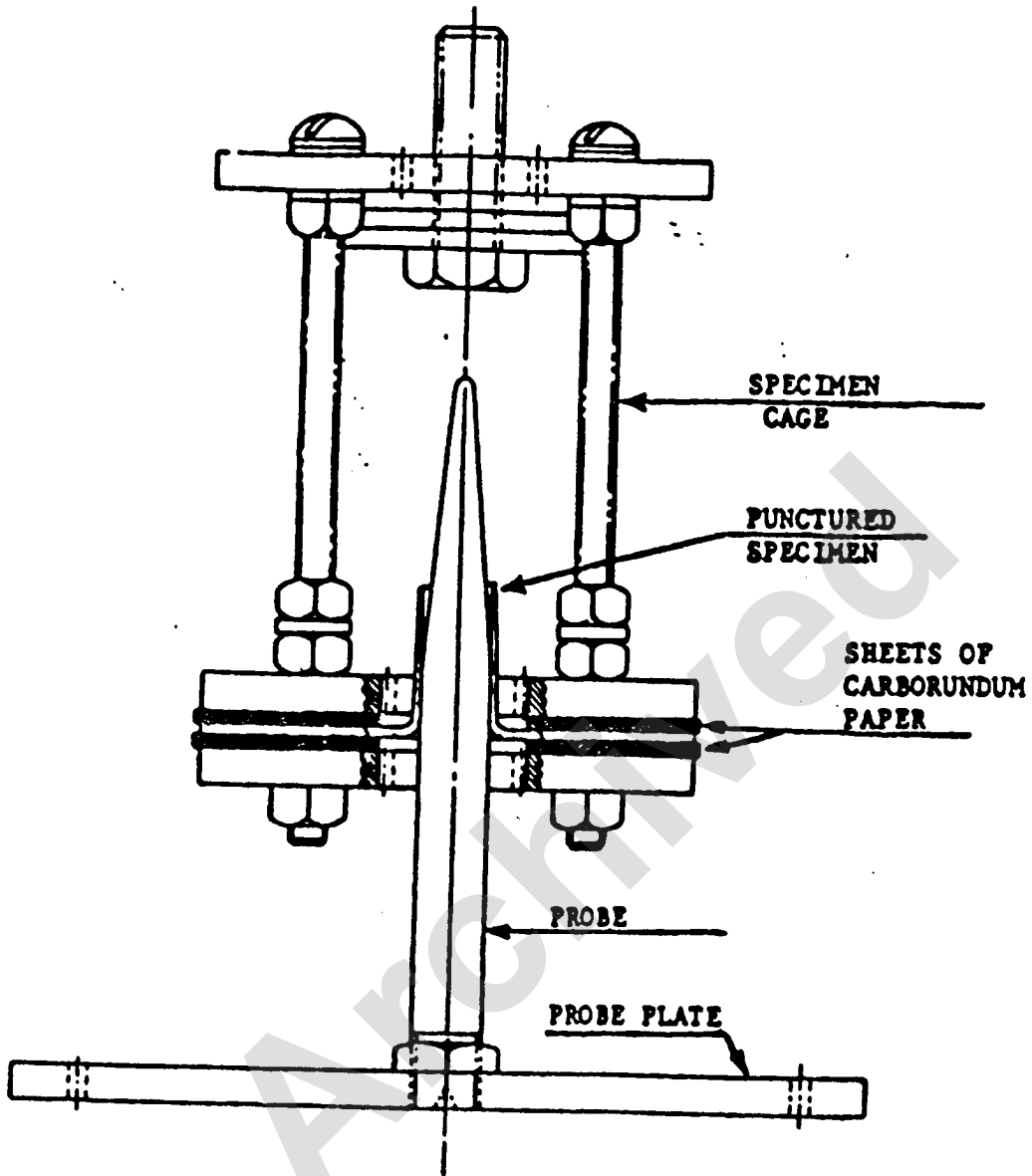
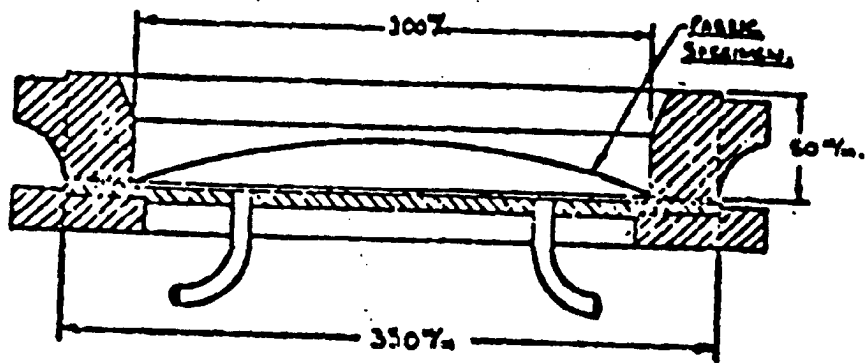


FIG. 1
PUNCTURE RESISTANCE AND ELONGATION TEST FIXTURE



Dimensions for air permeability test:

A = 300 mm

B = 350 mm

Dimensions for flex cracking, low temperature flexing test, synthetic sea-water resistance test, and ozone resistance test:

A = 75 mm

B = 125 mm

FIG. 2
POROSITY OR AIR PERMEABILITY TEST APPARATUS

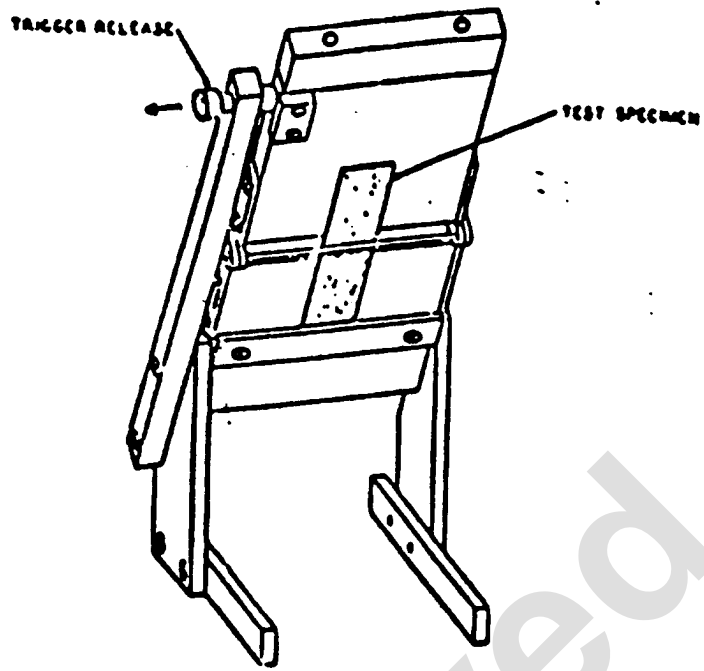
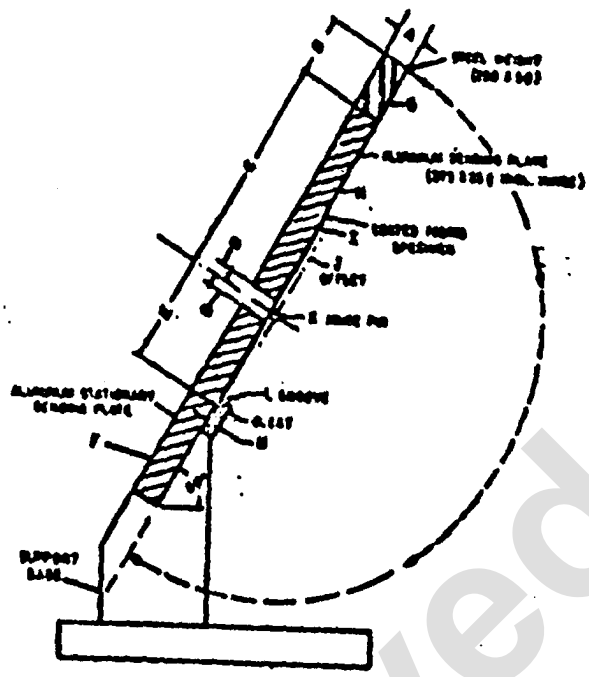
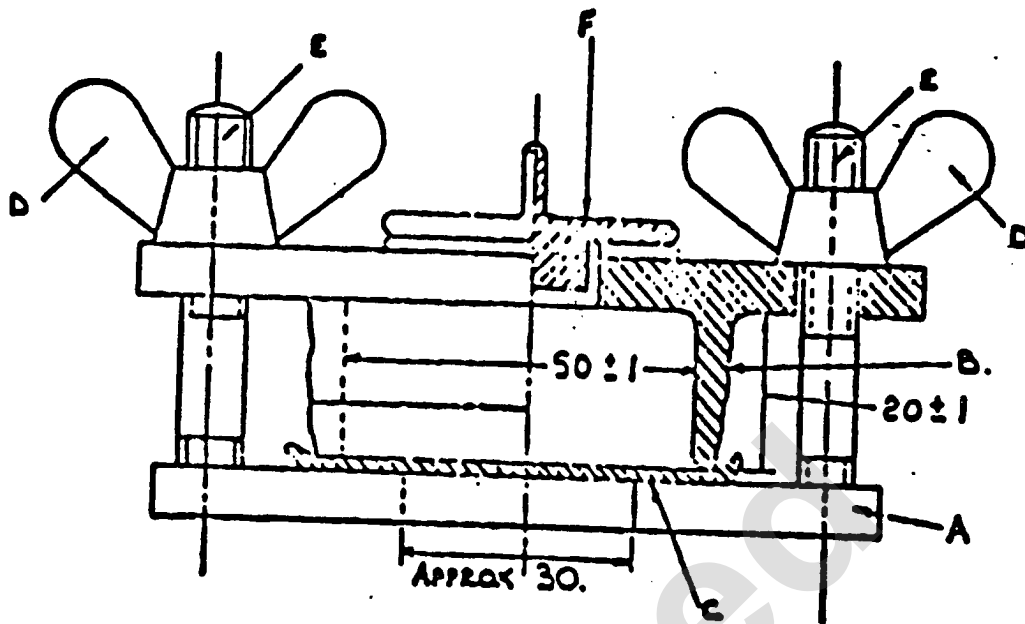


FIG. 3.
BENDING JIG FOR COATED FABRICS



	mm
A	13
B	25
C	100
D	3
E	48
F	100 by 110 by 13
G	100 by 25 by 13
H	100 by 100 by 13
I	100 by 25
J	3
K	3
L	3 by 3
M	6

FIG. 4
BENDING JIG. SCHEMATIC DIMENSIONS



- A Base-plate.
- B Open-ended cylindrical chamber.
- C Test specimen
- D Wing nuts.
- E Bolts mounted on base-plate.
- F Close fitting plug.

All dimensions given in mm.

FIG. 5.
APPARATUS TO PERFORM OIL RESISTANCE TEST.

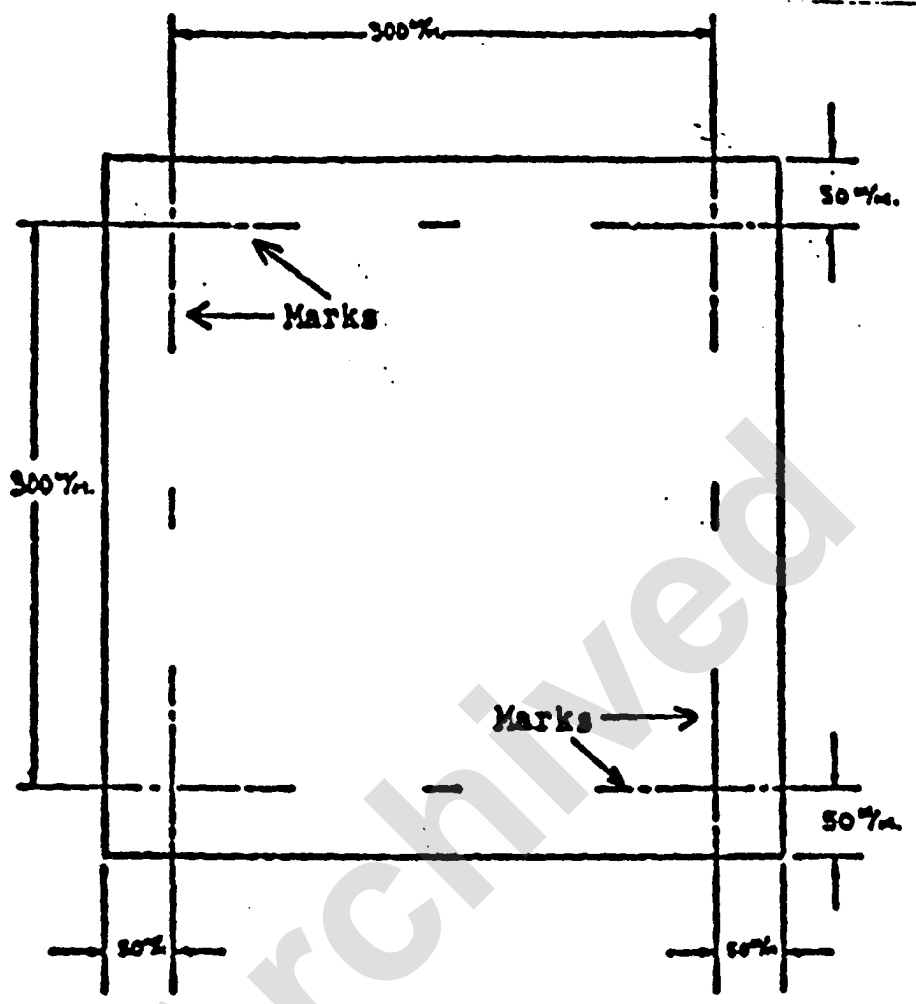


FIG. 6.
 MARKING DIAGRAM FOR RELAXATION SHRINKAGE FABRIC TEST SPECIMEN.