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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-I-538

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Insulation, Electrical, Pasted-Mica

FSC 5640

NOTICE

This document has been taken directly from U.S. Military Specification HH-I-538b and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace HH-I-538b. Any part numbers established by the original specification remain unchanged.

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1. SCOPE AND CLASSIFICATION:

1.1 Scope:

This specification covers pasted-mica electrical insulation for molded armature slot bases, commutator insulation, shells, heating elements, and other similar insulating purposes.

1.2 Classification:

1.2.1 Types and forms: Pasted-mica electrical insulation furnished under this specification shall be of the following types and forms, as specified (see 6.1).

Type PMR - Pasted mica, rigid
  Form S - Sheets (plates)
Type PMM - Pasted mica, moldable
  Form R - Rings
  Form S - Sheets (plates)
  Form T - Tubes
  Form X - Special shapes
Type PMF - Pasted mica, flexible
  Form S - Sheets (plates)
Type PMH - Pasted mica, heat-resistant
  Form S - Sheets (plates)

2. APPLICABLE DOCUMENTS:

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

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

PPP-B-585	Boxes, Wood, Wirebound
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
PPP-B-636	Box, Fiberboard
PPP-T-60	Tape, Pressure Sensitive Adhesive, Waterproof
FED-STD-102	Preservation, Packaging and Packing Levels
FED-STD-123	Marking for Domestic Shipment, (Civilian Agencies)
MIL-A-101	Adhesive, Water-Resistant, For Sealing Fiberboard Boxes

2.1 (Continued):

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 Marking for Shipment and Storage

2.2 American Standards Association, Inc. Publications:

Available from the American Standards Association, Inc., 10 East 40th Street, New York 16, NY.

C68.1 Measurement of Test Voltage in Dielectric Tests

2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 2131-62 Specification for Natural Muscovite Mica Splittings

2.4 National Electrical Manufacturers Association Publications:

Available from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, NY.

ME1-1956 Manufactured Electrical Mica

3. RREQUIREMENTS:

3.1 Composition:

3.1.1 Pasted-mica electrical insulation shall consist of, or contain, muscovite mica conforming to the requirements of ASTM D 2131-62 unless phlogopite mica is specifically required. When use of phlogopite mica is required, the electrical insulation, unless otherwise specified, shall conform to the minimum standards of performance prescribed hereinafter, for the corresponding item employing muscovite mica.

3.1.2 The mica shall not be calcined or treated in any manner which will adversely affect its suitability for the purpose intended.

3.2 Construction:

3.2.1 General: The pasted mica shall consist of layers of overlapping mica splittings held together by a suitable binding material. The finished surface shall be reasonably smooth and free from excess binder and loosened mica, and shall not be tacky.

3.2.2 Mica splittings:

3.2.2.1 Mica splittings used for pasted-mica electrical insulation shall be sound, clean, and free from mineral inclusions.

3.2.2.2 The size and thickness range of mica splittings used in the specified types of pasted-mica electrical insulation shall conform to the requirements shown in table I and ASTM D2131-62 for the applicable grade.

TABLE I - Size and thickness ranges for mica splittings

Type	Thickness	Minimum grade of splittings	Thickness, 10 splittings	
			Minimum	Maximum
	Inch		*Inch*	*Inch*
PMR	Up to 0.020, inclusive	Grade 6—3rd	0.007	0.011
	Over 0.020	Grade 6—3rd	.007	.011
PMM	Less than 0.015	Grade 6—3rd	.007	.011
	0.015 to 0.063 incl.	Grade 6—3rd	.007	.011
PMF	Less than 0.010	Grade 6—1st	.007	.010
	0.010 to 0.020, incl.	Grade 6—2nd	.007	.011
	Over 0.020	Grade 6—3rd	.007	.011

3.2.3 Binding material: The binding material for pasted mica electrical insulation shall be a high-quality insulating material free from any deleterious ingredients which may adversely affect the physical and electrical properties of the combination of mica and binder. The binding material shall be uniformly distributed and the proportion of binding material to mica shall be as low as is compatible with requisite mechanical and electrical properties hereinafter specified. It shall be chemically inert with respect to materials normally used in electrical equipment, under conditions of rated operating temperature and presence of humid salt atmosphere.

3.3 Type PMR, pasted mica, rigid:

3.3.1 General: Unless otherwise specified, type PMR mica shall be furnished in form S, sheets (plates).

3.3.2 Uniformity and density: The mica splittings and the binding material shall be as uniformly distributed as practicable, with neither high spots that have received excessive pressure nor low spots or pockets that are filled with binder. The density uniformity shall be taken as an index of the material uniformity and absence of air pockets. This density shall average not less than 0.088 pound per cubic inch per lot and shall be not less than 0.086 pound per cubic inch for each sheet.

3.3.3 Mica content: The mica content shall be not less than 93 percent by weight.

3.3.4 Binder-to-mica adhesion: The binding material shall provide satisfactory adhesion between the mica splittings. Satisfactory adhesion is indicated by the absence of delamination and surface cracking when sheets (plates) are bent to the radii specified in 4.5.4.

3.3.5 Compressibility, exudation, and slippage: The thickness of type PMR mica shall not decrease by more than 6 percent and there shall be only slight amounts of either splittings displacement or binder exudation when the material is compressed under 2,500 pounds per square inch at a temperature of 150 degrees C. (302 degrees F.) as described in 4.5.5.1.

3.3.6 Dielectric strength: The dielectric qualities of type PMR electrical insulation shall be expressed in terms of short-time and step-by-step dielectric break-down values. For all thicknesses, rigid mica sheets (plates) shall have average short-time dielectric strength of at least 600 volts per mil of specified thickness, and at least 390 volts per mil step by step.

3.3.7 Dimensions and tolerances: Size of sheets (plates) furnished shall be 18 by 36 inches or 25 by 37 inches, as specified. A tolerance of plus or minus 1/2 inch will be allowed. The sheets (plates) shall be furnished in standard thickness of 0.020, 0.025, 0.030, 0.0325, 0.035, 0.040, 0.045, and 0.050 inch, as specified. The thickness shall not vary by more than plus or minus 0.002 inch from the nominal value, and the average of 10 measurements shall be within plus or minus 0.001 inch of the specified thickness.

3.4 Type PMM, pasted mica, moldable:

3.4.1 Form R, rings:

3.4.1.1 General: The molded mica rings shall be made in accordance with an approved design or dimensional drawing furnished by the procuring agency. The rings may be either press-molded or form-molded, unless one is specified in the contract or order.

3.4.1.2 Mica content: The mica content of press molded rings, which, normally are 6 inches or less in diameter, shall be not less than 80 percent by weight. The mica content of form-molded rings, either complete or in sectional condition, shall be not less than 82 percent by weight, unless otherwise specified.

3.4.1.3 Dielectric strength: The dielectric strength for type PMM molded mica rings shall be as specified. Where particular values are not specified, minimum dielectric strength for type PMM mold rings shall be 125 volts per mil short-time and 75 volts per mil step-by-step.

3.4.1.4 Dimensions and tolerances: The dimensions and tolerances of molded mica rings shall be as specified on the dimensional drawing. The wall thickness shall not vary from those specified by more than the values shown in table II.

TABLE II - tolerance for wall thickness, type PMM, form R

Wall thickness	Tolerances for wall thickness plus or minus			
	Diameter up to 1 inch	Diameter 1 to 3 inches	Diameter 3 to 7 inches	Diameter 7 to 20 inches
Inches	*Inch*	*Inch*	*Inch*	*Inch*
Under 1/32	0.003	0.005	0.007	0.009
1/32 to 5/64	—	.007	.009	.010
5/64 and over	—	—	.012	.015

3.4.2 Form S, sheets (plates):

3.4.2.1 Mica content: The mica content shall be not less than 82 percent by weight.

3.4.2.2 Moldability: When uniformly heated to a temperature of 135 degrees C. (275 degrees F.) sheets (plates) of moldable mica shall be capable of being readily molded to the simple test form as described in 4.5.6, without chipping, flaking, cracking, or breaking. The molded form shall be retained upon cooling to room temperature.

3.4.2.3 Dielectric strength: Sheets (plates) of moldable mica shall have a dielectric strength in accordance with table III.

TABLE III. Dielectric strength, according to thickness, type PMM, form S

Thickness	Minimum average dielectric strength	
	Short time	Step-by-step
Inches	*Volts per mil.*	*Volts per mil.*
Up to 0.036	500	390
0.036 to 0.0625	350	250

3.4.2.4 Dimensions and tolerances: Size of sheets (plates) furnished shall be 18 by 36 inches or 25 by 37 inches, as specified. A tolerance of plus or minus 1/2 inch will be allowed. The sheets (plates) shall be furnished in thicknesses of 0.005, 0.010, 0.015, 0.020, 0.025, 0.030, 0.0325, 0.035, 0.040, 0.050, and 0.0625 inch as specified.

3.4.2.4.1 Milled material: Material milled to thicknesses of 0.020 to 0.050 inch, shall not vary by more than plus or minus 0.003 inch from the nominal value, and the average shall be within plus or minus 0.002 inch of the specified thickness; for material milled to thicknesses over 0.050 inch, the corresponding values shall be plus or minus 6 percent and plus or minus 4 percent, respectively.

3.4.2.4.2 Unmilled material: The average thickness of unmilled or rough milled material in thickness less than 0.015 inch shall be within plus or minus .003 inch of the specified thickness. Unmilled or rough milled material in thickness from 0.015 to 0.063 inch, shall not vary by more than plus or minus 0.008 inch from the nominal value, and the average shall be within plus or minus 0.005 inch of the specified thickness.

3.4.3 Form T, tubing:

3.4.3.1 General: Pasted-mica tubing of all cross-sectional shapes shall be included under form T; however, unless otherwise specified, tubing of circular cross-section shall be furnished. Unless otherwise specified, a thin protective covering of paper shall be applied to the outside of the tubing 1/4 inch in inside diameter and over and may be applied to the smaller sizes.

3.4.3.2 Mica content: The mica content shall be not less than 80 percent by weight for inside diameters greater than 1/4 inch. For inside diameters of 1/4 inch or less, the mica content shall be not less than 75 percent by weight. For tubing of other than circular cross-section, the mica content shall be not less than 70 percent by weight. Where a protective covering is supplied, the minimum mica content of the tubing may be 5 percent less, on the total weight basis.

3.4.3.3 Dielectric strength: The dielectric qualities required of mica tubing shall be expressed in terms of average dielectric breakdown values. For wall thicknesses of 1/8 inch or less, mica tubing of circular cross-section shall have a dielectric strength of 200 volts per mil of specified thickness step-by-step and 300 volts per mil short-time. For shapes other than circular cross-section the dielectric strength shall be as specified.

3.4.3.4 Dimensions and tolerances: Unless otherwise specified, mica tubing shall be furnished in the standard dimensions shown in table IV, as required.

TABLE IV - Standard dimensions, type PMM, form T

Inside diameter	Outside diameter	Wall thickness	Length
Inch	*Inches*	*Inch*	*Inches*
1/8	1/4	1/16	12
1/8	5/16	3/32	12
1/4	3/8	1/16	12
5/16	7/16	1/16	24
3/8	1/2	1/16	24
1/2	5/8	1/16	36
5/8	3/4	1/16	36
1	1-1/8	1/16	36

A tolerance of plus or minus 1/2 inch will be allowed in the specified length of the tubing. The average inside diameter of molded mica tubing shall be within plus 0.005 or minus 0.003 inch of the specified diameter. The average outside diameter of molded mica tubing shall be within plus or minus 0.010 inch of the specified diameter.

3.4.4 Form X, special shapes:

3.4.4.1 General: Molded and formed sections, such as armature slot bases, shields, and shells, as well as any special sections that may be specified, shall comprise form X. These items shall be made in accordance with an approved design or dimensional drawing furnished by the procuring agency.

3.4.4.2 Mica content: The mica content shall be not less than 80 percent by weight for simple shapes and 75 percent for small and intricate shapes, unless otherwise specified.

3.4.4.3 Dielectric strength: Molded and formed sections shall satisfy the dielectric strength requirements as specified for type PMM, form R. (See 3.4.1.3.)

3.4.4.4 Dimensions and tolerances: The dimensions and tolerances of molded and formed sections shall be as specified on the dimensional drawing.

3.5 Type PMF, pasted mica, flexible:

3.5.1 General: Type PMF electrical insulation shall be suitable for forming into or being applied onto ordinary shapes without any application of heat. Unless otherwise specified, type PMF mica shall be furnished in form S sheets (plates), and shall be packed with suitable interleaving material to minimize sticking.

3.5.2 Mica content: The mica content shall be not less than 80 percent by weight.

3.5.3 Flexibility: Type PMF mica sheets shall retain sufficient flexibility at a temperature of 25 degrees C. (77 degrees F.) to be capable of ready application to the test form described in 4.5.7 without chipping, flaking, or breaking.

3.5.4 Dielectric strength: Type PMF mica sheets shall have a dielectric strength as shown in table V

TABLE V - Dielectric strength, according to thickness, type PMF, form S

Thickness	Minimum average dielectric strength	
	Short-time	Step-by-step
Inches	*Volts per mil.*	*Volts per mil.*
0.005 up to 0.010 ..	525	450
.010 up to .020 ..	350	250
.020 and over	300	200

3.5.5 Dimensions and tolerances: Unless otherwise specified, size of sheets furnished shall be 18 by 36 inches, a tolerance of plus or minus 1/2 inch being allowed. Unless otherwise specified, the sheets shall be furnished in thicknesses of 0.005, 0.010, 0.015, 0.020, 0.025, 0.030, 0.0325, 0.035, 0.0375, 0.040, 0.045, 0.050, 0.0625, and 0.125 inch, as specified. For thicknesses less than 0.010 inch, measured values shall not vary by more than plus 0.007 and minus 0.003 inch from the nominal value; and the average shall be within plus 0.003 and minus 0.001 inch of the nominal value. For thicknesses of 0.010 to 0.020 inch, the corresponding values shall be plus 0.008, minus 0.005, and plus or minus 0.003 inch, respectively. For thicknesses of 0.020 inch and greater the corresponding values shall be plus 0.010, minus 0.008, and plus or minus 0.005 inch, respectively.

3.6 Type PMH, pasted mica, heat-resistant:

3.6.1 General: Type PMH electrical insulation shall be inorganic bonded, rigid, of uniform density, high dielectric strength, and suitable for use at high temperature where no water is present.

3.6.2 Uniformity and density: The mica splittings and the binding material shall be as uniformly distributed as practicable, with neither high spots that have received excessive pressure nor low spots or pockets that are filled with binder. The density uniformity shall be taken as an index of the material uniformity and absence of air pockets. This density shall average not less than 0.080-pound-per-cubic-inch-per-lot and shall be not less than 0.075-pound-per-cubic-inch for each sheet.

3.6.3 Mica content: The mica content shall be not less than 80 percent by weight.

3.6.4 Binder-to-mica adhesion: The binding material shall provide satisfactory adhesion between the mica splittings. Satisfactory adhesion is indicated by the absence of delamination and surface cracking when sheets (plates) are bent to the radii specified in 4.5.4.

3.6.5 Dielectric strength: The dielectric qualities of type PMH electrical insulation shall be expressed in terms of short-time dielectric break-down values. For all thicknesses, heat-resistant mica sheets (plates) shall have an average short-time dielectric strength of 400 volts per mil of specified thickness, when measured at room temperature. The average short-time dielectric breakdown strength shall be not less than 350 volts per mil when tested as specified in 4.5.2.8.1.1.

3.6.6 Dimensions and tolerances: Size of sheets (plates) furnished shall be 16 by 36 or 24 by 36 inches, as specified. A tolerance of plus or minus 1/2 inch will be allowed. The sheets (plates) shall be furnished in standard thicknesses of 0.010, 0.015, and 0.020 inch, as specified. The thickness shall not vary more than plus 0.008 or minus 0.005 inch from the nominal value, and the average of 10 measurements shall be within plus or minus 0.003 inch of the specified thickness.

3.6.7 Heat resistance: There shall be no appreciable change in the physical appearance of the insulation when tested as specified in 4.5.8.

3.7 Workmanship:

The workmanship shall be first class in every respect.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Inspection and tests:

4.2.1 General outline: The inspection procedure for mica electrical insulation offered for delivery shall fall within the following categories:

(a) Visual and dimensional inspection.
(b) Samples for laboratory tests.
(c) Physical tests (when required).
(d) Electrical tests (when required).

4.2.2 Lot: A lot for inspection shall consist of all mica of the same type (see 1.2.1) offered for delivery at one time. A unit of sampling shall be one each of the unit of product for the type and form of mica on order.

4.3 Visual and dimensional inspection:

4.3.1 Material and workmanship: Each sample of the finished product shall be given a careful visual and dimensional inspection, assuring that the mica electrical insulation offered for delivery is in strict conformity with the requirements of this specification.

4.3.2 Dimensions: Measurements shall be made to ascertain whether or not the dimensional tolerances have been exceeded.

4.4 Samples for laboratory tests:

4.4.1 Number and size of samples: When specified, samples for laboratory inspection and tests shall be taken from each lot of each type and form offered for delivery in accordance with inspection level II of MIL-STD-105. The acceptable quality level (AQL) shall be 6.5.

4.5 Tests:

4.5.1 Mica content: The pasted mica shall be examined for relative percentage of mica and binder or reinforcing material, either by extraction or by burning. The extraction method shall be used where the laminate under test comprises nonorganic material either in the binder or in the reinforcing or both. The mica content determination shall be made on a specimen of approximately 5 grams, accurately weighed to the nearest 0.001 gram. The sample shall be kept in an airtight, carefully dried, and labeled container until used for the mica content determination. The residue weight after removal of the binder, expressed as percent of total weight, shall constitute the mica content of the sample.

4.5.1.1 Extraction method: Any suitable extraction apparatus may be used, such as the Soxhlet or Wiley-Richardson, provided a solvent suitable to the particular apparatus is used.

4.5.1.2 Burning method: Determination of mica content by the burning method shall be conducted in accordance with paragraph 7.04 of NEMA Standard ME1-1956.

4.5.2 Dielectric strength:

4.5.2.1 Test equipment: A well-designed high voltage transformer shall be connected to an alternating current supply having as nearly a true sine wave as possible. The capacity of the source of supply of energy shall be not less than 2 kilovolt-amperes for voltages of 50,000 volts, or less, and not less than 5-kilovolt-amperes for voltages above 50,000 volts. The frequency shall not exceed 100 cycles per second.

4.5.2.2 Voltage control: The regulation shall be so controlled that the voltage from the secondary of the testing transformer can be raised gradually; in no case more than 500 volts per step if step control is used. The control may be made by generator field regulation, with an induction regulator, or with a variable ratio auto transformer. The transformer and its controlling equipment shall be of such size and design that, with the test specimen in the circuit, the crest factor (ratio of maximum to mean effective) of the test voltage shall not differ by more than plus or minus 5 percent from that of a sinusoidal wave over the upper half of the range of test voltage. The crest factor may be checked by means of an oscillograph, a sphere gap, or a peak-reading voltmeter in conjunction with an r.m.s. voltmeter.

4.5.2.3 Voltage measurements: The voltage may be measured by an approved method which gives root-mean-square values, preferably by means of a voltmeter connected to a special voltmeter coil in the high-voltage winding of the testing transformer, or to a separate step-down instrument potential transformer. A voltmeter on the low-voltage side of the transformer will be satisfactory if the known ratio of transformation does not change by more than 2 percent under the test condition. A properly calibrated electrostatic voltmeter connected across the high voltage supply will also be satisfactory. A sphere spark gap may be used in accordance with A.S.A. C68.1 to check the readings at very high voltages.

4.5.2.4 Surge protection: Some protection is desirable in the high-voltage circuit of testing transformers where the voltage is 25,000 volts or over, to prevent dangerous surges and limit the current at flash-over or when the test specimen is punctured. It is, however, desirable to have as much energy available as possible when puncture occurs. If impedance in the form of choke coils is used in series with the high-voltage terminals, it should be not greater than that which will limit the current through the specimen to double the normal rated current of the testing transformer.

4.5.2.5 Spark gap: When a sphere spark gap is used, a non-inductive resistance, approximately 1 ohm per volt, may be inserted in series with 1 terminal of the spark gap to damp high-frequency oscillations at the time of break-down and to limit the current flow. This resistance shall be as near the gap as possible. If the test is made with one side grounded, this resistance shall be on the grounded side of the circuit and, if neither side is grounded, one-half of the resistance shall be inserted on each side of the spark gap. Watertube resistors are preferable to carbon for this purpose as the carbon resistance may be materially decreased by the passage of current.

4.5.2.6 Test electrodes:

4.5.2.6.1 Form S: The cylindrical test electrodes for use with form S sheets (plates), shall be made of brass or copper. The contact ends shall be flat and polished. The cylinders shall be 1 inch in length and 2 inches in diameter. The edges of the contacting areas shall be rounded to a radius of 1/4 inch. The electrodes shall be self-aligning and shall be placed exactly opposite one another, with the specimen in a horizontal plane between them. The polished contacting areas shall be clean and free from projections.

4.5.2.6.2 Form T: The test electrodes for use with form T, tubing, shall be a cylindrical metal rod for the inner electrode, and a strip of metal foil 2-1/2 inches wide for the outer electrode. The rod shall be clean and polished. Each strip of metal foil shall be used only once. The rod shall fit as snugly inside the tubing as can be conveniently arranged. The edges at the ends of the rod shall be rounded to 1/4-inch radius. The electrodes shall be symmetrically located relative to each other. The rod shall be at least 3 inches long.

4.5.2.6.3 Forms R and X: The test electrodes for use with form R, rings, and form X, special shapes, shall consist of mercury or metal foil applied to the selected sample by means of a thin film of petrolatum.

4.5.2.7 Type and application of the electrodes and sample size shall be of such a nature as to avoid any surface burning or flash-overs. If flash-over occurs between electrodes, it shall not be considered as a failure. In some cases it may be necessary to immerse the sample and electrodes under oil to prevent flash-overs. When oil immersion is undesirable, sealing wax, phenolic resin varnish, bitumen, or other satisfactory insulating compound, poured around the electrodes so as to form a good bond without voids under the electrodes edges, may be used.

4.5.2.8 Methods of making dielectric tests: The test potential shall be applied by either of the following methods, as specified for the particular type of insulation:

(a) Short-time method
(b) One-minute step-by-step method.

4.5.2.8.1 Short-time method: Starting at zero the testing voltage shall be increased uniformly to break-down at a rate of 500 volts per second, except that if break-down occurs at this rate in less than 40 seconds, the rate shall be decreased so that break-down will occur in not less than 40 seconds. If the insulation fails at not less than 5,000 volts, the minimum time shall be reduced from 40 to 20 seconds. Ten such tests shall be made and the average of these 10 puncturing voltages, divided by average thickness of the sample, shall be taken as the short-time dielectric strength of the pasted mica. Ten thickness measurements shall be made of the insulation undisturbed by break-down but as near to the point of break-down as possible.

4.5.2.8.1.1 Type PMH electrical insulation shall be subjected to a temperature of 300 degrees C. (572 degrees F.) for 3 hours in a circulating-air oven and then cooled to room temperature.

4.5.2.8.2 One-minute step-by-step method: An initial voltage shall be applied, equal to 50 percent of the break-down voltage in the short time test, adjusted as shown in table VI. The voltage shall then be increased in increments as shown in table VI, up to failure, and held at each step for 1 minute. The change from one step to next higher shall be made within 10 seconds.

TABLE VI - Step-by-step method

Breakdown by short-time method	Adjust 50 percent of break-down voltage to nearest	Increment of increase
Kilovolts	*Kilovolts*	*Kilovolts*
12.5 or less	0.5	0.5
Over 12.5 to 25, inclusive	1.0	1.0
Over 25 to 50, inclusive	2.5	2.5
Over 50 to 100, inclusive	5.0	5.0
Over 100	10.0	10.0

4.5.2.8.2 (Continued):

Example:

Break-down voltage, short-time method = 41 kv.
50 percent of break-down voltage = 20.5 kv.
Initial voltage obtained by adjusting; 50 percent of break-down voltage to nearest 2.5 kv. = 20 kv.
Voltage will be increased by increments of 2.5 kv.
Therefore, second step = 22.5 kv., etc.

Ten such tests shall be made and the average of these 10 puncturing voltages divided by the average thickness of the sample shall be taken as the 1 minute, step-by-step, dielectric strength of the materials. Ten thickness measurements shall be made on the insulation undisturbed by break-down but as near the point of break-down as possible.

4.5.2.9 Oil characteristics: Oil used as a surrounding medium in the measurement of dielectric strength shall have a high dielectric break-down, low viscosity, and high flash point, and should not react with the material being tested. It shall be clear and free from impurities.

4.5.3 Density: The density of mica plates and sheets shall be determined from the sample weight and the volume calculated from the average of careful measurements of the dimensions. The test specimen for the density determination shall consist of the whole plate in accordance with 4.4.1.

4.5.4 Delamination: Rigid mica plates, 0.130 inch or less in thickness, shall be bent to the radii shown in table VII.

TABLE VII - Delamination test

Thickness of plate, inch.	Radius of curvature
Up to and including 0.035	24
0.036 to 0.070, inclusive	36
.071 to .100, inclusive	48
.101 to .130, inclusive	72

4.5.5 Compressibility, exudation, and slippage (for type PMR, form S):

4.5.5.1 Stability (exuding of binder and slipping of mica splittings) under heat and pressure, and the percentage decrease in thickness, shall be determined as follows: Representative specimens from one or more plates shall be taken from each lot offered for delivery. Where two or more thicknesses of plate are included in the lot, samples may be combined, or two or more tests conducted, at the discretion of the purchasing officer. Enough samples shall be cut to 3 by 2 inches to form a block approximately 1 inch thick, which shall be held in the testing clamp. The testing clamp shall be of metal and of the dimensions shown in figure 1. The temperature of the mica stack and clamp shall be measured by means of a thermometer or thermocouple inserted into recess "A". The clamp, with specimen, while cold, shall be placed in a hydraulic press or testing machine and a pressure of 2,000 pounds per square inch applied to the surface of the specimen. While under pressure the thickness of the mica stack at each of the four corners shall be carefully determined by means of a micrometer gage, the average of these readings to be taken as representing the thickness of the stack. The pressure on the stack shall then be increased to 2,500-pounds-per-square-inch. The bolts of the clamp shall be tightened while the stack is under pressure so as to maintain an approximate pressure of 2,500 pounds per square inch. The specimen with clamp attached shall be maintained at a temperature of 150 degrees plus or minus 5 degrees C. (302 degrees plus or minus 9 degrees F.) for 1/2 hour. The specimen with clamp attached shall be removed from the oven and transferred as quickly as possible to the hydraulic press or testing machine, and a pressure of 2,500 pounds per square inch on the surface of the specimen shall be applied immediately and maintained until the temperature of the specimen reaches the temperature at which the original thickness was determined (20 degrees to 30 degrees C.). The decrease in thickness from the thickness measured above at 2,000 pound per square inch shall be determined, when cooled to atmospheric temperature, from the average measurement of the four corners while under the specified pressure of 2,500 pounds per square inch. The mica shall then be removed from the clamp and examined for exudation and slippage.

4.5.6 Moldability (for type PMM, form S): Type PMM (moldable variety), in form S sheets (plates), shall be tested for molding characteristics as follows: The specimen shall be uniformly heated (both sides) on a hot plate at a temperature of 135 degrees plus or minus 10 degrees C. and then quickly formed around the specified mandrel. The specimen shall then be rolled on a cold surface until the specimen is cooled, and the mandrel then removed. The sizes of specimens shown in table VIII are recommended for the moldability test, in order to form a butt joint on the mandrel.

TABLE VIII - Specimens for moldability test

Specified thickness of plate	Size of specimen	Diameter of test mandrel
Inch	*Inches*	*Inches*
Up to and including 0.062	2 (width) by 4-11/16	1-1/2
0.063 to 0.094	2 (width) by 6-1/4	2