MIL-M-14F
15 JANUARY 1960
SUPERSEDING
(See section 6)

MILITARY SPECIFICATION

MOLDING PLASTICS AND MOLDED PLASTIC PARTS, THERMOSETTING

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. This specification covers the basic properties of molding compounds, as such, and the methods suited to their satisfactory determination. The appendix covers requirements for parts molded from such compounds, together with procedures for inspection of such parts.

1.2 Classification. Molding thermosetting plastic compounds shall be of the following types, as specified (see 6.2 and 40.3.3):

Phenolic resin:

Type CFG — Cellulose filler, general-purpose.

Type CFI–5 — Cellulose filler, impact-resistant; nominal impact strength, 0.6 foot-pounds per inch notch.

Type CFI–10 — Cellulose filler, impact-resistant; nominal impact strength, 1.0 foot-pounds per inch notch.

Type CFI–20 — Cellulose filler, impact-resistant; nominal impact strength, 2.0 foot-pounds per inch notch.

Type CFI–40 — Cellulose filler, impact-resistant; nominal impact strength, 4.0 foot-pounds per inch notch.

Type MFE — Mineral filler, best electrical properties.

Type MFG — Asbestos filler, general-purpose, heat-resistant.

Type MFH — Mineral filler, heat-resistant.

Type MFI–10 — Asbestos filler, impact-resistant; nominal impact strength, 1.0 foot-pounds per inch notch.

Type MFI–20 — Asbestos filler, impact-resistant; nominal impact strength, 2.0 foot-pounds per inch notch.

Type GPI–100 — Glass fiber filler, impact-resistant; nominal impact strength, 10.0 foot-pounds per inch notch.

Melamine resin:

Type CMG — Cellulose filler, general-purpose.

Type CMI–5 — Cellulose filler, impact-resistant; nominal impact strength, 0.60 foot-pounds per inch notch.

Type CMI–10 — Cellulose filler, impact-resistant; nominal impact strength, 1.0 foot-pounds per inch notch.

Type MME — Mineral filler, arc- and flame-resistant.

Type MMI–5 — Glass fiber filler, impact-resistant; nominal impact strength, 0.5 foot-pounds per inch notch.

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Type MMI–30—Glass fiber filler, impact-resistant; nominal impact strength, 3.0 foot-pounds per inch notch.

Polyester resin:

Type MAG — Mineral filler, general-purpose.

Type MAI–60—Glass fiber filler, impact-resistant; nominal impact strength, 6 foot-pounds per inch notch.

Polyester resin (diallyl phthalate cross-linked):

Type MAI–30 — Mineral filled, glass-fiber reinforced; nominal impact strength, 3.0 foot-pounds per inch notch.

Diallyl phthalate resin:

Type MDG — Mineral filler, general-purpose.

Type SDG — Glass fiber filler, general-purpose.

Type SDI–5 — Acrylic polymer fiber filler, impact-resistant; nominal impact strength, 0.5 foot-pounds per inch notch.

Type SDI–30 — Polyethylene terephthalate fiber filler, impact-resistant; nominal impact strength, 3.0 foot-pounds per inch notch.

Silicone resin:

Type MSG — Mineral filler, general-purpose.

Type MSI–30 — Glass fiber filler, impact-resistant; nominal impact strength, 3.0 foot-pounds per inch notch.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

L–P–406 — Plastics, Organic: General Specifications, Test Methods.

MILITARY

MIL–E–15090 — Enamel, Equipment, Light-Gray (Formula No. 111).

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications. The following document forms a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

DEPARTMENT OF THE INTERIOR

Bureau of Mines

Report BM–314 of 21 August 1959.

(Application for copies should be addressed to Bureau of Mines, Branch of Health Research, Central Experiment Station, 4800 Forbes Street, Pittsburgh 13, Pa.).

3. REQUIREMENTS

3.1 Qualification.

3.1.1 Molding thermosetting plastic compounds shall be a product (manufacturer's proprietary designation for a specific molding compound) which has been tested and has passed the qualification tests specified herein (see 6.3). In addition, molding thermosetting plastic compounds for Ordnance Corps, Department of the Army procurements furnished under this specification shall be a product which has been tested to obtain identity values (see 6.3).

3.1.2 Manufacturers shall obtain qualification approval for each product or compound. Materials qualified for one color will be qualified for all colors requested by manufacturers.

3.1.2 Manufacturers shall obtain qualification approval for each product or compound.

3.2 Compound. The compound shall consist of a suitable filler impregnated or intimately combined with a thermosetting condensation or polymerization product binder, processed to conform to this specification. No scrap compound previously cured and reground shall be utilized.

3.2.1 *Uniformity.* All molding compound of the same brand from one manufacturer shall be uniform in texture, in color (see 3.2.2), and in the specified properties as determined by the batch-acceptance inspection specified in 4.4.

3.2.2 *Color.* Unless otherwise specified in the contract or order, mineral filled phenolic-resin materials shall be furnished in natural color. Other types of compounds shall be supplied in the color specified by the procuring activity (see 6.2). In such cases, if the color is not specified, the compound shall be furnished in the normal color in which manufactured.[1] Natural-colored compounds are those in which no coloring matter of any sort has been added. In evaluating uniformity of color, consideration shall be given to the fact that variation in color of raw materials, particularly in the filler, may be reflected in the color of the "natural" molding compound. Coloring matters reducing the electrical properties below the specified limits shall not be used.

3.2.3 *Property values.* Standard specimens of the compounds shall conform to the property values shown in tables I, II, III (qualification); IV, V and VI (batch-acceptance).

3.3 Workmanship. The compound manufactured and processed (parts molded and processed) in accordance with this specification shall be such as to meet all the requirements of this specification and any referenced subsidiary specification, drawing or other document when inspected in accordance with section 4 (section 40).

[1] The normal color of type MAI–30 compound is such that when molded the color is an approximate match to light-grey as defined in class 2, type II of Specification MIL–E–15090.

4. QUALITY ASSURANCE PROVISIONS

4.1 Unless otherwise specified herein the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order.

4.2 Classification of tests. The tests shall be classified as follows:

Qualification tests (see 4.3).

Batch-acceptance inspection (at the manufacturer's plant (see 4.4). (Not required for Army Ordnance Corps procurements.)

Statement of identity values (by the manufacturer (see 6.3.1)). (For Army Corps procurement only.)

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory satisfactory to the Bureau of Ships. The tests shall consist of the tests specified in tables I, II and III.

4.3.1 *Specimens.* Tests shall be conducted on standard test specimens molded by the manufacturer of each compound for which qualification is required.

4.3.1.1 *Quantities to be furnished.* The manufacturer shall furnish the number of standard test specimens shown in table VII, of each compound for which qualification is required.

4.3.1.2 *Preparation.* Specimens shall be prepared for tests as specified in 4.5.1.

TABLE I. *Property values for qualification tests of phenolic molding compounds.*

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	Specification L-P-406	Modified by	Form and dimensions	Number tested		
Compressive strength endwise	1021.1	.....	1 by ½ by ½ inch	5	E-48/50+C-96/23/50	P.s.i. (minimum average)
Dielectric constant:						Maximum average
At 1 kilocycle	4021	.....	4-inch disk, ⅛ inch thick	3	E-48/50+des	
				3	E-48/50+D-24/23	
At 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+des	
				3	E-48/50+D-24/23	
Dissipation factor:						Maximum average
At 1 kilocycle	4021	.....	4-inch disk, ⅛ inch thick	3	E-48/50+des	
				3	E-48/50+D-24/23	
At 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+des	
				3	E-48/50+D-24/23	
Dielectric strength:						Volts per mil (minimum average)
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E-48/50+C-96/23/50	
Step-by-step test	4031	4.5.2.1		5		
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E-48/50+D-48/50	
Step-by-step test	4031	4.5.2.1		5		
Dielectric breakdown:						Kilovolts (minimum average)
Short-time test	4031	4.5.2.1.3	See figure 1 herein	1	E-48/50+C-96/23/50	
Step-by-step test	4031	4.5.2.1.3		3		
Short-time test	4031	4.5.2.1.3		1	E-48/50+D-48/50	
Step-by-step test	4031	4.5.2.1.3		3		
Flame resistance:						
Ignition time	2023.2	.....	5-inch bar, ½ by ½ inch	5	A	Seconds (minimum average)
Burning time						Seconds (maximum average)
Flexural strength, face[1]	1031.1	4.5.2.2	5-inch bar, ½ by ½ inch	5	E-48/50+C-96/23/50	P.s.i. (minimum average)
Heat distortion temperature, side[2]	2011.1	4.5.2.3	5-inch bar, ¼ by ½ inch	3	A	Degrees C (minimum average)
Impact strength:						Foot-pound per inch of notch (minimum average)
Face[2]	1071	.....	See figure 1071A of Specification L-P-406	5	E-48/50+C-96/23/50	
Side[2]				5		
Tensile strength	1012	.....	See figure 1012 of Specification L-P-406 ¼ inch specimen	5	E-48/50+C-96/23/50	P.s.i. (minimum average)
Volume resistance	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E-24/100+des+D-48/50	Percent (maximum average)
Water absorption	.....	4.5.2.7	4-inch disk, ⅛ inch thick	5	(See 4.5.2.7)	Megohms (minimum individual)
Surface resistance		4.5.2.7	4-inch disk, ⅛ inch thick	5	(See 4.5.2.7)	Megohms (minimum individual)

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.

TABLE I. *Property values for qualification tests of phenolic resin molding compounds.—Continued*

Property to be tested	Value required for each type of compound										
	Type CFG	Type CFI–5	Type CFI–10	Type CFI–20	Type CFI–40	Type MFE	Type MFG	Type MFH	Type MFI–10	Type MFI–20	Type GPI–100
Compressive strength endwise	25,000	23,000	20,000	20,000	18,000	15,000	15,000	15,000	18,000	18,000	20,000
Dielectric constant:											
At 1 kilocycle						6.0					6.0
At 1 megacycle						6.0					7.0
Dissipation factor:											
At 1 kilocycle						6.0					5.7
At 1 megacycle						0.030					6.0
						.033					0.04
Dielectric strength:						0.15					.05
Short-time test	300	250	240	210	175	.017					.03
Step-by-step test	200	150	180	150		325	150	215	45	45	.04
Short-time test	75	50	40	45	25	275	100	150	40	40	300
Step-by-step test	45	27.5	27.5	25	15	325	75	125	18	18	200
Dielectric breakdown:						275	45	80	10	10	75
Short-time test	(To be recorded as basis for determining initial voltage step-by-step)										50
Step-by-step test	30	18	18	18	18	45	10	35	4	6	40
Short-time test	(To be recorded as basis for determining initial voltage step-by-step)										
Step-by-step test	2.5	2.5	2.5	2.5	2.5	40	6	10	2	2	15
Flame resistance:											
Ignition time	60	60	60	60	60	60	150	120	120	120	120
Burning time	270	330	330	330	330	210	90	150	200	200	120
Flexural strength, face[1]	9,000	8,000	8,000	8,000	8,000	8,000	8,000	7,000	8,000	8,000	15,000
Heat distortion temperature, side[2]	115	115	115	115	115	115	120	130	175	175	200
Impact strength:											
Face[1]		0.60	1.10	2.30	5.20		0.84	0.26	1.30	2.56	10.0
Side[2]	0.24	.48	1.05	1.75	3.50		.64	.25	1.30	2.00	10.0
Tensile strength	6,000	5,700	5,600	5,700	6,000	4,200	4,500	4,200	5,400	6,000	4,500
Water absorption	3.0	4.0	4.0	4.0	4.0	0.10	0.50	0.35	2.0	2.0	1.5
Volume resistance						2.0					
Surface resistance						5.0					

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.

TABLE II. *Property values for qualification tests of melamine and polyester resin molding compounds.*

Property to be tested	Test method: Specification L–P–406	Test method: Modified by	Specimens: Form and dimensions	Specimens: Number tested	Conditioning procedure (see 4.5.1.5)	Unit of value
Arc resistance	4011.2	.....	4-inch disk, ⅛ inch thick	[2]3	A	Seconds (minimum average)
Compressive strength, endwise	1021.1	.....	1 by ½ by ½ inch	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Dielectric constant:						
At 1 kilocycle	4031	.....	4-inch disk, ⅛ inch thick	3	E–48/50+des	Maximum average
				3	E–48/50+D–24/23	
At 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
Dissipation factor:						
At 1 kilocycle	4021	.....	4-inch disk, ⅛ inch thick	3	E–48/50+des	Maximum average
				3	E–48/50+D–24/23	
At 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
Dielectric strength:						
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E–48/50+C–96/23/50	Volts per mil (minimum average)
Step-by-step test				5		
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E–48/50+D–48/50	
Step-by-step test				5		
Dielectric breakdown:						
Short-time test	4031	4.5.2.1.3	See figure 1 herein	1	E–48/50+C–96/23/50	Kilovolts (minimum average)
Step-by-step test				3		
Short-time test	4031	4.5.2.1.3		1	E–48/50+D–48/50	
Step-by-step test				3		
Flame resistance:						
Ignition time	2023.2	.....	5-inch bar, ½ by ½ inch	5	A	Seconds (minimum average)
Burning time						Seconds (maximum average)
Flexural strength, face[3]	1031.1	4.5.2.2	5-inch bar, ¼ by ½ inch	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Heat-distortion temperature, side[3]	2011.1	4.5.2.3	5-inch bar, ½ by ½ inch	3	A	Degrees C. (minimum average)

Impact strength: Face[1] Side[2]	1071	.....	See figure 1071A of Specification L–P–406	5 5	E–48/50+C–96/23/50	Foot-pounds per inch notch (minimum average)
Tensile strength	1012	.....	See figure 1012A of Specification L–P–406 (¼ inch specimen)	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Water absorption	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E–24/100+des+D–48/50	Percent (maximum average)
Heat resistance	1031.1	4.5.2.5	5-inch bar, ¼ by ½ inch	5	E–48/50+C–96/23/50 +E–1/100	Percent flexural strength retained (minimum)
Dimensional stability (high temperature)	.....	4.5.2.6	5-inch bar, ½ by ½ inch	5	(See 4.5.2.6)	Percent (maximum average)
Toxicity when heated: Carbon dioxide Carbon monoxide Ammonia Aldehydes as H. CHO Cyanide as HCN Oxides of nitrogen as No_2 Hydrogen chloride	.....	4.5.2.8	5-inch bar, ½ by ½ inch	4	A	Parts per million (maximum average)

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE II. *Property values for qualification tests of melamine and polyester resin molding compounds.—Continued*

Property to be tested	Value required for each type of compound								
	Type CMG	Type CMI–5	Type CMI–10	Type MME	Type MMI–5	Type MMI–30	Type MAG	Type MAI–60	Type MAI–30
Arc resistance	100	125	.....	125	180	180	175	130	175
Compressive strength, endwise	20,000	25,000	.....	25,000	28,000	20,000	15,000	18,000	20,000
Dielectric constant:									
At 1 kilocycle	.....	.....	.....	7.0	9.6	8.0	6.2	6.0	6.3
	.....	.....	.....	7.0	10.0	9.0	6.5	7.0	6.4
At 1 megacycle	.....	.....	.....	6.5	7.5	7.5	5.7	5.7	6.2
	.....	.....	.....	6.5	8.0	8.0	6.0	6.0	6.4
Dissipation factor:									
	.....	.....	.....	0.06	0.08	0.06	0.4	0.03	0.015
At 1 kilocycle	.....	.....	.....	.065	.10	.08	.06	.08	.017
At 1 megacycle	.....	.....	.....	.04	.03	.03	.02	.03	.012
	.....	.....	.....	.045	.04	.04	.03	.05	.015
Dielectric strength:									
Short-time test	275	250	.....	325	215	150	375	150	300
Step-by-step test	200	150	.....	275	150	125	325	125	250
Short-time test	125	50	.....	275	100	100	300	100	275
Step-by-step test	100	27.5	.....	225	50	50	250	50	250
Dielectric breakdown:									
Short-time test	(To be recorded as basis for determining initial voltage in step-by-step test)								
Step-by-step test	30	18	.....	40	40	40	40	40	45
Short-time test	(To be recorded as basis for determining initial voltage in step-by-step test)								
Step-by-step test	5	2.5	.....	35	5	5	35	35	45
Flame resistance:									
Ignition time	60	120	.....	90	600	600	60	90	100
Burning time	180	60	.....	180	0	0	200	90	75
Flexural strength, face[1]	8,000	7,500	11,000	6,000	8,500	8,500	7,500	12,000	14,000
Heat-distortion temperature, side[2]	120	160	.....	120	200	200	175	200	200

Impact strength:									
Face[1]	.....	0.60	1.00	.....	0.60	3.20	.....	10.0	3.0
Side[2]	.....	.48	1.00	.....	.48	3.20	.....	6.0	3.0
Tensile strength	5,000	5,700	.....	4,200	5,000	5,500	3,500	3,500	7,500
Water absorption	4.0	4.0	4.0	0.50	1.5	4.0	0.50	1.5	0.5
Heat resistance	.....	.....	.....	.....	50	50	.....	.....	.....
Dimensional stability (high temperature)	.....	.....	.....	0.7	.....	.....	0.2	.....	.....
Toxicity when heated:									
Carbon dioxide									15,000
Carbon monoxide									1,000
Ammonia									2,500
Aldehydes as H. CHO	.....	.....	.....	.....	.....	.....	.....	.....	50
Cyanide as HCN									60
Oxides of nitrogen as No_2									100
Hydrogen chloride									100

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE III. *Property values for qualification tests of diallyl phthalate and silicone molding compounds.*

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	Specification L–P–406	Modified by	Form and dimensions	Number tested		
Arc resistance	4011.2	.....	4-inch disk, ⅛ inch thick	[3] 3	A	Seconds (minimum average)
Compressive strength, endwise	1021.1	.....	1 by ½ by ½ inch	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Dielectric constant:						Maximum average
At 1 kilocycle	4021		4-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
At 1 megacycle	4021		2-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
Dissipation factor:						Maximum average
At 1 kilocycle	4021		4-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
At 1 megacycle	4021		2-inch disk, ⅛ inch thick	3	E–48/50+des	
				3	E–48/50+D–24/23	
Dielectric strength:						Volts per mil (minimum average)
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E–48/50+C–96/23/50	
Step-by-step test				5		
Short-time test	4031	4.5.2.1	4-inch disk, ⅛ inch thick	3	E–48/50+D–48/50	
Step-by-step test				5		
Dielectric breakdown:						Kilovolts (minimum average)
Short-time test	4031	4.5.2.1.3	See figure 1 herein	1	E–48/50+C–96/23/50	
Step-by-step test				3		
Short-time test	4031	4.5.2.1.3		1	E–48/50+D–48/50	
Step-by-step test				3		
Flame resistance:						Seconds (minimum average)
Ignition time	2023.2	.....	5-inch bar, ½ by ½ inch	5	A	Seconds (maximum average)
Burning time						
Flexural strength face[1]	1031.1	4.5.2.2	5-inch bar, ¼ by ½ inch	5	E–48/50+C–96/23/50	P.s.i. (minimum average)

Heat-distortion temperature, side[2]	2011.1	4.5.2.3	5-inch bar, ½ by ½ inch	3		Degrees C (minimum average)
Impact strength: Face[1] / Side[2]	1071	.....	See figure 1071A of Specification L–P–406	5 / 5	E–48/50+C–96/23/50	Foot-punds per inch notch (minimum average)
Tensile strength	1012	.....	See figure 1012Aof Specification L–P–406 (¼ inch specimen)	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Water absorption	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E–24/100+des+D–48/50	Percent (maximum average)
Heat resistance	1031.1	4.5.2.5	5-inch bar, ¼ by ½ inch	5	E–48/50+C–96/23/50+E–1/200	Percent flexural strength retained (minimum)
Dimensional stability (high temperature)	.....	4.5.2.6	5-inch bar, ½ by ½ inch	5	(See 4.5.2.6)	Percent (maximum average)
Volume resistance	.....	4.5.2.7	4-inch disk, ⅛ inch thick	5	(See 4.5.2.7)	Megohms (minimum) individual)
Surface resistance	.....	4.5.2.7	4-inch disk, ⅛ inch thick	5	(See 4.5.2.7)	Megohms (minimum) individual)

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE III. *Property values for qualification tests of diallyl phthalate and silicone molding compounds.—Continued*

Property to be tested	Value required for each type of compound					
	Type MDG	Type SDG	Type SDI–5	Type SDI–30	Type MSG	Type MSI–30
Arc resistance	115	115	100	115	210	175
Compressive strength, endwise	18,000	16,000	18,000	16,000	15,000	10,000
Dielectric constant:						
At 1 kilocycle	8.2	4.4	4.1	4.1	5.0	5.0
	9.5	4.5	4.2	4.2	5.2	5.5
At 1 megacycle	6.0	4.6	3.8	3.8	4.7	4.7
	6.0	4.7	3.9	3.9	5.0	5.1
Dissipation factor:						
At 1 kilocycle	0.14	0.009	0.025	0.016	0.015	0.015
	.20	.013	.028	.018	.020	.050
At 1 megacycle	.12	.015	.020	.020	.010	.010
	.14	.017	.023	.023	.015	.060
Dielectric strength:						
Short-time test	325	325	325	325	325	160
Step-by-step test	275	300	300	300	300	125
Short-time test	140	325	325	325	300	75
Step-by-step test	140	300	300	300	275	50
Dielectric breakdown:						
Short-time test	40	45	45	45	35	30
Step-by-step test		(To be recorded as basis for initial voltage in step-by-step test)				
Short-time test	35	40	40	40	35	30
Step-by-step test		(To be recorded as basis for initial voltage in step-by-step test)				
Flame resistance:						
Ignition time	.....	.....	.....	.....	90	90
Burning time	.....	.....	.....	.....	120	120
Flexural strength face[1]	6,800	9,000	8,000	10,000	6,000	7,000

Heat-distortion temperature, side[2]	148	160	100	115	200	200
Impact strength: Face[2] Side[2]	 0.28 .28	 0.30 .30	 0.60 .60	 3.00 2.75	 0.25 .25	 3.2 3.2
Tensile strength	4,000	4,500	3,500	3,600	2,500	2,000
Water absorption	0.70	0.50	0.50	0.50	0.50	0.50
Heat resistance	.....	.....	.....	.....	25	25
Dimensional stability (high temperature)	0.2	0.2	0.2	0.2	.....	.....
Volume resistance	2.0	10	100	10	1,000	.....
Surface resistance	5.0	10	100	10	1,000	.....

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE IV. *Property values for batch-acceptance of phenolic resin molding compounds.*

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	Specification L-P-406	Modified by	Form and dimensions	Number tested		
Dielectric constant at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+D-24/23	Maximum average
Dissipation factor at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+D-24/23	Maximum average
Dielectric strength step-by-step	4031	4.5.2.1	4-inch disk, ⅛ inch thick	5	E-48/50+D-48/50	Volts per mil (minimum average)
Flexural strength face[1]	1031.1	4.5.2.2	5-inch bar, ¼ by ½ inch	5	E-48/50+C-96/23/50	P.s.i. (minimum average)
Impact strength side[2]	1071	.....	See figure 1071A of Specification L-P-406	5	E-48/50+C-96/23/50	Foot-pounds per inch notch (minimum average)
Water absorption	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E-24/100+des+D-48/50	Percent (maximum average)

Property to be tested	Value required for each type of compound										
	Type CFG	Type CFI-5	Type CFI-10	Type CFI-20	Type CFI-40	Type MFE	Type MFG	Type MFH	Type MFI-10	Type MFI-20	Type GPI-100
Dielectric constant at 1 megacycle						6.0					6.0
Dissipation factor at 1 megacycle						0.017					0.04
Dielectric strength step-by-step	45	27.5	27.5	25	.....	.....	45	80	10	10	50
Flexural strength face[1]	9,000	8,000	8,000	8,000	8,000	8,000	8,000	7,000	8,000	8,000	15,000
Impact strength side[2]	.....	0.48	1.05	1.75	3.50	.....	0.64	.....	1.30	2.00	10.0
Water absorption	3.0	4.0	4.0	4.0	4.0	0.10	0.50	0.35	2.0	2.0	1.5

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.

TABLE V. *Property values for batch-acceptance inspection of melamine and polyester resin molding compounds.*

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	Specification L–P–406	Modified by	Form and dimensions	Number tested		
Arc resistance	4011.2	.....	4-inch disk, ⅛ inch thick	[3]3	A	Seconds (minimum average)
Dielectric constant at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E–48/50+D–24/23	Maximum average
Dissipation factor at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E–48/50+D–24/23	Maximum average
Dielectric strength step-by-step	4031	4.5.2.1	4-inch disk, ⅛ inch thick	5	E–48/50+D–48/50	Volts per mil (minimum average)
Flexural strength face[1]	1031.1	4.5.2.2	5-inch bar, ¼ by ½ inch	5	E–48/50+C–96/23/50	P.s.i. (minimum average)
Impact strength side[2]	1071	.....	See figure 1071A of Specification L–P–406	5	E–48/50+C–96/23/50	Foot-pounds per inch notch (minimum average)
Water absorption	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E–24/100+des+D–48/50	Percent (maximum average)

Property to be tested	Value required for each type of compound								
	Type CMG	Type CMI–5	Type CMI–10	Type MME	Type MMI–5	Type MMI–30	Type MAG	Type MAI–60	Type MAI–30
Arc resistance	100	125	.....	125	180	180	175	130	175
Dielectric constant at 1 megacycle	.....	.....	.....	6.5	8.0	8.0	6.0	6.0	6.4
Dissipation factor at 1 megacycle	.....	.....	.....	0.045	0.04	0.04	0.03	0.05	0.015
Dielectric strength step-by-step	.....	.....	.....	.....	50	50	.....	50	.....
Flexural strength face[1]	8,000	7,500	11,000	6,000	8,500	8,500	7,500	12,000	14,000
Impact strength side[2]	.....	0.48	1.00	.....	0.48	3.20	.....	6.0	3.0
Water absorption	4.0	4.0	4.0	0.50	1.5	4.0	0.50	1.5	0.5

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE VI. *Property values for batch-acceptance inspection of diallyl phthalate and silicone resin molding compounds.*

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	Specification L-P-406	Modified by	Form and dimensions	Number tested		
Arc resistance	4011.2	.....	4-inch disk, ⅛ inch thick	[3]3	A	Seconds (minimum average)
Dielectric constant at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+D-24/23	Maximum average
Dissipation factor at 1 megacycle	4021	.....	2-inch disk, ⅛ inch thick	3	E-48/50+D-24/23	Maximum average
Dielectric strength step-by-step	4031	4.5.2.1	4-inch disk, ⅛ inch thick	5	E-48/50+D-48/50	Volts per mil (minimum average)
Flexural strength face[1]	1031.1	4.5.2.2	5-inch bar, ¼ by ½ inch	5	E-48/50+C-96/23/50	P.s.i. (minimum average)
Impact strength, side[2]	1071	.....	See figure 1071A of Specification L-P-406	5	E-48/50+C-96/23/50	Foot-pounds per inch notch (minimum average)
Water absorption	7031	4.5.2.4	2-inch disk, ⅛ inch thick	3	E-24/100+des+D-48/50	Percent (maximum average)

Property to be tested	Value required for each type of compound					
	Type MDG	Type SDG	Type SDI-5	Type SDI-30	Type MSG	Type MSI-30
Arc resistance	115	115	100	115	210	175
Dielectric constant at 1 megacycle	6.0	4.7	3.9	3.9	5.0	5.0
Dissipation factor at 1 megacycle	0.14	0.017	0.023	0.023	0.015	0.050
Dielectric strength step-by-step	140	300	300	300	275	50
Flexural strength face[1]	6,800	9,000	8,000	10,000	6,000	7,000
Impact strength, side[2]	0.28	0.30	0.60	2.75	0.25	3.2
Water absorption	.70	.50	.50	0.50	.50	0.50

[1] The face of a test specimen is that area formed by the top or bottom force plug.
[2] The side of a test specimen is that area formed by the chase of the mold.
[3] Five readings shall be made on each of the three specimens.

TABLE VII. *Standard test specimens for qualification tests.*

Specimen designation	Description	Number of specimens									
		Types CFG, CFI–5 to –40, MFG, MFH, MFI–10 and –20	Types MFE and MAI–60	Types CMG and CMI–5	Type CMI–10	Types MAG and MME	Types MSI–30, MMI–5 and MMI–30	Types MDG, SDG, SDI–5 and SDI–30	Type MSG	Type GPI–100	Type MAI–30
1	2-inch disk, ⅛ inch thick	5	20	5	5	20	20	20	20	20	10
2	4-inch disk, ⅛ inch thick	20	37	25	.....	37	37	45	42	34	24
3	See figure 1 herein	12	12	12	.....		12	12	12	12	12
4	5-inch bar, ⅛ by ½ inch	18	18	18	10	25	18	25	18	18	30
4	5-inch bar, ½ by ½ inch										10 (for tests at Bureau of Mines)
4A	5-inch bar, ¼ by ½ inch	8	8	8	5	8	16	8	16	11	20
7	See ¼ inch specimen on figure 1012A of Specification L–P–406	10	10	10	.....	10	10	10	10	10	10

4.3.1.3 *Instruction for submission of qualification sample.* Each set of test specimens shall be marked with the manufacturer's name or trade-mark, grade (brand designation of the molding compound), date of manufacture, and the claimed type under this specification. The date and file number of the authorizing letter shall also be furnished.

4.4 Batch-acceptance inspection. Batch-acceptance inspection shall be as shown in tables IV, V and VI. They shall be conducted at the manufacturer's plant on standard specimens molded by the manufacturer from each batch of compound to be supplied to molders for production of molded parts under this specification. The molding of specimens and the conduct of tests shall be under the supervision of the inspector.

4.4.1 *Definition.* A batch is a homogeneous unit of finished molding compound manufactured at one time.

4.4.2 *Preparation of specimens.* Specimens shall be prepared as specified in 4.5.1.

4.4.3 *Test equipment and test facilities.* The manufacturer shall furnish and maintain all necessary facilities and equipment for making all batch-acceptance inspection. The test equipment shall be adequate in quantity to enable the testing to keep up with the production, and shall be of sufficient accuracy and quality to permit performance of the required tests..

4.4.4 *Results of tests.* A copy of the results of the batch-acceptance inspection shall be furnished the Government inspector.

4.4.5 *Rejection.* Failure to comply with tables IV, V, and VI shall result in rejection of the batch of compound.

4.5 Test procedures.

4.5.1 *Standard test specimens.*

4.5.1.1 *Number.* The minimum number of standard test specimens to be tested shall be as specified in tables I, II, III, IV, V, and VI.

4.5.1.2 *Form.* The form of the standard test specimens shall be as specified in the applicable method of Specification L–P–406 and as shown in tables I, II, III, IV, V, and VI.

4.5.1.3 *Molding of test specimens.* Test specimens shall be molded by methods which are representative of sound practice. No special treatment shall be used to improve the properties of the specimens when compared with parts molded in commercial production.

4.5.1.4 *Tolerance.* Tolerance on dimensions shall be plus or minus 5.0 percent.

4.5.1.5 *Conditioning.* Standard test specimens shall be conditioned before test, as specified in tables I, II, III, IV, V and VI.

4.5.1.5.1 *Nomenclature.* The following letters shall be used to indicate the respective general conditioning procedures:

Condition A — As received; no special conditioning.

Condition C — Humidity conditioning.

Condition D — Immersion conditioning in distilled water.

Condition E — Temperature conditioning.

Condition desiccation — Desiccation condition, cooling over silica gel or calcium chloride in a desiccator at 23° Centigrade (C.) for 16 to 20 hours after temperature conditioning.

4.5.1.5.2 *Designation.* Conditioning procedures shall be designated as follows:

(a) A capital letter indicating the general condition of the specimen; that is, as received, humidity, immersion, or temperature conditioning.

(b) A number indicating in hours the duration of the conditioning.

(c) A number indicating in degrees centigrade the conditioning temperature.

(d) A number indicating relative humidity, whenever relative humidity is controlled.

The numbers shall be separate from each other by slant marks, and from the capital letter by a dash. A sequence of conditions shall be denoted by use of a plus (+) sign between successive conditions.

Examples:

Condition C–96/23/50 — Humidity condition, 96 hours at 23° ± 1.1° C. and 50 ± 2 percent relative humidity.

Condition D–48/50 — Immersion condition, 48 hours at 50° ± 1°C.

Condition E–48/50 — Temperature condition, 48 hours at 50° ± 3°C.

Condition E–48/50 + C–96/23/50 — Temperature condition, 48 hours at 50° ± 3°C.; followed by humidity condition, 96 hours at 23° ± 1.1°C. and 50 plus or minus 2 percent relative humidity.

4.5.2 *Methods of test.* All test measurements with the exception of dielectric strength, dielectric breakdown, heat resistance, and volume and surface resistance (see 4.5.2.1, 4.5.2.1.3, 4.5.2.5 and 4.5.2.7) shall be taken at standard laboratory atmosphere of 23° ± 1.1°C. and 50 plus or minus 2 percent relative humidity. The test methods shall be in conformance with the applicable method of Specification L–P–406 (see tables I, II, III, IV, V and VI) modified as follows:

4.5.2.1 *Dielectric strength.* The apparatus and procedure specified in method 4031 of Specification L–P–406 shall be used. Tests shall be made under oil at a frequency not exceeding 100 cycles per second (c.p.s.), at the temperature of the final conditioning.

4.5.2.1.1 *Short-time test.* The voltage shall be increased uniformly at the rate of 500 volts per second.

4.5.2.1.2 *Step-by-step test.* The voltage shall be increased in increments, as shown in table VIII up to failure, and shall be held at each step for 1 minute. The change from one step to the next higher shall be made within 10 seconds.

TABLE VIII. *Voltage increase for step-by-step test.*

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

4.5.2.1.3 *Dielectric breakdown.* The apparatus and procedure specified in method 4031 of Specification L–P–406 shall be used, except that the electrodes shall be American Standard No. 3 tapered pins. The test potential shall be applied successively between the numbered pairs of electrodes (see figure 1) and the average of the three readings shall be taken as the reading for the specimen. Tests shall be made under oil at a frequency not exceeding 100 c.p.s. at the temperature of the final conditioning.

4.5.2.2 *Flexural strength.* Method 1031.1 of Specification L–P–406 shall be used. The span-depth ratio shall be 16 to 1.

4.5.2.3 *Heat-distortion temperature.* Method 2011.1 of Specification L–P–406 shall be used. The specimens shall be placed directly on the oil bath and not in an air bath surrounded by an oil bath.

4.5.2.4 *Water absorption.* Method 7031 of Specification L–P–406 shall be used, modified as follows:

(a) The specimens shall be conditioned at 100° ± 2° C. for 24 hours, followed by 16 to 20 hour period of cooling over silica gel or calcium chloride in a desiccator at 23° C. ± 1.1° C.

(b) The specimens shall be immersed in distilled water maintained at a

temperature of 50° ± 1° C. for 48 hours. The report shall include only the following data: The percentage increase in weight during immersion calculated to the nearest 0.01 percent as follows:

$$\text{Increase in weight (percent} = \frac{\text{wet weight-conditioned weight}}{\text{conditioned weight}} \times 100$$

4.5.2.5 *Heat resistance.* The method shall be the same as specified in 4.5.2.2 except that:

(a) Specimens of types MMI–5 and MMI–30 shall be given an additional conditioning of 1 hour at 150° ± 2° C. and then be tested at 150° ± 2° C.

(b) Specimens of types MSG and MSI–30 shall be given an additional conditioning of 1 hour at 200° ± 2° C. and then be tested at 200° ± 2° C.

The average of five such determinations divided by the average flexural strength determined as in 4.5.2.2 shall be multiplied by 100 and recorded as percent flexural strength retained.

4.5.2.6 *Dimensional stability (high temperature).* The specimens shall be machined so the ½ by ½ inch ends are smooth and parallel. The specimens shall be subjected to condition C–96/23/50 (see 4.5.1.5.2). The initial length of the specimens shall then be measured to the nearest 0.001 inch. The specimens shall then be subjected to 10 cycles, each cycle as follows: 48 hours in a circulating air oven at 125° ± 5° C. plus 24 hours at 23° C. ± 1.1° C. and 50 plus or minus 2 percent relative humidity. At the completion of 10 cycles the final length of the specimens shall be measured to the nearest 0.001 inch. The percentage dimensional change is calculated to the nearest 0.1 percent as follows:

$$\text{Dimensional change (percent)} = \frac{\text{(initial length - final length)}}{\text{initial length}} \times 100$$

The average percent dimensional change of the five specimens shall be recorded.

4.5.2.7 *Volume and surface resistance — condition C–720/70/100+dew.*

4.5.2.7.1 *Specimens.* Four inch diameter ⅛ inch thick specimens shall be used. Specimens shall be cleaned by noninjurious methods to assure freedom from contamination. Precautions shall be taken in handling the specimens to avoid additional contamination. Five specimens shall be employed for the measurements of this test.

4.5.2.7.2 *Electrodes.* Electrodes shall consist of a guarded electrode 2 inches in diameter, ¼ inch guard ring spaced ¼ inch from the guarded electrode on the same side and the third electrode 3 inches in diameter on the opposite side and concentric with the guarded electrode. Dimensions of electrodes shall be maintained to a tolerance of plus or minus 1/64 inch. Silver paint, permeable to moisture (equivalent to Dupont No. 4817) shall be used for painting electrodes on the specimens. The electrodes shall exhibit a resistance of not more than 5 ohms both before and after the C–720/70/100+dew conditioning when measured with potentials of not greater than 3 volts between points diametrically opposite on each electrode. The specimens shall be permitted to air dry after painting for at least one week in an atmosphere of less than 60 percent relative humidity at a temperature of 25° C. ± 5° C.

4.5.2.7.3 *Humidity chamber.* The humidity chamber shall consist of a glass container with a corrosion resistant cover. The cover shall be provided with thru-panel type insulators. The insulators may serve as supports for the electrode holders as shown on figure 2. The chamber shall be of such size that the ratio of specimens surface area to water surface area shall not exceed 2.5. The ratio of volume of air in the humidity chamber to surface area of the water shall not exceed 10. One hundred percent relative humidity with condensation shall be obtained by natural evaporation from

a quantity of distilled water located at the bottom of the chamber. The cover shall be sealed to the chamber by an inert sealing compound applied to the exterior joints formed by the cover and the walls of the chamber. A small vent hole shall be provided in the cover to equalize pressure. The vent hole shall be sealed as soon as the air temperature in the humidity chamber has reached 70° C.

4.5.2.7.4 *Specimen holders.* The specimens shall be installed in a vertical plane in the conditioning chamber with the lower edge of the specimen not closer than 1 inch from the surface of the water. The specimens may be held in position by the electrode contactors in a manner similar to that shown on figure 2. Electrical connection to the specimen holders may be made by means of the through-panel insulators. The insulators shall be capable of withstanding the adverse conditions within the chamber without excessive loss of insulating properties. (Insulator resistance to cover plate shall at all times exceed 10 megohms). Polytetrafluoroethylene ("Teflon") insulators on the humidity side of the conditioning chamber are recommended to meet this requirement. These should be cleaned with alcohol before the start of each test. Electrode contactors and all other metallic parts of the sample shall be silvered plated. Contact pressure against the electrodes may be provided by backing the contactors with phosphor bronze springs or other corrosion-resistant spring material.

4.5.2.7.5 *Heating chamber.* The humidity chamber shall be installed in an oven or other heating chamber capable of maintaining a temperature of 70° ± 1° C. The rate of heating of the oven shall be such that the air temperature at a point near the volumetric center of the humidity chamber shall attain 70° C. in 4 hours plus or minus 1 hour. The quantity of water in the chamber shall be such that the water temperature shall attain 65° C. in 4 hours plus or minus 1 hour. Room temperature shall be maintained at 25 ± 5° C. The insulation of the conductors connecting the through-panel insulators to the measuring equipment shall not be significantly deteriorated by the elevated temperatures encountered in the oven. Polytetrafluoroethylene coated wire is recommended.

4.5.2.7.6 *Measurements*[1]. Volume and surface resistances shall be measured by the three terminal method employing measuring equipment such as a megohm bridge capable of applying 500 volts direct current (d.c.) to the specimen. A single set of measurements shall be made of each specimen while in the conditioning chamber after 30 days of the specified conditioning. Conversion of the measurements to resistivities is not required since electrode dimensions are specified. The potentials shall be applied to the specimens as shown on figure 3 or with polarities opposite to those shown on the figure. Surface resistance measurements shall be made on the same specimens as those used for volume resistance except that the potentials of guard and low electrodes shall be interchanged. The volume and surface resistance shall be measured in each case, 1 minute after the potentials are applied. Low values of volume and surface resistance (below 5 megohms) may be measured by the circuits shown on figure 4.

[1] Because of the variability of the resistance of a given specimen with test conditions and because of non-uniformity of the same material from specimen to specimen, determinations are usually not reproducible to closer than 10 percent and are often even more widely divergent. A range of values of 10 to 1 may be obtained under apparently identical conditions. Errors in resistance determinations may result from the fact that the current measuring device is shunted by the resistance between the guarded terminal and the guard system. In some bridge techniques a standard resistor in the bridge is shunted by the resistance between the unguarded terminal and the guard system. To assure validity of the volume and surface resistance measurements obtained by the bridge methods the resistance between the unguarded terminal and the guard terminal should be at least five times greater than the standard resistance employed in the bridge. This may be ascertained by direct two terminal measurements between these two terminals.

4.5.2.8 *Toxicity when heated.* The method described in Bureau of Mines Report BM–314 shall be used.

5. PREPARATION FOR DELIVERY

5.1 Not applicable to this specification.

6. NOTES

6.1 Intended use.

6.1.1 *Type CFG.* This type is a general-purpose, wood-flour-filled phenolic compound intended for applications requiring good electrical properties with mechanical properties better than the acceptable minimum. Preheating the molding compound is advisable and improves the electrical properties. Moldability of this material is excellent.

6.1.2 *Type CFI–5.* This type is a moderate-impact, cotton- or paper-filled phenolic compound intended for use where good all around mechanical properties are required. Impact strength is approximately 0.6 foot-pounds per inch notch.

6.1.3 *Type CFI–10.* This type is a medium-impact, cotton rag-filled phenolic compound providing good finish. Impact strength is approximately 1.0 foot-pounds per inch notch.

6.1.4 *Type CFI–20.* This type is a high-impact, rag- or cotton-filled phenolic compound, providing good finish. Impact strength is approximately 2.0 foot-pounds per inch notch.

6.1.5 *Type CFI–40.* This type is the highest-impact grade of cotton-filled phenolic compound. Impact strength is approximately 4.0 foot-pounds per inch notch.

6.1.6 *Type MFE.* This type is a low-loss, high-dielectric-strength, low-water absorption, mineral-filled phenolic compound intended for applications requiring the best dielectric properties for a phenolic material. To secure optimum electrical properties, this compound should be preheated immediately before molding. Care should be taken, however, to prevent precuring.

6.1.7 *Type MFG.* This type is a general-purpose, asbestos-filled phenolic compound intended for applications requiring good mechanical and heat-resistant properties.

6.1.8 *Type MFH.* This type is a mineral-filled phenolic compound intended for applications requiring highest heat resistance. Its mechanical properties are relatively low.

6.1.9 *Type MFI–10.* This type is a heat-resistant, medium-impact, asbestos-filled phenolic compound. Impact strength is approximately 1.0 foot-pounds per inch notch.

6.1.10 *Type MFI–20.* This type is a heat-resistant, high-impact, asbestos-filled phenolic compound. Impact strength is approximately 2.0 foot-pounds per inch notch.

6.1.11 *Type GPI–100.* This type is a glass-fiber filled phenolic resin molding compound of high impact strength and good electrical properties. Impact strength is approximately 10.0 foot-pounds per inch notch.

6.1.12 *Type CMG.* This type is a cellulose-filled, general-purpose, melamine molding compound with good electrical and mechanical properties, for use where good arc resistance is required.

6.1.13 *Type CMI–5.* This type is a cellulose-filled, moderate-impact melamine compound with good all around mechanical properties for use where resistance to arcing and moderate impact is required.

6.1.14 *Type CMI–10.* This type is a cellulose-filled, moderate impact phenol modified melamine compound with good all around mechanical properties suitable for tableware and similar applications. It is not intended for electrical use.

6.1.15 *Type MME.* This type is a mineral-filled melamine compound for use where good dielectric properties and arc and flame resistance are required. Of the melamine compounds this one is the most dimensionally stable.

6.1.16 *Type MMI–5.* This type is a glass fiber-filled melamine resin molding compound of lower impact strength and higher dielectric constant and dissipation factor at 1 megacycle than type MMI–30. It has superior "moldability" when compared with type MMI–30. Impact strength is approximately 0.5 foot-pounds per inch notch.

6.1.17 *Type MMI–30.* This type is a glass fiber-filled melamine compound of high-impact strength for use where heat-resistance, arc resistance and flame resistance are required.

6.1.18 *Type MAG.* This type is a mineral-filled polyester compound for use where good dielectric properties and arc resistance are required.

6.1.19 *Type MAI–60.* This type is a glass fiber-filled polyester compound for use where high-impact strength, good dielectric properties, and arc resistance are required.

6.1.20 *Type MAI–30.* Type MAI–30 is a mineral filled, glass-fiber reinforced alkyd resin molding compound having excellent handling and molding characteristics. It is an arc-resistant, flame-resistant, heat-resistant, high-impact compound having good mechanical and excellent electrical characteristics.

6.1.21 *Type MDG.* This type is a mineral-filled diallyl phthalate compound for use where good dielectric properties and low shrinkage are required.

6.1.22 *Type SDG.* This type is a glass-filled diallyl phthalate resin compound of low-loss, high dielectric strength, low shrinkage and good moisture resistance, and relatively low impact strength.

6.1.23 *Type SDI–5.* This type is an acrylic polymer fiber filled diallyl phthalate resin compound of low-loss, high dielectric strength, low shrinkage, excellent moisture resistance, and moderate impact strength.

6.1.24 *Type SDI–30.* This type is a polyethylene terephthalate fiber filled diallyl phthalate resin compound of low-loss, high dielectric strength, low shrinkage, very good moisture resistance and high impact strength.

6.1.25 *Type MSG.* This type is a mineral-filled silicone compound of low-loss, high, dielectric strength and excellent heat resistance.

6.1.26 *Type MSI–30.* This type is a glass-fiber-filled silicone compound of high impact strength and heat resistance, but somewhat poorer electrical properties than type MSG.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.

(b) Type required (see 1.2).

(c) Color required (see 3.2.2.2 and 30.4).

(d) Dimensions and spacing required (see 30.5.1 and 30.5.2).

(e) Requirements and inspection for molded parts (see 30.5, 30.6, 30.7 and section 40).

(f) Applicable levels of packaging and packing required (see 50.1 and 50.2).

6.3 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL–14, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Chief of the Bureau of Ships, Department of the Navy, Washington 25, D. C., and information pertaining to qualification of products may be obtained from that activity.

6.3.1 *Identity values.* When a product qualified under this specification is to be used for molding parts for Army Ordnance Corps procurement, the manufacturer of the molding material must submit identity values for the product to Commanding Officer, Picatinny Arsenal, Dover, New Jersey, Attention:

ORDBB–TG1. The types of identity values required, methods of determination and the plus and minus tolerances for values on molded parts may be obtained from the applicable molded parts specification. The manufacturer is urged to select identity values on the basis of average results obtained from specimens and molded commercial items made from a large number of production batches of the material in order that the values will be representative of normal production and sound molding procedure.

6.4 Toxicity when heated. It is desired that the following maximum concentrations of the toxic gases not be exceeded when the materials are subjected to the heat test as specified in Bureau of Mines Report BM–314:

Toxic gas	*Maximum parts per million*
Carbon dioxide	15,000
Carbon monoxide	1,000
Ammonia	2,500
Aldehydes as H. CHO	50
Cyanide as HCN	60
Oxides of Nitrogen as NO_2	100
Hydrogen chloride	100

6.5 Engineering information. Table IX gives engineering information on the electrical properties of silicone resin molded materials covered by this specification when measured at elevated temperatures after 1 hour exposure to the elevated temperature. This information will not be used for approval action under this specification, nor for acceptance or rejection of lots under this specification.

6.6 Color chips may be obtained from the Chemical Laboratory, Norfolk Naval Shipyard, Portsmouth, Va.

6.7 Supersession data. This specification supersedes Specifications MIL–M–14E, dated 10 February 1956, MIL–M–18794A (NAVY), dated 29 April 1957, MIL–M–19061 (SHIPS), dated 10 October 1955, MIL–M–19536 (NAVY), dated 7 November 1956 and MIL–M–21699 (SHIPS), dated 12 January 1959.

6.8 Certain provisions of this specification are the subject of international standardization agreements (ABC NAVY–STD–17A). When

TABLE IX. *Engineering information on electrical properties of silicone resin molding compounds at eleated temperatures.*

Property	Condition	Unit of value	Range of values	
			Type MSG	Type MSI–30
Dielectric strength S/T	E–48/50+C–96/23/50	Volts per mil.	344 – 416	167 – 277
	E–1/150		376 – 433	113 – 288
	E–1/200		310 – 445	152 – 325
	E–1/250		284 – 443	95 – 408
Dielectric constant (1 kc.)	E–48/50+des	.....	3.64 – 4.90	3.89 – 3.97
	E–1/150		3.98 – 5.74	3.99 – 4.23
	E–1/200		4.29 – 5.48	3.89 – 4.53
	E–1/250		4.67 – 5.73	3.82 – 4.93
Dissipation factor (1 kc.)	E–48/50+des	.....	0.00405 – 0.00898	0.00217 – 0.004
	E–1/150		.0204 – 0.0478	.0131 – 0.0174
	E–1/200		.021 – 0.137	.0169 – 0.0716
	E–1/250		.024 – 0.411	.0307 – 0.176
Dielectric constant (1 mc.)	E–48/50+des	.....	3.15 – 4.67	3.65 – 3.86
	E–1/150		3.65 – 4.95	3.81 – 4.38
	E–1/200		3.63 – 4.77	3.68 – 4.33
	E–1/250		3.55 – 4.54	3.62 – 4.14
Dissipation factor (1 mc.)	E–48/50+des	.....	0.004 – 0.00620	0.00274 – 0.004
	E–1/150		.0064 – 0.012	.0019 – 0.0034
	E–1/200		.0070 – 0.011	.0024 – 0.0031
	E–1/250		.0094 – 0.0145	.0025 – 0.0035

amendment, revision or cancellation of this specification is proposed the departmental custodians will inform their respective (DepSO) so that appropriate action may be taken respecting the international agreement concerned.

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Preparing activity:
Navy—Bureau of Ships
(Project 707–54)

Custodians:
Army—Signal Corps
Navy—Bureau of Ships

International interest (see sec. 6)

APPENDIX

10 SCOPE

10.1 This appendix covers general requirements for parts molded from compounds covered by this specification, together with procedures for the inspection of such parts (not applicable for Army Ordnance Corps procurements).

20. APPLICABLE DOCUMENTS

20.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

PPP–B–585 — Boxes, Wood, Wirebound.

PPP–B–591 — Boxes, Fiberboard, Wood-Cleated.

PPP–B–601 — Boxes, Wood, Cleated-Plywood.

PPP–B–621 — Boxes, Wood, Nailed and Lock-Corner.

PPP–B–636 — Boxes, Fiber.

PPP–T–76 — Tape, Pressure-Sensitive Adhesive, Paper, Water-Resistant.

MILITARY

MIL–P–116 — Preservation, Methods of.

MIL–B–10377 — Box: Wood - Cleated, Veneer, Paper Overlaid.

MIL–L–10547 — Liners, Case, Waterproof.

STANDARDS

MILITARY

MIL–STD–105 — Sampling Procedures and Tables for Inspection by Attributes and Appendix — Sampling for Expensive Testing by Attributes.

MIL–STD–129 — Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

20.2 **Other publications.** The following document forms a part of this specification. Unless otherwise indicated the issue in effect on date of invitation for bids shall apply.

OFFICIAL CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd St., New York 16, N. Y.)

30. REQUIREMENTS

30.1 **Preproduction sample.** Prior to production, molded parts shall be submitted for the inspection specified in 40.3.

30.2 **Material.** Molded parts shall be molded from compounds which have received qualification (see 3.1 and 6.3) and batches of compounds which have been tested and accepted (see 4.4). No scrap compound (previously cured and reground) shall be used.

30.3 **Uniformity.** All molded parts from the same molder shall be uniform in color, in finish, and in specified properties determined by the preproduction and lot-acceptance inspection.

30.4 **Color.** Unless otherwise specified in the contract or order, mineral filled phenolic-resin materials shall be used in natural color. Other types of compounds shall be used in the color specified by the procuring activity (see 6.2). In such cases, if the color is not specified, the compound shall be used in the normal color in which manufactured. Natural colored compounds are those in which no coloring matter of any sort has been added. In evaluating uniformity of color, consideration shall be given

to the fact that variation in color of raw materials, particularly the filler, may be reflected in the color of the "natural" molded parts. Coloring matters reducing the electrical properties of the molding compound below the specified limits shall not be used (see 3.2.2).

30.5 *General (as applicable).*

30.5.1 *Dimensions.* All molded parts shall conform to the dimensions specified (see 6.2) and shall be within the dimensional tolerances specified. (This is necessary to assure a high degree of interchangeability of parts of the same kind.)

30.5.2 *Inserts.* All inserts, holes, and lugs shall conform to the dimensions and spacings specified (see 6.2). The inserts, holes, and lugs shall not be damaged in any way, nor shall they be coated with molding compound or foreign substance in such a way as to result in imperfect electrical contact or poor mechanical fit. All inserts shall be so designed and assembled in the compound that they will easily withstand the tensile or torsional load that is to be applied.

30.5.3 *Threads.* All threaded sections, whether threaded metal inserts or threads molded or tapped into the part itself, shall be smooth, clean, and free from nicks, tears, or other damage.

30.5.4 *Surface defects and porosity (except types MAI-60, MAI-30, MMI-30 and MSI-30).* The molded finish on parts shall not be disturbed. All molded parts shall be free from warp, cracks, chipped edges or surfaces, blisters, uneven surfaces, scratches, dents, and heat marks. Unless otherwise specified in the contract or order, or in the detailed specification, they shall be free from fins, burrs, or projecting ridges at the dividing line of the mold, and free from unsightly finish caused by chipping, filing, or grinding of the ridges without subsequent buffing or polishing. All molded parts shall be uniformly dense throughout the structure, and free from porosity. They shall contain no holes, air or gas pockets, resin pockets, solvent areas, delamination, soft spots, area lacking resin, or uncured areas.

30.5.5 *Surface defects and porosity (types MAI-60, MAI-30, MMI-30 and MSI-30 only).* Molded parts having slight blemishes caused by contamination in the air or mold, burn marks, noticeable surface flow lines, or surface porosity and crazing are considered acceptable, and shall not be cause for rejection. In general, the molded surface finish on parts should not be disturbed; however, where gates are removed and where flash is removed, the surface may be ground or filed (medium or fine cuts) without subsequent buffing or polishing. Minor chipping is considered acceptable provided no loose chips are present. Knit line cracks around the gate portion of the molded part and stress line cracks in most cases are considered acceptable. Tight, small blisters that cannot be broken or dented are considered acceptable except where uneven surface cannot be tolerated. Questionable defects such as cracks, blisters, or chipping that cannot be resolved should be referred to the contractor responsible for the equipment in which the part is used to determine acceptability of the molded parts in question.

30.5.6 *Machinability.* All molded parts shall be suitable for fabrication by standard machining operations, when performed in accordance with good practice, and shall not crack, split, craze or distort as a result of such operations.

30.5.7 *Marking.* Each molded part shall clearly show the drawing or part number (if available) the cavity number, and the molder's trade-mark or symbol, unless such markings are impracticable because of the small size of the parts or because of special applications. If part but not all of markings listed can be shown, the order of preference shall be as listed above.

30.6 **Contract inspection.** Parts shall conform to the inspection specified (see 6.2).

30.7 **Optional tests.** Where additional tests consistent with the end use of the molded part

are mutually agreed to by the purchaser of the molded part and the molder (see 6.2), the requirements for such parts shall be established as follows:

(a) For any property which is expressed in terms of a minimum requirement, the minimum acceptable value for lot-acceptance inspection shall be the lowest value obtained and acceptable on the preproduction inspection.

(b) For any property which is expressed in terms of a maximum requirement, the maximum acceptable value for lot-acceptance inspection shall be the highest value obtained and acceptable on the preproduction inspection.

Information in 60.1 shall serve as a guide in the formulation of such tests and requirements for molded parts.

30.8 Compatibility with explosives. When suitability for use with a particular explosive is required, a special test shall be conducted at a designated Government laboratory to determine the compliance of the material in this respect. This test shall be requested by the procuring activity.

30.9 Workmanship. The compound manufactured and processed (parts molded and processed) in accordance with this specification shall be such as to meet all the requirements of this specification and any referenced subsidiary specification, drawing or other document when inspected in accordance with section 4 (section 40).

40. QUALITY ASSURANCE PROVISIONS

40.1 Unless otherwise specified herein the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order.

40.2 Classification of inspection. The methods of sampling, examination, and tests conducted upon molded thermosetting plastic parts shall be classified as follows:

Preproduction inspection (see 40.3).

Lot acceptance inspection (see 40.4).

40.3 Preproduction inspection. After award of contract but prior to production, tests shall be made on each kind of part furnished under the contract or order. Any production started before approval shall be at the contractor's risk. If additional contracts are awarded for the part, the Government inspector may waive these tests when prior preproduction inspection will establish the limits on which lot acceptance inspection can be based for subsequent deliveries.

40.3.1 *Sampling for preproduction inspection.* The samples for preproduction examination and tests shall consist of a sufficient number of parts to perform the examination and tests specified in 40.3.3 through 40.3.6.

40.3.2 *Location of preproduction inspection.* Where possible, all examination and tests specified in 40.3.3 through 40.3.6, shall be conducted at the molder's plant or at a commercial laboratory under contract to the molder under the supervision of a Government inspector.

40.3.3 *Preproduction verification of type.* It shall be ascertained from the Qualified Product List that the compound used is of the particular type (see 1.2) specified for the part; that it is a product that has been approved (see 3.1); and that it has passed the batch acceptance inspection (see 4.4).

40.3.4 *Preproduction visual examination.* Molded parts shall be examined for uniformity in color (see 30.3); for dimensions, inserts, threads, surface defects, porosity, machinability, and marking (as applicable) (see

30.5.1 to 30.5.7, inclusive) ; and for workmanship (see 30.9).

40.3.5 *Preproduction contract inspection.* Contract inspection shall consist of such tests as are specified (see 30.6).

40.3.6 *Preproduction optional tests.* Optional tests shall consist of those additional tests, consistent with the end use of the molded part (see 30.7) chosen from the guide to the formulation of tests and requirements for molded parts (see 60.1) and mutually agreeable to the purchaser of the molded part and the molder. Initiative for the establishment of optional tests and requirements normally rests with the purchaser of the molded part who shall provide the molder and Government inspector with copies of contracts, specifications, drawings, or other documents wherein the tests and requirements are specified.

40.4 Lot acceptance inspection. Lot acceptance examination and tests shall be conducted on samples from a lot of parts as a basis for acceptance or rejection under the contract or order.

40.4.1 *Inspection lot.* A lot shall consist of all like molded parts molded from the same batch of qualified molding compound under fixed molding conditions and furnished at one time.

40.4.2 *Sampling for visual examination.* Sampling for visual examination shall be in accordance with Standard MIL–STD–105. The Acceptable Quality Level (AQL) shall be 4.0 percent defective, and the normal inspection level shall be level II. Single, double, or multiple sampling shall be used as determined by the inspector.

40.4.3 *Sampling for lot acceptance tests.*

40.4.3.1 *Nondestructive tests.* Sampling shall be in accordance with the appendix to Standard MIL–STD–105 at inspection level L–8. The Acceptable Quality Level shall be equal to 4.0 percent defective.

40.4.3.2 *Destructive tests.* Sampling shall be in accordance with the appendix to Standard MIL–STD–105 at inspection level L–4. If any part fails any test the lot represented by the sample shall be rejected.

40.4.4 *Location of lot acceptance inspection.* Lot acceptance examination and tests shall be performed at the same location and under the same supervision as that specified in 40.3.2.

40.4.5 *Lot acceptance verification of type.* It shall be ascertained that the material is acceptable as specified in 40.3.3.

40.4.6 *Lot acceptance visual examination.* Each of the sample parts selected in accordance with 40.4.2 shall be examined as specified in 40.3.4.

40.4.7 *Lot acceptance contract inspection tests.* Each of the sample parts selected in accordance with 40.4.3 shall be tested as specified in 40.3.5 (see 30.6).

40.4.8 *Lot acceptance—optional tests.* Each of the sample parts selected in accordance with 40.4.3 shall be tested as specified in 40.3.6 (see 30.7).

40.5 Inspection of preparation for delivery. Molded parts, packages, and packs shall be selected and inspected in accordance with Specification MIL–P–116 to verify conformance to the requirements of section 50 herein.

50. PREPARATION FOR DELIVERY

50.1 Preservation and packaging.

50.1.1 *Level A.* Molded parts shall be packaged in accordance with method III of Specification MIL–P–116. Contact preservative is not required.

50.1.2 *Level C.* Molded parts shall be preserved and packaged in accordance with the manufacturer's commercial practice.

50.2 Packing.

50.2.1 *Level A.* Molded parts, packaged as specified (see 6.2) shall be packed in overseas type, wood cleated fiberboard, nailed wood, wirebound wood, fiber, wood cleated veneer paper overlaid, or wood cleated plywood boxes conforming to Specification PPP-B-591, PPP-B-621, PPP-B-585, PPP-B-636, class 3, MIL-B-10377, or PP-B-601, respectively, at the option of the contractor. Shipping containers shall have caseliners conforming to Specification MIL-L-10547 and shall be closed and sealed in accordance with the appendix thereto. Caseliners for boxes conforming to Specification PPP-B-636 may be omitted provided all joints and corners of the boxes are sealed with minimum 1½ inch wide tape conforming to Specification PPP-T-76. Boxes shall be closed and strapped in accordance with the applicable box specification or appendix thereto. The gross weight of wood or wood cleated boxes shall not exceed 200 pounds; fiber boxes shall not exceed the weight limitations of the applicable box specification.

50.2.2 *Level B.* Molded parts, packaged as specified (see 6.2) shall be packed in domestic type wood cleated fiberboard, nailed wood, wirebound wood, cleated plywood or wood cleated veneer paper overlaid boxes or class 2 fiber boxes conforming to Specification PPP-B-591, PPP-B-621, PPP-B-585, PPP-B-601, MIL-B-10377 or PPP-B-636, respectively, at the option of the contractor. Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood or wood cleated boxes shall not exceed 200 pounds; fiber boxes shall not exceed the weight limitations of the applicable box specification.

50.2.3 *Level C.* Molded parts, packaged as specified (see 6.2) shall be packed in containers which will insure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules or other regulations as applicable to the mode of transportation.

50.3 Marking. In addition to any special marking required by the contract or order or herein, interior and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129.

60. NOTES

60.1 Guide to the formulation of tests and requirements for molded parts.

60.1.1 *General.* The following tests and requirements, which have been specified for various kinds of molded parts used in Military applications, should serve as a guide in the formulation of tests and requirements for molded parts. These do not all apply to every kind of molded part but they are listed to indicate, in a general way, what tests and requirements should be considered. The suggested tests and requirements are purposely given in general terms, since the nature of the applications vary and the specific detailed description of the tests and requirements should depend on the specific circumstances of the application.

60.1.2 *Performance properties and tests.*

60.1.2.1 *Shockproofness and impact strength.*

(a) Molded parts may be mounted on the Navy class HI shock machine, and shock-tested. Various methods of loading the parts may be used.

(b) Molded parts may be dropped from fixed heights on specified surfaces.

(c) Molded parts may be subjected to impact from steel balls dropped from a fixed height.

(d) Sections cut from molded parts may be tested as above or subjected to Izod impact tests.

60.1.2.2 *Static loading.*

(a) Molded parts may be subjected to static loading under a combination of one or more of the following types of stresses: Tensile, compression, shear, flexure, bending, torsion, or bearing.

(b) Molded parts may be subjected to fatigue tests resulting from repeated cycles of stresses of the above types.

60.1.2.3 *Vibration.* Molded parts may be subjected to harmonic vibration, in each of three mutually perpendicular planes, at the resonant frequency of the part.

60.1.2.4 *Dielectric strength.* Molded parts may be subjected to dielectric strength tests between current-carrying parts of the same and opposite polarity. Proof tests usually employ an alternating current, 60-cycle voltage of twice the rated voltage plus 1,000 volts applied for 1 minute. Endurance tests may be conducted when applied voltages are maintained for much longer periods. Short-circuit tests may be used as an indication of suitability for emergency operations.

60.1.2.5 *Insulation-resistance.* Molded parts may be subjected to insulation-resistance tests between current-carrying parts of the same and opposite polarity. In such cases, readings are usually taken 1 minute after the application of voltage.

50.1.2.6 *Dielectric loss.* Molded parts for electronic uses may be subjected to dielectric loss tests (dissipation factor, dielectric constant) at the frequency involved in the application.

60.1.2.7 *Arc resistance.* Molded parts may be subjected to arc-resistance tests, particularly in applications involving high-arcing voltages or in switch-gear power applications which involve making and breaking circuits.

60.1.3 *Conditions for performance properties and tests.* Choice of conditions to which the molded parts are to be subjected before tests are performed should be based on the following service conditions:

Normal operation — Continuous or interrupted service.

Abnormal operation — Continuous or interrupted service.

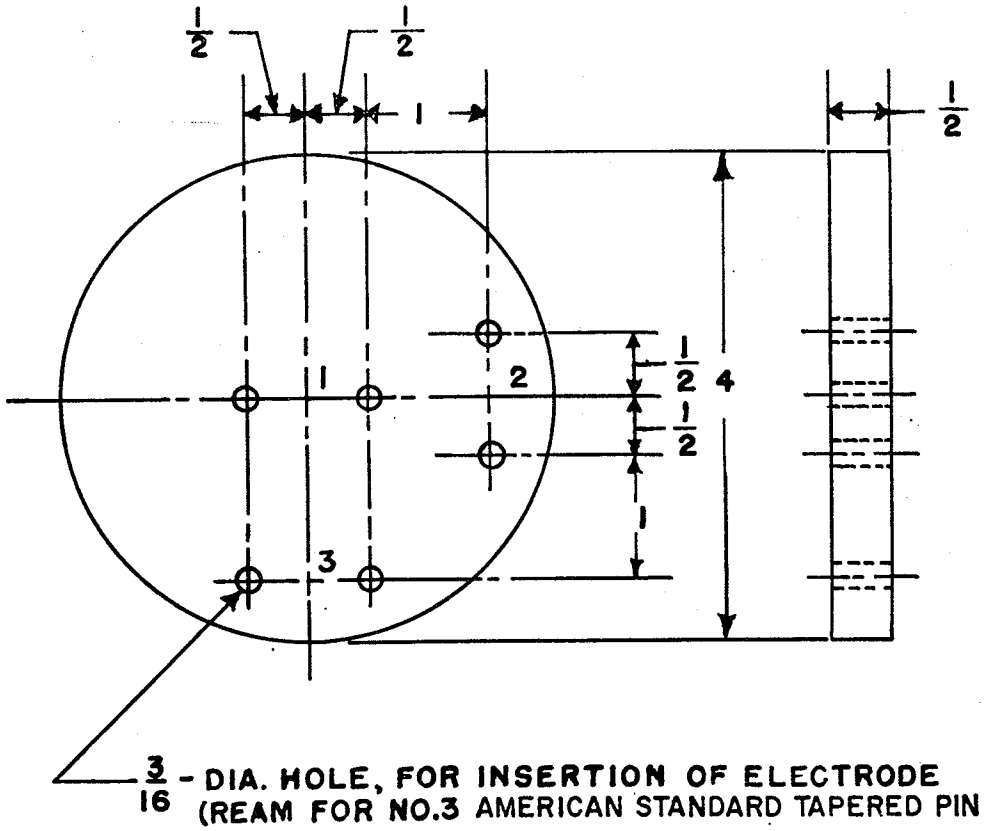
Emergency operation.

The following factors should be taken into consideration in choosing the conditions:

Temperature — High, normal, and low.

Moisture — High humidity and water immersion.

Contaminants — Salt, oil, dust, fungus, and combinations thereof.



NOTES:

1. ALL DIMENSIONS IN INCHES.
2. TOLERANCES ON DIMENSIONS, PLUS OR MINUS 5 PERCENT.
3. DISKS SHALL BE FURNISHED UNDRILLED AND SHALL BE DRILLED BY LABORATORY.

TEST: DIELECTRIC BREAKDOWN

FIGURE 1. *Standard test specimen drilled for three pairs of electrodes.*

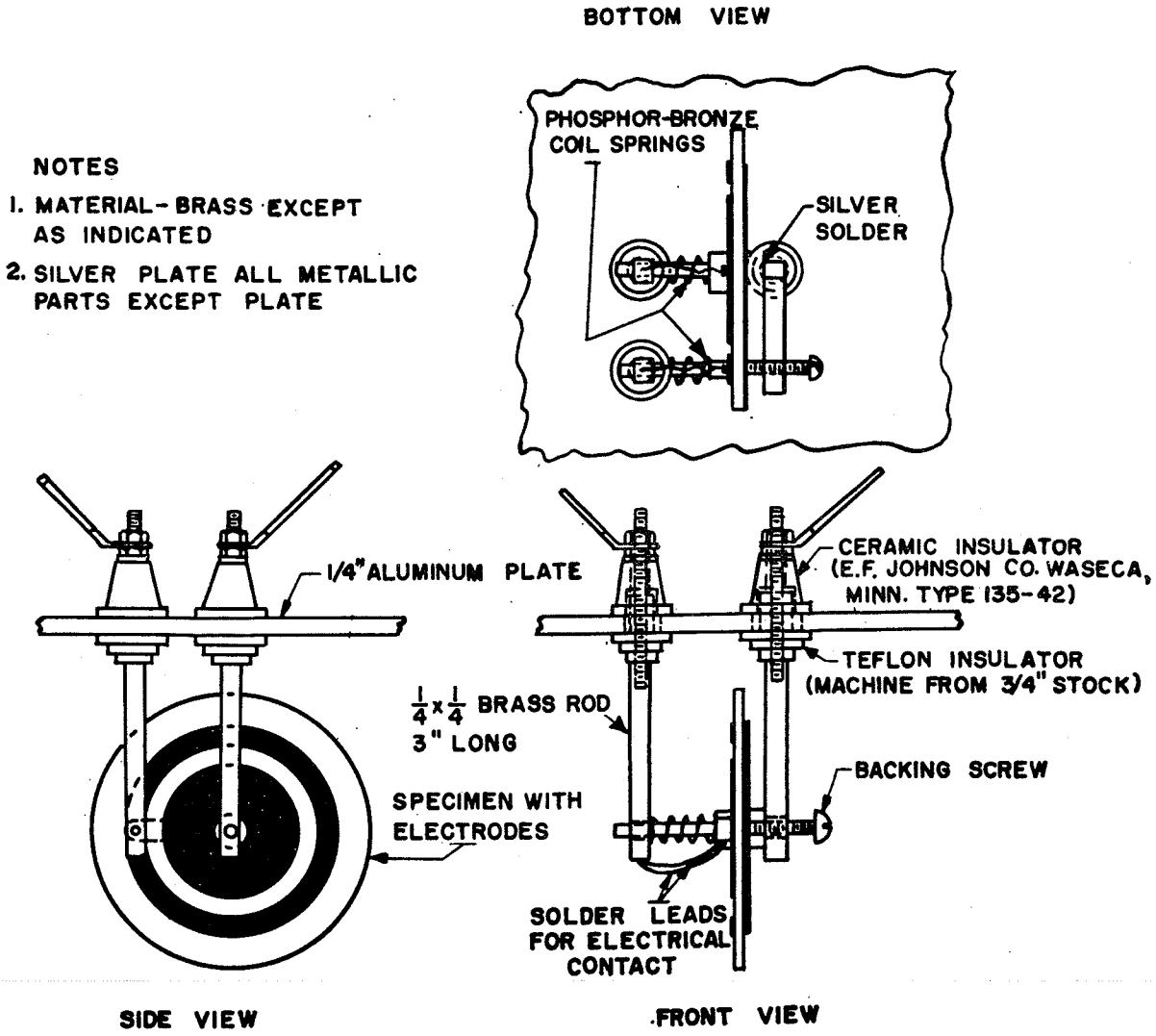


FIGURE 2. *Specimen holders, electrodes, test samples, and humidity chamber cover — volume and surface resistance test.*

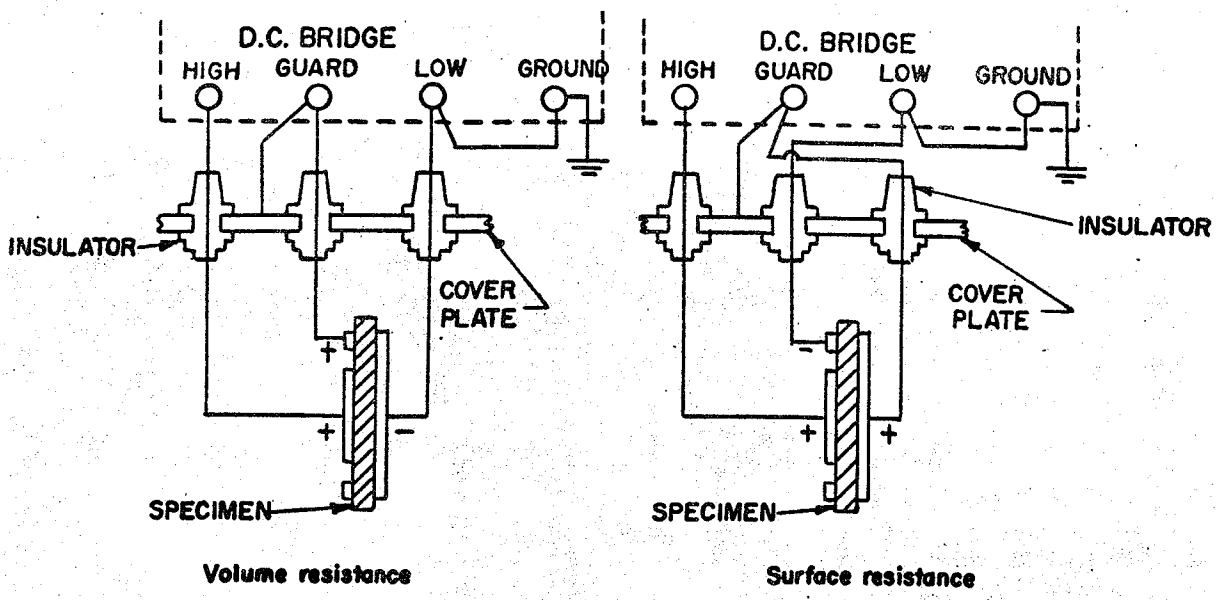
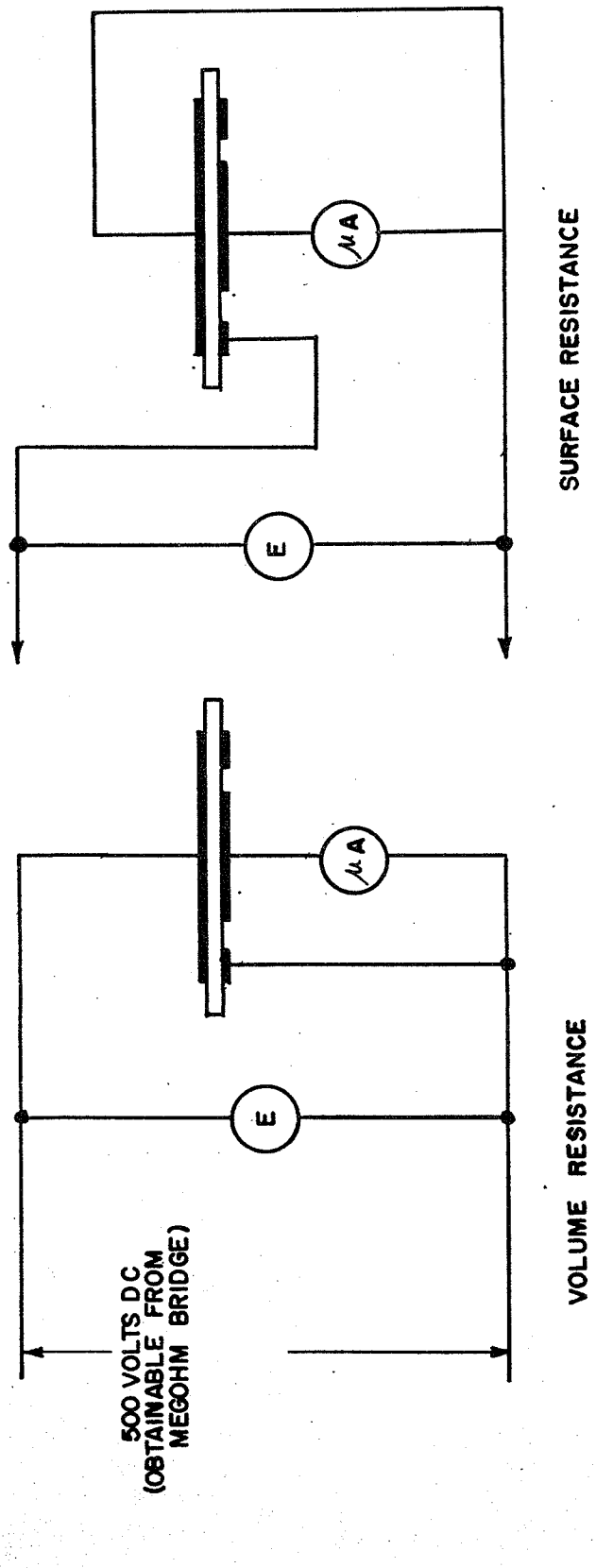


FIGURE 3. *Arrangements for volume resistance and surface resistance test.*



$$R(\text{MEGOHMS}) = \frac{E}{\mu A}$$

FIGURE 4. *Circuits for measuring low values of volume and surface resistance.*