

INCH- POUND

MIL-M-24519E(NAVY)

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SUPERSEDING

MIL-M-24519D(SH)

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MILITARY SPECIFICATION

MOLDING PLASTICS, ELECTRICAL, THERMOPLASTIC

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the basic properties of thermoplastic molding compounds used to mold electric and electronic component parts.

1.2 Classification. The thermoplastic molding compounds governed by this specification are of the following types, as specified (see 6.2).

<u>Type</u>	<u>Description</u>
PT-F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate) compound, flame resistant.
GPT-7.5F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate) compound, 7.5 percent glass reinforced, flame resistant.
GPT-15F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate compound, 20 percent glass reinforced, flame resistant.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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<u>Types</u>	<u>Description</u>
GPT-20F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate compound, 20 percent glass reinforced, flame resistant.
GCT-30F	- Thermoplastic polyester (1, 4-cylohexylenedimethylene terephthalate -(PCT) compound, 30 percent fiber reinforced, flame retardant.
GPT-30F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate) compound, 30 percent glass reinforced, flame resistant.
GAT-22F	- Thermoplastic, polyarylether compound, 22 percent glass reinforced, flame resistant.
GET-30F	- Thermoplastic polyester (polyethylene terephthalate) compound, 30 percent glass reinforced, flame resistant.
GET-35F	- Thermoplastic polyethylene terephthalate compound, 35 percent glass reinforced, flame retardant.
GMT-40F	- Thermoplastic polyester (polytetramethylene terephthalate or poly 1, 4 butylene terephthalate) compound, 40 percent glass and mineral reinforced, flame resistant.
GLT-10F	- Thermoplastic polyetherimide compound, 10 percent glass reinforced, flame resistant.
GLT-20F	- Thermoplastic polyetherimide compound, 20 percent glass reinforced, flame resistant.
GLT-30F	- Thermoplastic polyetherimide compound, 30 percent glass reinforced, flame resistant.
GST-40F	- Thermoplastic polyphenylene sulfide compound, 40 percent glass reinforced, flame resistant.
MLT-20F	- Mineral plastic polytherimide compound, 20 percent mineral filled, flame resistant.
GLCP-30F	- Thermoplastic polyester, 30 percent glass reinforced liquid crystalline.
GLCP-50F	- Thermoplastic polyester, 50 percent glass reinforced liquid crystalline.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS)

AD297457 - Procedure and Analytical Method for Determining Toxic Gases Produced by Synthetic Compounds.

(Application for copies should be addressed to the Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies. (DOD adopted)
- D 150 - Standard Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials. (DOD adopted)
- D 229 - Standard Method of Testing Rigid Sheet and Plate Materials Used for Electrical Insulation. (DOD adopted)
- D 256 - Standard Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials. (DOD adopted)
- D 495 - Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation. (DOD adopted)
- D 570 - Standard Test Method for Water Absorption of Plastics. (DOD adopted)
- D 638 - Standard Test Method for Tensile Properties of Plastics. (DOD adopted)
- D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load. (DOD adopted)
- D 695 - Standard Test Method for Compressive Properties of Rigid Plastics. (DOD adopted)
- D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. (DOD adopted)
- D 4507 - Standard Specification for Thermoplastic Polyester (TPES) Materials. (DOD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

Publication 112 - Method for Determining the Comparative and the Proof Tracking Indices of Solid Insulating Materials Under Moist Conditions.

(Application for copies should be addressed to the United States of America Standards Institute, Sales Department, 10 East 40th Street, New York, NY 10016.)

UNDERWRITERS LABORATORIES (UL)

94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

(Application for copies should be addressed to the Underwriters Laboratories Incorporated, 333 Pfingsten Road, Northbrook, IL 60062.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

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

3. REQUIREMENTS

3.1 Qualification. Thermoplastic molding compounds furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.5).

3.1.1 Qualification for compound and colors. Contractors shall obtain qualification approval for each compound. Material qualified for one color (natural) will not be qualified for all other colors. The material (virgin) shall have moisture content no more than 1 percent maximum, to prevent excessive warpage. A sealed bag shall be used for shipping and storage. Bags shall be kept sealed until its use.

3.2 Materials.

3.2.1 Recovered materials. Unless otherwise specified herein, all material incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. For the purposes of this specification, recovered materials are defined as materials of a single compound grade that is considered unusable as a finished product after completion of the molding process. This includes material designated as mold runners, sprues, or a molded product that has not had additional operations performed after the molding process. Recovered materials

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shall continue to meet the performance requirements of this specification. Material shall be free from foreign substances and dry to 1 percent moisture maximum content. None of the above shall be interpreted to mean that the use of used products is allowed under this specification unless otherwise specifically specified.

3.2.2 Uniformity. Molding compound of the same type from one contractor shall be uniform in texture, in color (see 3.2.3), and in the properties specified herein as determined by the quality conformance inspection specified in 4.4.

3.2.3 Color. Unless otherwise specified (see 6.2), materials shall be provided in natural color. The color shall be designated for Qualified Products List (QPL) testing (see 6.5). 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 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.

3.2.4 Material property values. Standard specimens of the compounds shall conform to the property values specified in table I.

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TABLE I. Property values for qualification tests of thermoplastic molding compounds.

Property to be tested	Value required for each type of compound									
	Type PT-F	Type GCT-30F	Type GPT-7.5F	Type GPT-15F	Type GPT-20F	Type GPT-30F	Type CAT-22F	Type GET-30F	Type GET-35F	Type GET-35F
Arc resistance	50	50	55	65	60	70	80	70	75	75
Compressive strength, 10 percent deflection	12,000	17,500	12,500	13,500	14,000	16,200	13,500	17,500	18,000	18,000
Dielectric constant: At 100 Hz At 10 ⁶ Hz	3.6 3.4	4.1 3.5	3.8 3.6	3.9 3.7	3.9 3.7	4.1 4.0	3.8 3.8	4.1 4.0	4.2 4.1	4.2 4.1
Dissipation factor: 100 Hz 10 ⁶ Hz	0.005 0.03	0.01 0.03	0.0050 0.0300	0.005 0.03	0.005 0.03	0.010 0.03	0.003 0.02	0.010 0.03	0.010 0.030	0.010 0.030
Dielectric strength: Short-time test Short-time test	350 325	400 375	360 330	370 340	375 350	400 375	400 375	400 375	400 380	400 380
Dielectric breakdown: Short-time test Short-time test	43 40	50 46	45 41	46 42	46 42	50 46	50 46	50 46	50 46	50 46
Flame resistance: Ignition time Burning time	50 35	50 20	55 50	55 50	50 50	55 20	55 50	50 20	50 20	50 20
Flexural strength	13,000	24,000	15,000	19,000	20,000	24,000	20,000	24,000	26,000	26,000
Flammability	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
Heat-deflection temperature	160	440	270	360	375	385	300	400	410	410
Impact strength	0.6	0.9	0.6	0.7	0.8	1.1	0.8	1.1	0.9	0.9
Tensile strength	8,000	16,000	8,400	11,500	12,000	15,000	12,000	15,000	11,500	11,500
Water absorption	0.40	0.30	0.35	0.35	0.30	0.30	0.40	0.30	0.30	0.30
Heat resistance	50	80	50	50	50	50	70	50	50	50
Dimensional stability (high temperature)	0.2	0.2	0.2	0.2	0.2	0.2	.12	0.2	0.2	0.2
Volume resistance	1.0x10 ⁹	1.0x10 ⁸	1.0x10 ⁹	1.0x10 ⁹	1.0x10 ⁹	1.0x10 ⁹	1x10 ¹¹	1.0x10 ⁹	1x10 ⁹	1x10 ⁹
Surface resistance	1.0x10 ⁸	1.0x10 ⁸	1.0x10 ⁸	1.0x10 ⁹	1.0x10 ⁸	1.0x10 ⁹	3.5x10 ¹⁰	1.0x10 ⁹	1x10 ⁹	1x10 ⁹
Tracking index	180	200	180	180	180	180	125	180	180	180
Toxicity when heated: Carbon dioxide Carbon monoxide Ammonia Aldehydes as H.CHO Cyanide as HCN Oxides of nitrogen as NO ₂ Hydrogen chloride	2,500 1,000 2,500 50 60 100 100	15,000 1,000 2,500 50 60 100 100	2,500 1,000 2,500 50 60 100 100	2,500 1,000 2,500 50 60 100 100	2,500 1,000 2,500 50 60 100 100	2,500 1,000 2,500 50 60 100 100	10,000 500 50 50 60 60 50	15,000 1,000 2,500 50 50 60 100	15,000 1,000 2,500 50 60 100 100	15,000 1,000 2,500 50 60 100 100

TABLE 1. Property values for qualification tests of thermoplastic molding compounds - Continued.

Property to be tested	Value required for each type of compound										Units	
	Type GMT-40F	Type GLT-10F	Type GLT-20F	Type GLT-30F	Type GST-40F	Type MLT-20F	Type GLCP-30F	Type GLCP-50F				
Arc resistance	70	85	85	85	30	85	130	130	130	130	130	Seconds
Compressive strength, 10 percent deflection	16,200	19,000	20,000	22,000	20,000	20,000	11,000	11,000	11,000	11,000	11,000	lb/in ²
Dielectric constant: At 100 Hz At 10 ⁸ Hz	4.1	3.4	3.4	3.6	4.3	3.5	5.0	5.5	5.5	5.5	5.5	-
	4.0	3.5	3.5	3.6	4.2	3.5	4.8	5.2	5.2	5.2	5.2	-
Dissipation factor: 100 Hz 10 ⁸ Hz	0.005	0.007	0.012	0.004	0.002	0.004	0.04	0.04	0.04	0.04	0.04	-
	0.03	0.009	0.012	0.009	0.007	0.009	0.04	0.04	0.04	0.04	0.04	-
Dielectric strength: Short-time test Short-time test	400	450	450	450	320	450	480	480	480	480	480	Volt/ml
	375	430	430	430	300	430	480	480	480	480	480	Volt/ml
Dielectric breakdown: Short-time test Short-time test	50	56	56	56	40	56	56	56	56	56	56	Kilovolts
	46	54	54	54	37	54	56	56	56	56	56	Kilovolts
Flame resistance: Ignition time Burning time	55	65	65	65	50	65	100	100	100	100	100	Seconds
	20	20	20	20	20	20	20	20	20	20	20	Seconds
Flexural strength	24,000	26,600	28,500	31,400	22,000	22,500	25,000	28,000	28,000	28,000	28,000	lb/in ²
Flammability	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	-
Heat-deflection temperature	385	400	400	400	475	410	425	425	425	425	425	°F
Impact strength	1.1	0.9	1.0	1.1	1.1	0.6	1.3	0.8	0.8	0.8	0.8	ft-lb/in
Tensile strength	15,000	16,000	18,700	23,000	16,000	13,000	18,000	21,000	21,000	21,000	21,000	lb/in ²
Water absorption	0.30	0.69	0.60	0.55	0.08	0.60	0.08	0.08	0.08	0.08	0.08	Percent
Heat resistance	50	85	85	85	95	95	85	85	85	85	85	Percent
Dimensional stability (high temperature)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	Percent
Volume resistance	1.0x10 ⁹	1x10 ¹¹	1x10 ¹¹	1x10 ¹⁰	1.0x10 ¹⁰	1x10 ¹¹	1x10 ¹⁰	1x10 ¹⁰	1x10 ¹⁰	1x10 ¹⁰	1x10 ¹⁰	Ohm
Surface resistance	1.0x10 ⁸	1x10 ¹⁰	1x10 ¹⁰	1x10 ¹⁰	1.0x10 ¹⁰	1x10 ¹⁰	1x10 ¹⁰	1x10 ⁸	1x10 ⁸	1x10 ⁸	1x10 ⁸	Ohm
Tracking Index	180	135	135	135	150	140	120	140	140	140	140	Volts
Toxicity when heated:												
Carbon dioxide	15,000	5,000	5,000	5,000	2,500	5,000	15,000	15,000	15,000	15,000	15,000	Parts per million
Carbon monoxide	1,000	250	250	250	200	250	1,000	1,000	1,000	1,000	1,000	Parts per million
Ammonia	2,500	20	20	20	100	20	500	500	500	500	500	Parts per million
Aldehydes as HCHO	50	20	20	20	20	20	50	50	50	50	50	Parts per million
Cyanide as HCN	60	20	20	20	10	20	50	50	50	50	50	Parts per million
Oxides of nitrogen as NO ₂	100	50	50	50	50	50	100	100	100	100	100	Parts per million
Hydrogen chloride	100	50	50	50	10	50	50	50	50	50	50	Parts per million

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4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Naval Sea Systems Command (NAVSEA). Qualification inspection shall consist of the tests specified in tables I and II.

4.3.1 Specimens for qualification inspection. Tests shall be performed on standard test specimens molded by the manufacturer of each compound for which qualification is required. The number of test specimens to be tested shall be as specified in tables II and III.

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

4.4 Quality conformance inspection. Quality conformance shall be as specified in table IV. Tests shall be performed at the manufacturer's plant on standard specimens molded by the manufacturer from each batch of compound to be provided to molders for production of molded parts under this specification.

4.4.1 Batch. A batch shall be considered a homogeneous unit of finished molding compound manufactured at one time.

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TABLE 11. Specimens and conditioning for qualification tests.

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	ASTM	Modified by	Form and dimensions	Number tested		
Arc resistance	D 495	-	4-inch disk, 1/8 inch thick	3	A	Seconds (minimum average)
Compressive strength, 10 percent deflection	D 695	-	1 by 1/2 by 1/2 inch	5	E-48/50-C-96/23/50	lb/in ² (minimum average)
Dielectric constant: At 10 ⁶ Hz At 10 ⁸ Hz	D 150	-	4-inch disk, 1/8 inch thick	3	E-48/50-des	Maximum average E-48/50-D-24/23
				3	E-48/50-D-24/23	
				3	E-48/50-des	
Dissipation factor: At 10 ⁶ Hz At 10 ⁸ Hz	D 150	-	4-inch disk, 1/8 inch thick	3	E-48/50-des	Maximum average E-48/50-D-24/23
				3	E-48/50-D-24/23	
				3	E-48/50-des	
Dielectric strength: Short-time test Short-time test	D 149	4.5.2.1 & 4.5.2.1.1	4-inch disk, 1/8 inch thick 4-inch disk, 1/8 inch thick	3	E-48/50-C-96/23/50	Volt per mil (minimum average)
				3	E-48/50-D-48/50	
Dielectric breakdown: Short-time test Short-time test	D 149	4.5.2.1.2	4-inch disk, 1/8 inch thick	3	E-48/50-C-96/23/50	Kilovolt (minimum average)
				3	E-48/50-D-48/50	
Flame resistance: Ignition time Burning time	D 229	4.5.2.9	5-inch bar, 1/2 by 1/2 inch	5	A	Seconds (minimum average) Seconds (maximum average)
				5		
Flexural strength	D 790	4.5.2.2	5-inch bar, 1/4 by 1/2 inch	5	E-48/50-C-96/23/50	lb/in ² (minimum average)
Flammability	-	4.5.2.10	5-inch bar, 1/2 x thickness	5	(see 4.5.2.10)	(see 4.5.2.10)

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TABLE II. Sampling and conditioning for qualification tests - Continued.

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	ASTM	Modified by	Form and dimensions	Number tested		
Heat-deflection temperature	D 648	4.5.2.3	5-inch bar, 1/2 by 1/4 inch	3	A	Degrees Fahrenheit (minimum average)
Impact strength	D 256	-	In accordance with ASTM D 256 and ASTM D 4507 except thickness of SP	5	E-48/50+C-96/23/50	ft-lb/in notch (minimum average)
Tensile strength	D 638	-	In accordance with ASTM D 638	5	E-48/50+C-96/23/50	lb/in ² (minimum average)
Water absorption	D 570	4.5.2.4	2-inch disk, 1/8 inch thick	3	E-24/100+des+D-48/50	Percent (maximum average)
Heat resistance	D 790	4.5.2.5	5-inch bar, 1/4 by 1/2 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, 1/2 by 1/2 inch	5	(see 4.5.2.6)	Percent (maximum average)
Volume resistance	-	4.5.2.7	4-inch disk, 1/8 inch thick	5	(see 4.5.2.7)	Ohm (minimum individual)
Surface resistance	-	4.5.2.7	4-inch disk, 1/8 inch thick	5	(see 4.5.2.7)	Ohm (minimum individual)
Tracking index	-	4.5.2.11	4-inch disk, 1/8 inch thick	3	(see 4.5.2.11)	Volt
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, 1/2 by 1/2 inch	4	A	p/m

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TABLE III. Standard test specimens for qualification tests.

Specimen designation	Specimen description	Number of specimens for each type	Inches <u>1/</u>	mm
1	4 by 1/8 inch disk	52	1/8 (.125)	3.18
2	1 by 1/2 by 1/2 inch	5	1/4 (.250)	6.35
3	2 by 1/8 inch disk	3	1/2 (.500)	12.70
4	5 by 1/2 by 1/2 inch	14	1 (1.00)	25.40
5	5 by 1/2 by 1/4 inch	13	2 (2.00)	50.80
6	2-1/2 by 1/2 by 1/2 inch (ASTM D 256)	5	2-1/2 (2.50)	63.50
7	ASTM D 638	5	4 (4.00)	101.60
8	5 by 1/2 inch by thickness	5	5 (5.00)	127.00

1/ Metric equivalents are given for general information only and are based upon 1.00 inch = 25.4 millimeter (mm).

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

4.4.3 Rejection. Failure to conform to the requirements of table IV shall result in rejection of the batch 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 II, III, and IV as applicable.

4.5.1.2 Form. The form of the standard test specimens shall be as specified in the applicable ASTM standard, and as specified in tables II, III, and IV, as applicable.

4.5.1.3 Molding of test specimens. Test specimens shall be molded by methods which are representative of commercial practice. Special treatments shall not be used to improve the properties of the specimens when compared with parts molded in commercial production.

4.5.1.4 Tolerance. Unless otherwise specified (see 6.2), tolerance on dimensions shall be plus or minus 5.0 percent.

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TABLE IV. Property values for quality conformance inspection of thermoplastic molding compounds.

Property to be tested	Test method		Specimens		Conditioning procedure (see 4.5.1.5)	Unit of value
	ASTM	Modified by	Form and dimensions	Number tested		
Arc resistance	D 495	-	4-inch disk, 1/8 inch thick	3	A	Seconds (minimum average)
Dielectric constant at 1 megahertz	D 150	-	4-inch disk, 1/8 inch thick	3	E-48/50+D-24/23	Maximum average
Dissipation factor at 1 megahertz	D 150	-	4-inch disk, 1/8 inch thick	3	E-48/50+D-24/23	Maximum average
Dielectric strength short time	D 149	4.5.2.1	4-inch disk, 1/8 inch thick	3	E-48/50+D-48/50	Volts per mil (minimum average)
Flexural strength	D 790	4.5.2.2	5-inch bar, 1/4 by 1/2 inch	5	E-48/50+C-96/23/50	lb/in ² (minimum average)
Impact strength	D 256	-	In accordance with ASTM D 256	5	E-48/50+C-96/23/50	ft-lb/in notch (minimum average)
Water absorption	D 570	4.5.2.4	2-inch disk, 1/8 inch thick	3	E-24/100+des+D-48/50	Percent (maximum average)

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TABLE IV. Property values for quality conformance inspection of thermoplastic molding compounds - Continued.

Property to be tested	Value required for each type of compound									
	Type PT-F	Type GCT-30F	Type GPT-7.5F	Type GPT-15F	Type GPT-20F	Type GPT-30F	Type GAT-22F	Type GET-30F	Type GET-35F	
Arc resistance	50	50	55	65	70	70	80	70	75	
Dielectric constant at 1 megahertz	3.4	3.5	3.6	3.7	3.7	4.0	3.8	4.0	4.1	
Dissipation factor at 1 megahertz	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	
Dielectric strength short-time	350	400	360	370	375	400	400	400	400	
Flexural strength	13,000	26,000	15,000	19,000	20,000	24,000	20,000	24,000	26,000	
Impact strength, side	0.60	0.9	0.60	0.70	0.8	1.1	1.0	1.1	0.9	
Water absorption	0.40	0.30	0.35	0.35	0.30	0.30	0.40	0.30	0.30	

Property to be tested	Value required for each type of compound									
	Type GMT-40F	Type GLT-10F	Type GLT-20F	Type GLT-30F	Type GST-40F	Type MLT-20F	Type GLCP-30	Type GLCP-50F	Units	
Arc resistance	70	85	85	85	30	85	130	130	Seconds	
Dielectric constant at 1 megahertz	4.0	3.5	3.5	3.6	4.0	3.5	4.8	5.2	.	
Dissipation factor at 1 megahertz	0.03	0.009	0.012	0.009	0.007	0.009	0.04	0.04	.	
Dielectric strength short-time	400	450	450	450	320	450	480	480	Volts/mil	
Flexural strength	24,000	26,600	28,500	31,400	22,000	22,500	25,000	28,000	lb/in ²	
Impact strength, side	1.1	0.9	1.0	1.1	1.1	0.6	1.3	0.8	ft-lb/in	
Water absorption	0.30	0.69	0.60	0.55	0.08	0.60	0.08	0.08	Percent	

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4.5.1.5 Conditioning. Standard test specimens shall be conditioned before testing, as specified in tables II and IV.

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 degrees Celsius ($^{\circ}\text{C}$) 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 $^{\circ}\text{C}$ the conditioning temperature.
- (d) A number indicating relative humidity (R.H.), whenever R.H. is controlled.

The numbers shall be separated 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 $23 \pm 1.1^{\circ}\text{C}$ and 50 ± 2 percent R.H.
- Condition D-48/50 - Immersion condition, 48 hours at $50 \pm 1^{\circ}\text{C}$.
- Condition E-48/50 - Temperature condition, 48 hours at $50 \pm 3^{\circ}\text{C}$.
- Condition E-48/50+C-96/23/50 - Temperature condition, 48 hours at $50 \pm 3^{\circ}\text{C}$, followed by humidity condition, 96 hours at $23 \pm 1.1^{\circ}\text{C}$ and 50 ± 2 percent R.H.

4.5.2 Methods of test. Each test measurement, with the exception of dielectric strength, dielectric breakdown, heat resistance, and volume and surface resistance (see 4.5.2.1, 4.5.2.1.2, 4.5.2.5, and 4.5.2.7) shall be taken at standard laboratory atmosphere of $23 \pm 1.1^{\circ}\text{C}$ and 50 ± 2 percent R.H. The test methods shall be in accordance with the applicable ASTM standard (see tables II and IV) modified as applicable.

4.5.2.1 Dielectric strength. Thermoplastic molding compounds shall be tested for dielectric strength in accordance with ASTM D 149. Tests shall be made under oil at a frequency not exceeding 100 hertz (Hz) at the temperature of the final conditioning. Specimens shall meet the requirements specified in 3.2.4.

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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 Dielectric breakdown. Thermoplastic molding compounds shall be tested for dielectric breakdown in accordance with ASTM D 149. The electrodes shall be brass or stainless steel cylinders 1 inch in diameter by 1 inch long with the edges rounded to a 1/8-inch radius. Tests shall be made under oil at a frequency not exceeding 100 Hz at the temperature of the final conditioning. Specimens shall meet the requirements specified in 3.2.4.

4.5.2.2 Flexural strength. Thermoplastic molding compounds shall be tested for flexural strength in accordance with ASTM D 790. The span-depth ratio shall be 16 to 1. Specimens shall meet the requirements specified in 3.2.4.

4.5.2.3 Heat-deflection temperature. Thermoplastic molding compounds shall be tested for heat-deflection temperature in accordance with ASTM D 648. Specimens shall be tested directly in an oil bath and not in air. The stress load shall be 264 pounds per square inch (lb/in²). Specimens shall meet the requirements specified in 3.2.4.

4.5.2.4 Water absorption. Thermoplastic molding plastics shall be tested for water absorption in accordance with ASTM D 570, modified as follows:

- (a) The specimens shall be conditioned at $100 \pm 2^\circ\text{C}$ for 24 hours, followed by a 16 to 20 hour period of cooling over silica gel or calcium chloride in a desiccator at $23 \pm 1.1^\circ\text{C}$.
- (b) The specimens shall be immersed in distilled water maintained at a temperature of $50 \pm 1^\circ\text{C}$ for 48 hours. The information shall consist of the percentage increase in weight during immersion calculated to the nearest 0.01 percent as follows:

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

Specimens shall meet the requirements specified in 3.2.4 (see 6.3).

4.5.2.5 Heat resistance. Thermoplastic molding compounds shall be tested for heat resistance as specified in 4.5.2.2, modified as follows:

- (a) Specimens of PT-F shall be given an additional conditioning of 1 hour at $150 \pm 2^\circ\text{C}$ and then be tested at $23 \pm 2^\circ\text{C}$.
- (b) Specimens of GPT-7.5F, GPT-15F, GPT-20F, GPT-30F, GAT-22F, GET-30F, GMT-40F, GLT-10F, GLT-20F, GLT-30F, GST-40F, MLT-20F, GLCP-30F and GLCP-50F shall be given an additional conditioning of 1 hour at $200 \pm 2^\circ\text{C}$, and then be tested at $23 \pm 2^\circ\text{C}$.

The average of five such determinations divided by the average flexural strength (determined as specified in 4.5.2.2) shall be multiplied by 100, and shown as percent flexural strength retained. Specimens shall meet the requirements specified in 3.2.4 (see 6.3).

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4.5.2.6 Dimensional stability (high temperature). Specimens shall be machined so the 1/2 by 1/2-inch ends are smooth and parallel. Specimens shall be subjected to the 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, with each cycle consisting of the following:

- (a) Specimens shall be placed in a circulating air oven at $125 \pm 5^\circ\text{C}$ for 48 hours.
- (b) After this procedure, specimens shall be subjected to $23 \pm 1.1^\circ\text{C}$ and 50 ± 2 percent R.H. for 24 hours.

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 shall be calculated to the nearest 0.1 percent as follows:

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

The average percent dimensional change of the five specimens shall be shown. Specimens shall meet the requirements specified in 3.2.4 (see 6.3).

4.5.2.7 Volume and surface resistance. Thermoplastic molding compounds shall be conditioned at C-720/70/100+dew for the volume and surface resistance test as specified in 4.5.2.7.1 through 4.5.2.7.6, inclusive.

4.5.2.7.1 Specimens. Five 4-inch diameter, 1/8-inch thick specimens shall be used. Specimens shall be cleaned by noninjurious methods to prevent contamination. Precautions shall be taken in handling the specimens to avoid additional contamination. Five specimens shall be used for the measurements of this test.

4.5.2.7.2 Electrodes. Electrodes shall consist of a guarded electrode 2 inches in diameter, a 1/4-inch guard ring spaced 1/4 inch from the guarded electrode on the same side, and a 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 (Dupont No. 4517, or equal) shall be used for painting electrodes on the specimens. Electrodes shall exhibit a resistance of not more than 5 ohms 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 1 week in an atmosphere of less than 60 percent R.H. at a temperature of $25 \pm 5^\circ\text{C}$.

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 through-panel insulators. The insulators shall serve as supports for the electrode holders as shown on figure 1. The chamber shall be of such size that

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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 10:1. One hundred percent R.H. 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 points 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. 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. Specimens shall be held in position by electrode contactors as shown on figure 1. Electrical connection to the specimen holders shall be made by means of through-panel insulators. Insulators shall be constructed to withstand the adverse conditions within the chamber without excessive loss of insulating properties. (Insulator resistance to cover plate shall exceed 10 megohms at all times.) Polytetrafluoroethylene insulators on the humidity side of the conditioning chamber are recommended to meet this requirement. If used, these shall be cleaned with alcohol before the start of each test. Electrode contactors, and all other metallic parts of the sample, shall be silver-plated. Contact pressure against the electrodes shall 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 constructed to maintain a temperature of $70 \pm 1^\circ\text{C}$. 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 be 70°C in 4 ± 1 hours. The quantity of water in the chamber shall be such that the water temperature shall be 65°C in 4 ± 1 hours. Room temperature shall be maintained at $25 \pm 5^\circ\text{C}$. 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. Volume and surface resistances shall be measured by the three-terminal method employing measuring equipment such as a megohm bridge constructed to apply 500 volts direct current (Vdc) to the specimen. A single set of measurements shall be made on 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 2, or with polarities opposite to those shown on figure 2. 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

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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) shall be measured by the circuits shown on figure 3¹. Specimens shall meet the requirements specified in 3.2.4.

4.5.2.8 Toxicity when heated. Thermoplastic molding compounds shall be tested for toxicity in accordance with NTIS AD297457. Specimens shall meet the requirements specified in 3.2.4.

4.5.2.9 Flame resistance. Flame resistance shall be determined in accordance with method II of ASTM D 229 with the modifications specified in 4.5.2.9.1 through 4.5.2.9.7, inclusive. Specimens shall meet the requirements specified in 3.2.4.

4.5.2.9.1 Weight and weight loss. Determinations of weight and weight loss, such as in definitions, apparatus, procedures, calculations, and report sections, are not applicable.

4.5.2.9.2 Flame cabinet. The 9/16-inch slot at the bottom of the flame cabinet shall be on all four sides. The door shall be provided with a 1-1/4 inch diameter peep hole located directly opposite the heater coil when the door is closed. The hole shall be kept closed during testing by means of a cover.

4.5.2.9.3 Pyrometer. The means of correction from black-body radiation to actual conditions of this test shall be accomplished with a pyrometer calibrated for black-body emission. In addition, 6 °C shall be added to the pyrometer to obtain the true temperature of the Nichrome V, or equal, coil.

4.5.2.9.4 Specimens. Test specimens shall be as follows:

- (a) Specimens shall be molded to 1/2 by 1/2 by 5 ± 1/16 inches.
- (b) The test sample shall consist of five test specimens.

¹ Because of the variability of the resistance of a given specimen with test conditions, and 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 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.

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4.5.2.9.5 Calibration. Calibration of this equipment shall be accomplished by adjusting the heater current to obtain an equilibrium temperature of $860 \pm 2^\circ\text{C}$.

4.5.2.9.6 Calculation of burning time. Burning time shall be calculated by arranging the five values of burning time in increasing order of magnitude, as T_1 , T_2 , T_3 , T_4 , and T_5 . The following ratios shall be computed:

$$\frac{T_2 - T_1}{T_3 - T_1} \quad \text{and} \quad \frac{T_3 - T_4}{T_3 - T_1}$$

If either of these ratios exceeds 0.642, then T_1 or T_3 shall be considered abnormal, and shall be eliminated. The burning time shown shall be the average of the remaining four values (see 6.3).

4.5.2.9.7 Average ignition time. The ignition time shall be calculated as the arithmetic mean of the five specimens.

4.5.2.10 Flammability. Flammability rating shall be determined in accordance with UL 94. Results shall be shown as V-0. Specimens shall meet the requirements specified in 3.2.4 (see 6.3).

4.5.2.11 Comparative tracking index (CTI). The CTI shall be determined in accordance with IEC Publication 112. Specimens shall be as specified in 3.2.4.

4.6 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirement specified herein apply only for direct Government acquisition.)

5.1 Packaging. The material shall be commercially packaged in an air-tight and moisture-proof bag and weigh approximately 40 to 50 pounds per package. This packaging will be used for shipment as well as in storage. Also, this package shall be sealed at all times until it is used.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory).

6.1 Intended use. The general purpose thermoplastic compounds covered by this specification are intended for applications requiring good electrical and mechanical properties. The compounds are used in electronic connectors and similar applications.

6.1.1 Flame resistant types of thermoplastic compounds. Flame retardants reduce arc tracking resistance of the compounds and should not be used in applications above 300 volts.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type required (see 1.2).
- (c) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).
- (d) Color required if other than natural color (see 3.2.3).
- (e) Tolerance, if other than plus or minus 5.0 percent (see 4.5.1.4).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference paragraph</u>	<u>DID number</u>	<u>DID title</u>	<u>Suggested tailoring</u>
4.5.2.4, 4.5.2.5, 4.5.2.6, 4.5.2.9.6, and 4.5.2.10	DI-MISC-80678	Certification/data report	10.3.1 does not apply

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Compounds containing recovered materials. The properties of compounds containing recovered materials as defined by this specification (see 3.2.1) may be effected. Users of compounds containing recovered materials should determine that the compounds meet the performance requirements of this specification as determined by the results of the quality conformance inspection (see 4.4).

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 24519 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 51222, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification MIL SD-6" (see 6.5.1).

6.5.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

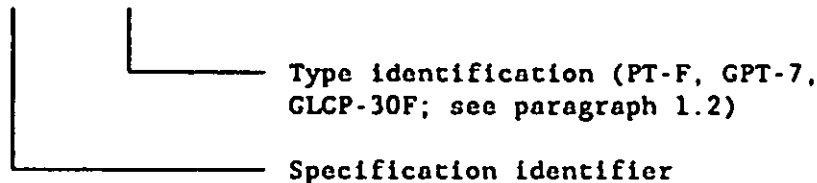
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6.6 Natural colors of molding compounds. The natural color of the various types of molding compounds approximate the following color chips of FED-STD-595.

<u>Types</u>	<u>FED-STD-595</u>	<u>Chip number</u>
PT-F	White	37886
GCT-30F	Off-White	13613
GPT-7.5F	White	37778
GPT-15F	White	37778
GPT-20F	White	37778
GPT-30F	White	37778
GAT-22F	Dark straw	20318
GET-30F	Light buff	13522
GET-35F	Gray	36320
GMT-40F	Beige	30318
GLT-10F	Brown	20100
GLT-20F	Brown	20122
GLT-30F	Brown	20142
GST-40F	Brown	10632
GST-40F	Black	17038
MLT-20F	Greenish/brown	24098/24201 <u>1/</u>
GLCP-30F	White	37778
GLCP-50F	White	37778

6.7 Part or identification number (PIN). The PIN used for molding plastics acquired to this specification are created as follows:

M24519-XXXXX



6.8 Subject term (key word) listing.

Dielectric
 Flame resistant
 Glass reinforced
 Plastics, electrical molding
 Poly(cyclohexylenedimethylene)
 Polyarylether
 Polyethylene
 Polyester
 Polyetherimide
 Polyphenylene

1/ The greenish/brown chip number falls between green chip 24098 and brown chip 24201.

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6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

User activities:

Navy - AS, MC

Preparing activity:

Navy - SH
(Project 5970-N678)

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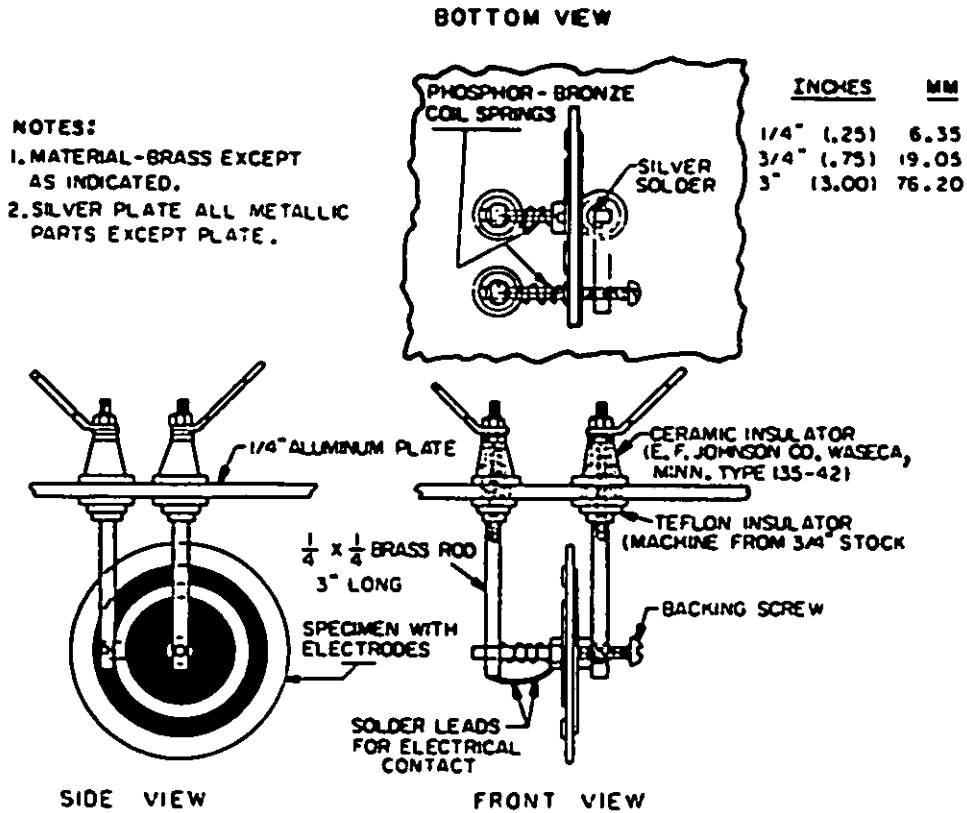


FIGURE 1. Specimen holders, electrodes, test samples, and humidity chamber cover - volume and surface resistance test.

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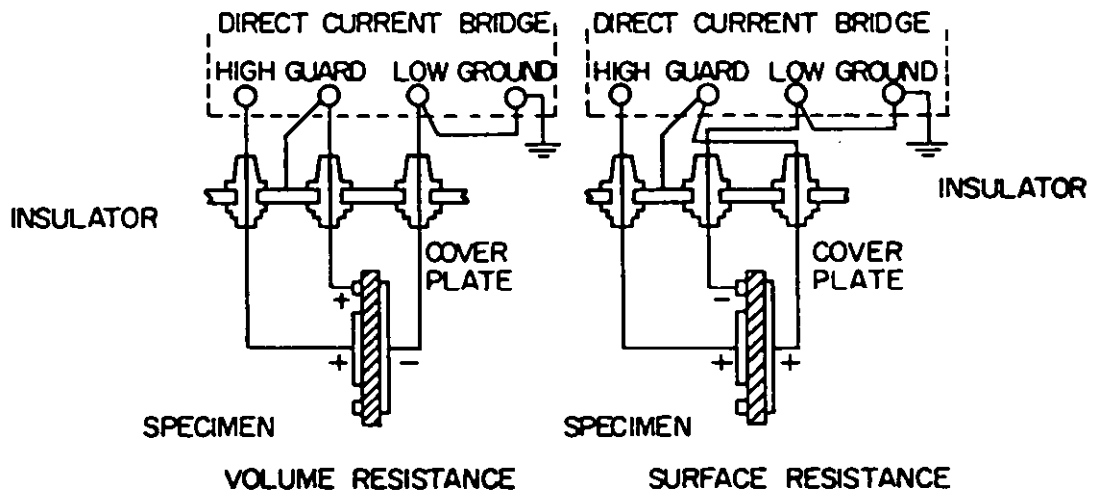
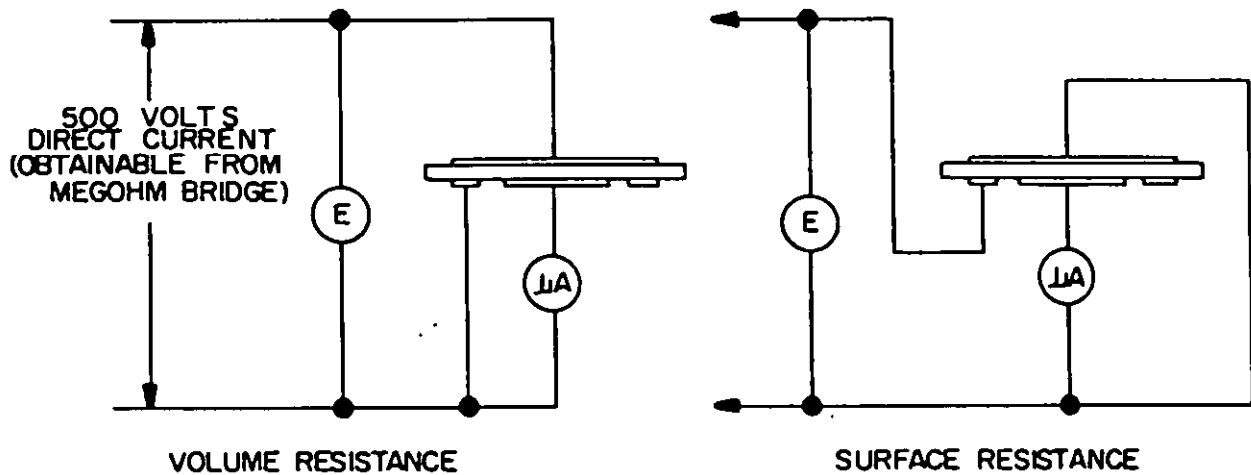


FIGURE 2. Arrangements for volume resistance and surface resistance test.



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

FIGURE 3. Circuits for measuring low values of volume and surface resistance.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-M-24519E(NAVY)

2. DOCUMENT DATE (YYMMDD)

3. DOCUMENT TITLE

MOLDING PLASTICS, ELECTRICAL, THERMOPLASTIC

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

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)

7. DATE SUBMITTED
(YYMMDD)

(1) Commercial
 (2) AUTOVON
(If applicable)

B. PREPARING ACTIVITY

a. NAME Technical Point of Contact (TPOC):

C. Y. Lu (SEA 56223)

b. TELEPHONE (Include Area Code)

(1) Commercial

(2) AUTOVON

PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS

TPOC: 703-602-3123

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Department of the Navy (SEA 5523)
Washington, DC 20362-5101

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5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466
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