INCH-POUND
MIL-M-14H
2 April 1990

SUPERSEDING
MIL-M-14G
13 October 1972
(See 6.6)

# MILITARY SPECIFICATION

# MOLDING COMPOUNDS, THERMOSETTING

*This specification is approved for use by all departments and agencies of the Department of Defense.*

## 1. SCOPE

**1.1 Scope.** This specification covers the basic properties of thermoset molding compounds and the test methods used to establish the properties.

**1.2 Classification.** Molding thermosetting plastic compounds shall be of the following resins and are covered by the individual specification sheets (see 3.1).

**Resin**

Phenolic, cellulose filled
Phenolic, mineral/glass filled
Melamine
Polyester
Diallyl iso-phthalate
Diallyl ortho-phthalate
Silicone
Epoxy

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 55Z3, 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.

AMSC N/A FSC 9330

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

**2.1.1 Standards.** The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

FEDERAL

| | |
|---|---|
| FED-STD-313 | Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities |
| FED-STD-406 | Plastics: Methods of Testing |

MILITARY

| | |
|---|---|
| MIL-STD-45662 | Calibration Systems Requirements |

(Unless otherwise indicated, copies of federal and military standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

**2.1.2 Other Government document.** The following other Government document, forms a part of this document to the extent specified herein. Unless otherwise specified, the issue is that cited in the solicitation.

DEFENSE DOCUMENTATION CENTER (DDC)

Report Number AD297457

(Application for copies should be addressed to the Defense Documentation Center, Cameron Station, Alexandria, VA 22314.)

**2.2 Non-Government publications.** The following documents 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 618 | Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing; (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) |

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

| | |
|---|---|
| 112 | Recommended Method for Determining the Comparative Tracking Index of Solid Insulating Materials Under Moist Conditions |

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

UNDERWRITERS LABORATORY INCORPORATED (UL)

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

(Application for copies should be addressed to the Underwriters Laboratory 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, (except for related specification sheets) 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 Specification sheets.** The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

**3.2 Qualification.** 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 6.4).

**3.2.1 Certified requalification.** This requalification is required every 5 years after any change in formulation or process. Prior qualification would be invalid if formulation or process changes.

**3.3 Toxic products.** The material shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the Naval Medical Command (NAVMEDCOM) who will act as an advisor to the contracting agency.

**3.4 Prohibited materials.** The following materials shall not be present in formulations for these molding compounds: asbestos, mercury, organic silicone additives. Silicone molding compounds such as type MSG and MSI-30 which are made with silicone resins, are excluded from the restriction on silicone additives.

**3.5 Material safety data sheet (MSDS).** The contracting activity shall be provided a material safety data sheet at the time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.7).

**3.6 Compound.** The compound shall consist of a 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.

**3.7 Color.** Materials qualified for one color will be qualified for all colors of that specific type of compound. Coloring agents which reduce the electrical properties below the specified limits shall not be used. Compounds shall be supplied in the color specified by the contracting activity (see 6.2).

**3.8. Uniformity.** All molding compound of the same brand from one manufacturer shall be uniform in texture, in color (see 3.7), and in the specified properties as determined by the batch-acceptance inspection specified in 4.4.

**3.9 Property values.** Standard specimens of the compounds shall conform to the property values shown in the individual specification sheets for qualification (see 4.3) and batch acceptance (see 4.4).

## 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 conducted at a laboratory acceptable to the Naval Sea Systems Command. Qualification inspection shall consist of the tests specified in the individual specification sheets (see 3.1). Application for approval of qualification inspection shall be made to the same activity.

**4.3.1 Specimens.** Tests shall be conducted on standard test specimens (see 4.5.1) molded by the manufacturer of each compound for which qualification is required.

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

**4.3.3 Retention of qualification.** Manufacturers supplying thermosetting plastic compounds already qualified and listed on the applicable qualified products list for this specification may be required to requalify one or more of such types at the option of the Naval Sea Systems Command. This option may be exercised if requirements are added, test procedures revised, requirements revised, or if the pattern of batch acceptance test data shows a significant change or trend when compared to the historical data base. Further, any manufacturer who makes a significant change in raw materials used in the formulation of such compounds must notify the qualifying activity of the nature of the change and supply data showing that molded properties are not adversely affected. Such a change may also require requalification of the specific product at the option of the qualifying activity.

**4.4 Quality conformance inspection.** Quality conformance inspection shall consist of the batch acceptance tests and shall be as specified in the individual specification sheets (see 3.1 and 6.3). They shall be conducted at the contractors plant or other approved facilities, on standard specimens molded by the contractor from each batch of compound to be supplied to molders for production of molded parts.

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

**4.4.2 Test equipment and test facilities.** The manufacturer shall furnish and maintain all necessary facilities and equipment for making all batch acceptance inspections. The test equipment shall conform to the requirements of MIL-STD-45662.

**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 is specified in tables I, II, III, and IV.

**4.5.1.2 Form.** The form of the standard test specimens shall be as specified in the ASTM test method or other applicable test method.

**4.5.1.3 Molding of test specimens.** Test specimens shall be molded by methods which could include post-core. 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 unless otherwise stated herein.

**4.5.1.5 Conditioning.** Standard test specimens shall be conditioned before test, as specified in tables I, II, III, 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 per ASTM D618
Condition D – Immersion conditioning in distilled water per ASTM D618
Condition E – Temperature conditioning per ASTM D618
Condition desiccation – Desiccation condition, cooling over silica gel or calcium chloride in a desiccator at 23 degrees Celsius (°C) for 16 to 20 hours after temperature conditioning per ASTM D618.

**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 Celsius the conditioning temperature

d. A number indicating relative humidity, whenever relative humidity 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.

TABLE I. *Sampling and conditioning for mechanical/physical qualification tests.*

| Property to be tested–mechanical/physical | Test method | | Specimens | | Conditioning procedure (see 4.5.1.5) | Unit of value |
|---|---|---|---|---|---|---|
| | ASTM | Modified by | Form and dimension | Number tested | | |
| Compressive strength, end wise | D 695 | – | 1 by 1/2 by 1/2 inch | 5 | E-48/50 + C-96/23/50 | $lb/in^2$ (minimum average) |
| Dimensional stability | – | 4.5.2.1 | 5-inch bar, 1/2 by 1/2 inch | 5 | C-96/23/50 | Percent (maximum average) |
| Flexural strength | D 790 | 4.5.2.2 | 5-inch bar, 1/4 by 1/2 inch | 5 | E-45/50 + C-96/23/50 | $lb/in^2$ (minimum average) |
| Heat deflection temperature | D 648 | 4.5.2.3 | 5-inch bar, 1/2 by 1/2 inch | 3 | A | Degrees Celsius (minimum average) |
| Heat resistance[1] | D 790 | 4.5.2.4 | 5-inch bar, 1/4 by 1/2 inch | 5 | E-1/at designated temperature test Test at temperature | Degrees Celsius (minimum average) at temperature |
| Impact strength, side[2] | D 256 | – | As per ASTM D 256 | 5 | E-48/50 + C-96/23/50 | ft-lb/in notch (minimum average) |
| Tensile strength | D 638 | – | As per ASTM D 638 | 5 | E-48/50 + C-96/23/50 | $lb/in^2$ (minimum average) |
| Water absorption | D 570 | 4.5.2.5 | 2-inch disc, 1/8 inch thick | 3 | E-24/100 + des + D-48/50 | Percent (maximum (average) |

[1]A 50 percent retention of initial flexural strength is required.
[2]The side of a test specimen is that area formed by the chase of the mold.

TABLE II. *Sampling and conditioning for electrical qualification tests.*

| Property to be tested—mechanical/physical | Test method | | Specimens | | Conditioning procedure (see 4.5.1.5) | Unit of value |
|---|---|---|---|---|---|---|
| | ASTM | Modified by | Form and dimension | Number tested | | |
| Arc resistance | D 495 | – | 4-inch disc, 1/8 inch thick | 3 | A | Seconds (minimum average) |
| Dielectric breakdown: | | | | | | Kilovolt (minimum average) |
| Short-time test | D 149 | 4.5.2.6 | 4-inch disc, 1/2 inch thick | 1 | E-48/50 + C-96/23/50 | |
| Step-by-step test | | | | 3 | E-48/50 + C-96/23/50 | |
| Short-time test | | | | 1 | E-48/50 + D-48/50 | |
| Step-by-step test | | | | 3 | E-48/50 + D-48/50 | |
| Dielectric constant: | | | | | | Maximum average |
| At 1 kilohertz | D 150 | – | 4-inch disc, 1/8 inch thick | 3 | E-48/50 + des | |
| | | | | 3 | E-48/50 + D-24/23 | |
| At 1 megahertz | | | 2-inch disc, 1/8 inch thick | 3 | E-48/50 + des | |
| | | | | 3 | E-48/50 + D-24/23 | |
| Dielectric strength: | | | | | | Volts per mil (minimum average) |
| Short-time test | D 149 | 4.5.2.6 | 4-inch disc, 1/8 inch thick | 3 | E-48/50 + C-96/23/50 | |
| Step-by-step test | | | | 5 | E-48/50 + C-96/23/50 | |
| Short-time test | | | | 3 | E-48/50 + D-48/50 | |
| Step-by-step test | | | | 5 | E-48/50 + D-48/50 | |
| Dissipation factor: | | | | | | Maximum average |
| At 1 kilohertz | D 150 | – | 4-inch disc, 1/8 inch thick | 3 | E-48/50 + des | |
| | | | | 3 | E-48/50 + D-24/23 | |
| At 1 megahertz | | | 2-inch disc, 1/8 inch thick | 3 | E-48/50 + des | |
| | | | | 3 | E-48/50 + D-24/23 | |

TABLE II. *Sampling and conditioning for electrical qualification tests – Continued.*

| Property to be tested--mechanical/physical | Test method | | Specimens | | Conditioning procedure (see 4.5.1.5) | Unit of value |
|---|---|---|---|---|---|---|
| | ASTM | Modified by | Form and dimension | Number tested | | |
| Surface resistance | – | 4.5.2.7 | 4-inch disc, 1/8 inch thick | 5 | C-720/70/100 + dew | Megohms (minimum individual) |
| Comparative track index | 1 EC Publication 112 | 4.5.2.8 | 4-inch disc, 1/8-inch thick | 5 | A | Volts |
| Volume resistivity | – | 4.5.2.7 | 4-inch disc, 1/8 inch thick | 5 | C-720/70/100 + dew | Megohms (minimum individual) |
| Water extract conductance | FED-STD-406 method 7071 | – | – | – | – | Siemens per centimeter |

TABLE III. *Sampling and conditioning for combustion qualification tests.*

| Property to be tested–mechanical/physical | Test method | | Specimens | | Conditioning procedure (see 4.5.1.5) | Unit of value |
|---|---|---|---|---|---|---|
| | ASTM | Modified by | Form and dimension | Number tested | | |
| Flame resistance:<br>Ignition time<br><br>Burning time | D 229 | 4.5.2.9 | 5-inch bar, 1/2/by 1/2 inch | 5 | A | Seconds (minimum average)<br>Seconds (minimum average) |
| Flammability | UL 94 | 4.5.2.10 | 5-inch bar, 1/2 inches thickness | 5 | A | Rating/thickness (1/16 inch or 1/8 inch) |
| Toxicity when heated:<br>Carbon dioxide<br>Carbon monoxide<br>Ammonia<br>Aldehydes as HCHO<br>Cyandide as HCN<br><br>Oxide of nitrogen as $NO_2$<br>Hydrogen chloride | – | 4.5.2.11 | 5-inch bar, 1/2 by 1/2 inch | 4 | A | Parts per million (maximum average) |

TABLE IV. *Sampling and conditioning for batch accpetance tests.*

| Property to be tested–mechanical/physical | Test method | | Specimens | | Conditioning procedure (see 4.5.1.5) | Units of value |
|---|---|---|---|---|---|---|
| | ASTM | Modified by | Form and dimension | Number tested | | |
| Arc resistance | D 495 | – | 4-inch disk, 1/8 inch thick | 3 | A | Seconds (minimum average) |
| Comparative track index | IEC 112 | 4.5.2.8 | 4-inch disk, 1/8 inch thick | 5 | A | Volts |
| Dielectric constant at 1 megahertz | D 150 | – | 2-inch disk, 1/8 inch thick | 3 | E-48/50 + D-24/23 | Maximum average |
| Dissipation factor at 1 megahertz | D 150 | – | 2-inch disk, 1/8 inch thick | 3 | E-48/50 + D-24/23 | Maximum average |
| Dielectric strength, step-by-step | D 149 | 4.5.2.6 | 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, side[1] | D 256 | – | As per ASTM D 256 | 5 | E-48/50 + C-96/23/50 | ft-lb/in notch (minimum average) |
| Water absorption | D 570 | 4.5.2.5 | 2-inch disk, 1/8 inch thick | 3 | E-24/100 + des + D-48/50 | Percent (maximum average) |
| Water extract conductance | FED-STD-406 method 7071 | – | – | – | – | Siemens per centimeter |

[1]The side of a test specimen is that area formed by the chase of the mold.

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 | – Temperature condition, 48 hours at 50 ± 3 °C followed by + C-96/23/50 humidity condition, 96 hours at 23 ± 1.1 °C and 50 ± 2 percent. relative humidity. |

4.5.2 **Methods of test.** Unless otherwise specified, all test measurements shall be taken at standard laboratory atmosphere of 23 ± 1.1 °C and 50 ± 2 percent relative humidity. The test methods shall be in accordance with the applicable ASTM method except where modified (see 4.5.2.1 through 4.5.2.11).

4.5.2.1 **Dimensional stability.** The specimens shall be molded or machined so the 1/2 by 1/2-inch ends are smooth and parallel. The 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, each cycle as follows: 48 hours in a circulating air oven at 125 ± 5 °C plus 24 hours at 23 ± 1.1 °C and 50 ± 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:

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

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

4.5.2.2 **Flexural strength.** Test method ASTM D 790 shall be used. The span-depth ratio shall be 16-to-1 and the dimensions of the test bar shall be 5 by 1/2 by 1/4 inches.

4.5.2.3 **Heat-deflection temperature.** Test method ASTM D 648 shall be used. The specimens shall be placed directly in the oil bath and not in air. The stress load shall be 264 pounds per square inch ($lb/in^2$).

4.5.2.4 **Heat resistance.** The specimen shall be conditioned for 1 hour at the designated temperature. After this conditioning, the flexural strength shall be tested at this same temperature following the procedures outlined in ASTM D 290. When measured at the elevated test temperature, the molding compound shall meet the heat resistance requirement of retaining 50 percent of the flexural strength value as determined at 23 °C. The average of five determinations divided by the average flexural strength as determined at 23 °C, shall be multiplied by 100 and recorded as percent flexural strength retained at the specified conditioning and testing temperature.

For example:

Temperature at which at least a 50 percent retention of flexural strength is maintained. To be conditioned at temperature for 1 hour before testing. Test to be conducted at temperature.

| Type | Temperature (°C) | |
|---|---|---|
| SDG & SDG-F | 140 | All other materials for heat resistances temperature is to be determined by individual laboratory and returned to NAVSEA for consideration. |
| GDI-30 & GDI-30F | 150 | |
| MDG & MDG-F | 125 | |
| SIG & SIG-F | 175 | |
| GII-30 & GII-30F | 185 | |
| MIG & MIG-F | 150 | |

**4.5.2.5 Water absorption.** Test method ASTM D 570 shall be used, modified as follows:

a. The specimens shall be conditioned at 100 ± 2 °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 ± 1.1 °C.

b. The specimens shall be immersed in distilled water and 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:

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

**4.5.2.6 Dielectric test.**

**4.5.2.6.1 Dielectric breakdown.** The apparatus and procedure specified in ASTM D 149 shall be used. 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.

**4.5.2.6.2 Dielectric strength.** The apparatus and procedure specified in ASTM D 1249 shall be used. Test shall be made under oil at a frequency not exceeding 100 hertz (Hz). The electrodes shall be brass or stainless steel cylinders 1-inch long with the edges rounded to 1/8-inch radius.

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

**4.5.2.6.2.2 Step-by-step test.** The voltage shall be increased in increments, as shown in table V, 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 V. *Voltage increase for step-by-step test.*

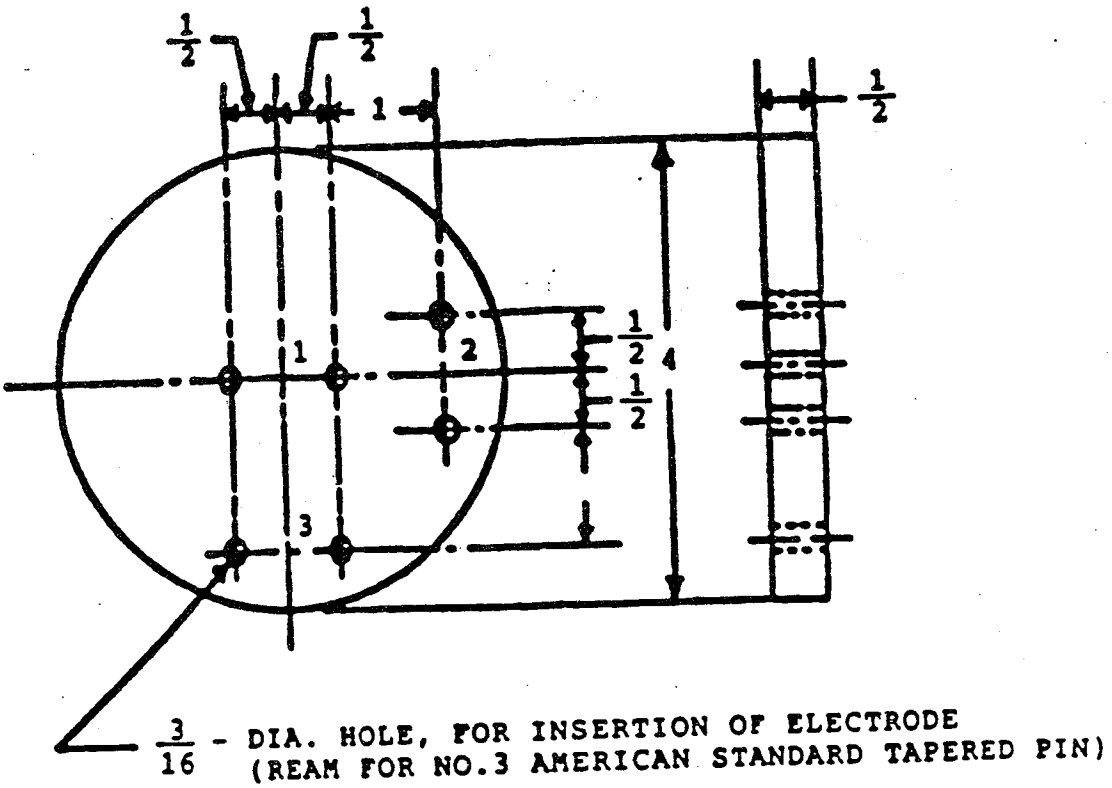
| Breakdown by short-time method, kilovolts | Increment of increase, kilovolts |
|---|---|
| 12.5 or less | 0.5 |
| Over 12.5 to 25, inclusive | 1.0 |
| Over 25 to 50, inclusive | 2.5 |
| Over 50 to 100, inclusive | 5.0 |
| Over 100 | 10.0 |

**4.5.2.7 Volume and surface resistance**

**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 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, 1/4-inch guard ring spaced 1/4 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 (Dupont No. 4517 or equal) 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 1 week in an atmosphere of less than 60 percent relative humidity at a temperature of 25 ± 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 through-panel type insulators. The insulators may serve as supports for the electrode holders as shown on figure 2. The chambers 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 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.



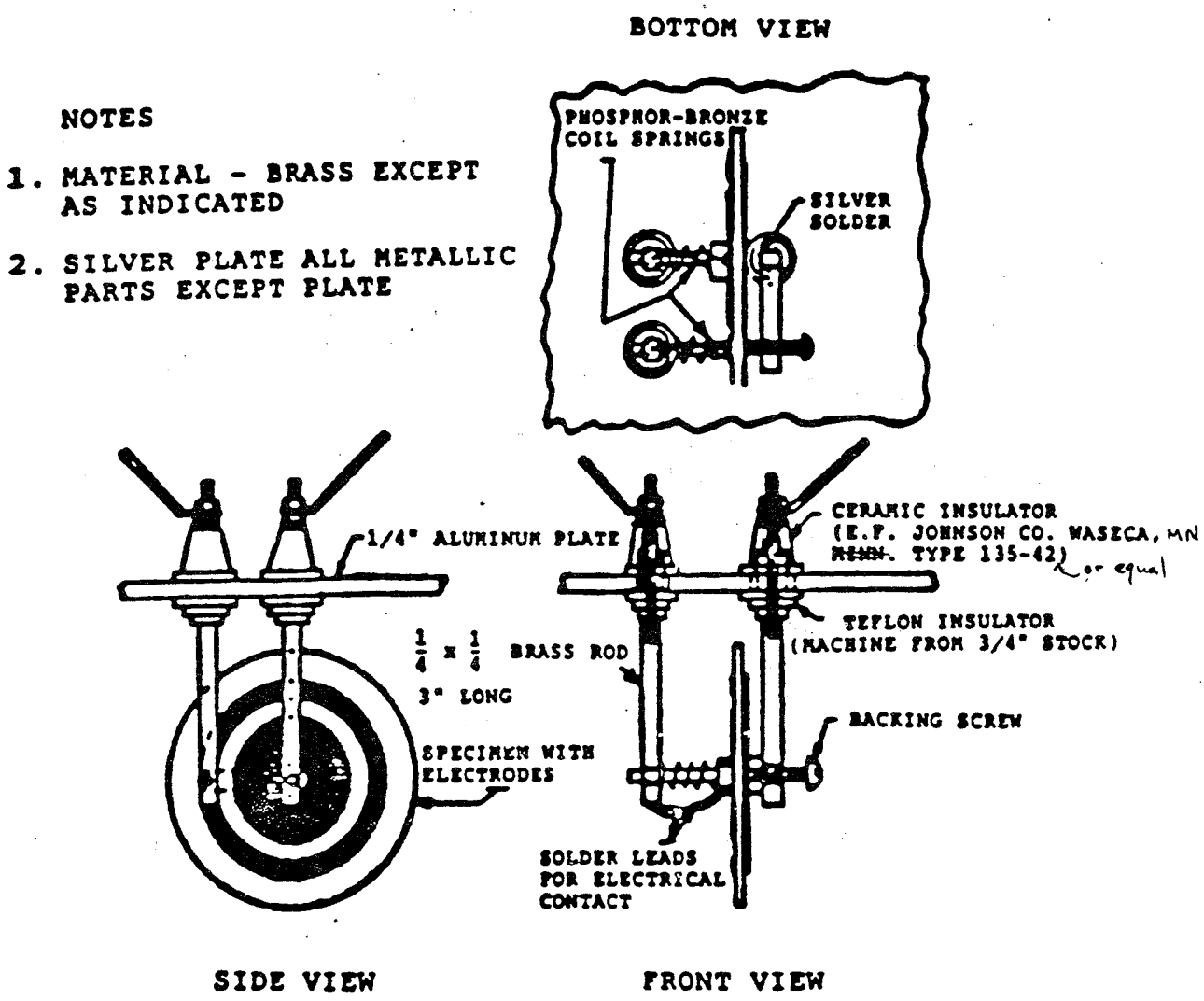

NOTES:

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

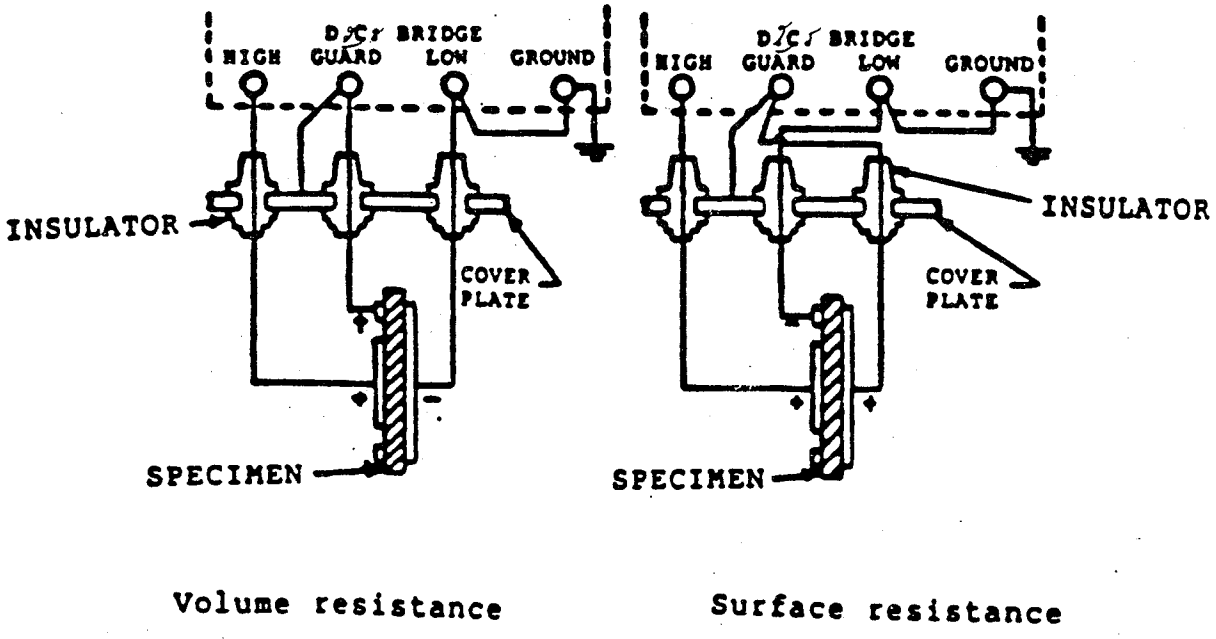
SH13231944

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



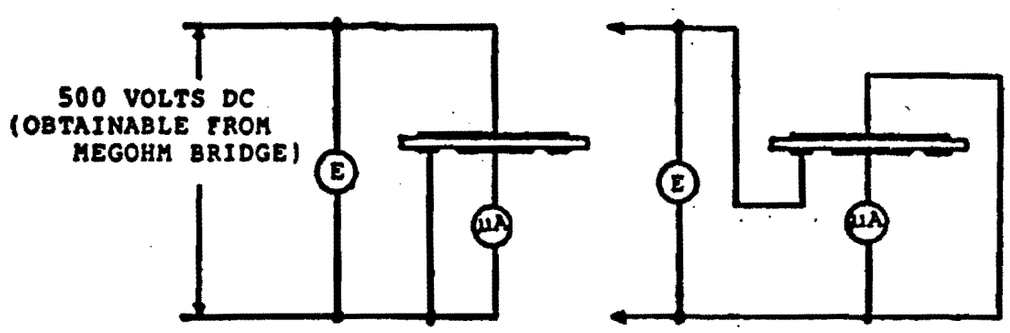

SH 13231945

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




SH 13231946

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




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

SH13231947

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