

MIL-I-16923G
4 October 1972
SUPERSEDING
MIL-I-0016923F(SHIPS)
22 July 1971
USED IN LIEU OF
MIL-I-16923E
19 July 1963
(See 6.7 and 6.8)

MILITARY SPECIFICATION
INSULATING COMPOUND, ELECTRICAL, EMBEDDING

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a general purpose casting and potting compound which has excellent electrical and hydrolytic stability characteristics. The purpose of the compound is to preserve the electrical properties of the equipment to which it is applied by sealing against such environmental conditions as moisture, dirt, fumes, fungus, or other deleterious substances which may be encountered in Military service (see 6.1).

2. APPLICABLE DOCUMENTS

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

SPECIFICATION

FEDERAL

VV-I-530 - Insulating Oil Electrical, (for Transformers, Switches, and Circuit-Breakers).

STANDARDS

FEDERAL

FED-STD-406 - Plastics; Methods of Testing.

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129 - Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications required by suppliers 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 to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Freight Classification Committee, Rm. 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Qualification. The insulating compound furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

QTL-I-16923G

3.2 Quantitative requirements. When specimens are subjected to the tests specified in tables I or II, as applicable, the values obtained shall be as specified in the applicable table.

3.2.1 The specific gravity of the compound shall be within plus or minus 0.1 grams per cubic centimeter of the value of the original qualified product.

3.3 Qualitative requirements.

3.3.1 The material shall cure throughout to a permanently infusible state without volatile loss. It shall be of sufficiently low viscosity, and shall have such wetting properties at the pouring temperature that it will flow between elements of the part or parts of the assembly to be embedded, displacing all air and leaving no voids and both the pouring and curing temperatures shall not exceed 130°C. The material shall be capable of mechanically supporting the part or assembly embedded and shall not require a case or other external support after curing has been completed, and shall not cause deterioration of materials used in electronic assemblies and parts.

3.3.2 Flammability. Cast specimens shall be self-extinguishing when tested as specified in 4.6.6.

3.3.3 Moisture resistance. Cast specimens shall not exhibit softening, blistering, or warping after moisture conditioning at 70°C., 95 percent relative humidity (R.H.) for 10 days.

3.3.4 Color. Coloring materials may be used in the embedding compounds if they do not reduce the electrical and physical properties below the limits specified in tables I and II. Certification to the Naval Ship Engineering Center to this fact may be used as the basis for including various colored embedding compounds on QPL-16923 provided the basic material with or without coloring agents, has passed the qualification tests, in table I.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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

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

4.3 Qualification tests.^{1/} Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of the tests specified in table I.

4.3.1 Samples. The manufacturer shall furnish a sufficient amount of the compound ingredients to produce 200 cubic inches of cast specimens.

^{1/} Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3 and 6.4).

MIL-I-16923G

Table I - Quantitative requirements for qualification tests.

Property	Units	MIL-I-16923G	FLD-STD-406	Value
Specific gravity ^{1/}		4.6.2	5011	2/
Mechanical shock	Lb. min.	4.6.3	----	3
Dielectric strength, 1/8 inch	Volts/mil. min.	4.6.4	4031	325
Dielectric constant		4.6.5	4021	
60 Hz	min.			5
10 ⁶ Hz	min.			4.5
Dissipation factor		4.6.5	4021	
60 Hz	min.			.04
10 ⁶ Hz	min.			.05
Flammability		4.6.6	2021	
Thermal shock	Cycles min.	4.6.7	----	10
Water absorption D-24/23	Percent max.	4.6.8	7031	0.2
Impact Izod	Ft. lb. per inch notch min.		1071	0.3
Hydrolytic stability		4.6.9		
Hardness			1083	
As received	min.			75
After conditioning	max.			10% reduction from initial value for individual product
Volume resistivity	ohm cm		4041	
As received	min.			1 X 10 ¹³
After conditioning	max.			1 X 10 ¹²

^{1/} Value to be reported for comparison purposes.^{2/} For information purposes only.

Table II - Quantitative requirements for quality conformance tests.

Property	Units	MIL-I-16923G	FLD-STD-406	Value
Specific gravity ^{1/}		4.6.2	5011	
Mechanical shock	Lb. min.	4.6.3		3
Dielectric strength, 1/8 inch	Volts/mil. min	4.6.4	4031	325
Flammability		4.6.6	2021	
Thermal shock	Cycles min.	4.6.7		10
Water absorption D-24/23	Percent max.	4.6.8	7031	0.2
Hardness Shore D	min.		1083	75

^{1/} Within ± 0.1 grams per cubic centimeter of the value of the qualified product.

4.3.2 Manufacturer's instructions. The manufacturer shall furnish instructions for the casting of specimens which shall include:

- Proportions of each ingredient.
- Sequence and temperature for mixing ingredients.
- Stirring required in mixing.
- Shelf-life of ingredients.
- Lot-life of mixed ingredients.
- Pouring temperature.
- Curing time and temperature for casting each type specimen.
- Mold release agents and mold materials required.

4.4 quality conformance inspection.

4.4.1 Inspection lot. For purposes of sampling, a lot shall consist of all compound manufactured as one batch and offered for delivery at one time.

4.4.2 Sampling for examination of filled containers. A random sample of filled containers shall be selected from each lot in accordance with MIL-STD-105 at inspection level I, and acceptable quality level (AQL) = 1.5 percent defective, to verify compliance with all stipulations of this specification regarding fill, closure, marking, and other requirements not involving tests.

MIL-I-16923G

4.4.3 Sampling for quality conformance tests. From each lot, two containers of each ingredient necessary to form the compound shall be selected. From each of these containers a specific amount of the ingredient shall be taken to produce 75 cubic inches of cast specimens. Each sample shall be separately subjected to the tests of table II. If either sample fails any test, this shall be cause for rejection of the lot.

4.4.4 Examination of filled containers. Each sample filled container selected in accordance with 4.4.2 shall be examined for defects of the container and the closure, for evidence of leakage, and for unsatisfactory markings; each sample filled container shall also be weighed to determine the amount of the contents. Any container in the sample having one or more defects, or under required fill, shall not be offered for delivery, but the number of defects shall be included in the count. If the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, this shall be cause for rejection of the lot represented by the sample.

4.5 Test specimens.

4.5.1 Mold. Specimens shall be cast at the testing laboratory. Unless otherwise specified (see 6.2), the mold (see figure 1) shall consist of two highly polished steel plates, 3/8 inch thick, coated with a release agent and spaced by U-shaped spacers. The thickness of the test specimen of polytetrafluorethylene or a similar material to which the compound will not adhere. The mold assembly shall be clamped together with sufficient pressure to prevent leakage of the compound. A mold to produce 6 by 6-inch specimens is suggested. The resulting cast slabs shall then be cut into the size specimens required.

4.5.2 Casting. The compound ingredients shall be mixed in accordance with the manufacturer's directions, then poured into the molds. When the ingredients are mixed at temperatures above 23°C., the molds shall be preheated approximately 10°C. above the mixing temperature before the mixture is poured into the molds (see 3.3.1). In pouring, precautions shall be taken to avoid the entrapping of air. Specimens shall then be cured in accordance with the manufacturer's instructions as to time and temperature. All specimens shall be conditioned 48 hours at standard laboratory conditions (see 4.6.1) before test.

4.6 Test procedures.

4.6.1 Unless otherwise specified (see 6.2), all tests shall be conducted under standard laboratory conditions (relative humidity of 50 ± 2 percent and a temperature of $23^\circ \pm 1.1^\circ\text{C}.$). The test methods shall be in conformance with the applicable method of FED-STD-406, except as otherwise specified in the following paragraphs. At test conditions other than standard laboratory conditions, the same tolerances apply to the temperature and humidity.

4.6.2 Specific gravity.

4.6.2.1 Method 5011 shall be used in measuring each of the three specimens 3 inches by 1 inch by 1/8-inch cut from slabs cast as specified in 4.5. The average of the three measurements shall be reported.

4.6.2.2 The specific gravity of the ingredients of the insulating compound shall be measured with a pycnometer, a Westphal balance or a hydrometer, depending on the nature of the materials. Three determinations shall be made and averaged. The specific gravity shall be expressed as the ratio of the weight of a given volume of the material at 23°C. to that of an equal volume of water at the same temperature.

4.6.3 Mechanical shock.

4.6.3.1 Specimen. Three specimens 2 by 2 inches by 1/2 inch, prepared as specified in 4.5 shall be tested.

4.6.3.2 Apparatus. A set of steel balls varying in size from 1 to 4 inches in diameter shall be used. The balls shall vary in size in increments of 1/16 inch up to 2-1/2 inches and 1/4 inch thereafter. The steel balls shall be held and released by a rigidly supported magnetic device designed to drop the balls on the exact center of the specimen, located on a steel plate of surface dimensions larger in all directions than the test specimen and 1 inch thick.

4.6.3.3 Procedure. A specimen shall be placed flat on a horizontal steel plate located so that, when the balls are dropped a vertical distance of 3 feet, they will strike the center. Each specimen shall be struck with each ball starting with the smallest and proceeding toward the largest until the specimen fractures.

MIL-I-16923G

4.6.3.4 Report. The weight of the ball which caused fracture of each specimen shall be reported.

4.6.4 Dielectric strength.

4.6.4.1 Apparatus. The apparatus specified in method 4031 of FED-STD-406 shall be used. Tests shall be on specimens immersed in transformer oil conforming to VV-I-530. The test electrodes shall consist of two metal cylindrical rods 1/4 inch in diameter with edges round to a radius of 1/32 inch. The pressure between electrodes shall be approximately 0.1 pound.

4.6.4.2 Procedure. The procedure specified in method 4031 shall be used. The short-time test to breakdown, using 500 volts per second, shall be conducted.

4.6.4.3 Specimens. Tests shall be made on each of eight 3 by 3 inches by 1/8 inch specimens cut from two slabs cast in accordance with 4.5.

4.6.4.4 Report. Dielectric strength shall be reported as the minimum, maximum, and average of the eight measurements, in volts per mil.

4.6.5 Dissipation factor and dielectric constant. The test circuits specified in method 4021 shall be used.

4.6.5.1 Specimens. One specimen shall be cast as specified in 4.5. Three disks or squares of required size shall then be cut from the slab for measurement.

4.6.5.2 Electrodes. Metal foil electrodes of suitable size and without guard rings shall be applied as specified in 4.6.9.3.

4.6.5.3 Procedures. Dissipation factor and capacitance measurements shall be made on each specimen at 60 Hz and 10⁶ Hz.

4.6.5.4 Report. The average of three measurements at each frequency shall be reported.

4.6.6 Flammability. Method 2021 of FED-STD-406 shall be used, except that specimens shall be placed directly on the wire mesh and the flame applied only once. Three specimens 6 inches by 1/2 inch by 1/8 inch cut from slabs cast as specified in 4.5 shall be used.

4.6.6.1 Report. The report shall include the percentage of specimen consumed between test marks and the observations made noting the tendency of the material to flame, smolder, melt or char.

4.6.7 Thermal shock.

4.6.7.1 Specimens. Five specimens shall be cast in molds similar to the molds shown on figure 3. In preparing the mold, the glass tube shall be coated with a release agent and the 1 inch long, 3/4-inch cold drawn low carbon steel hex bar shall be polished with number "0" emery cloth and washed with a 50:50 xylolalcohol mixture. The casting procedure shall be as specified in 4.5.2.

4.6.7.2 Apparatus. The apparatus shall be as follows:

- (a) An analytical type, electrically heated oven so designed that specimens can be introduced and removed with a minimum drop in temperature. The oven shall be held at 130°C.
- (b) An alcohol-dry ice bath at -55° ±2°C.

4.6.7.3 Procedure. Specimens shall be placed in the oven for 1/2 hour at the specified temperature, removed, then immediately plunged into the dry ice alcohol bath and left for 10 minutes. After each cycle, the alcohol on the specimens shall be quickly wiped off and the next cycle started. Cycling shall continue until the specimen fails or 10 cycles have been completed. Specimens shall be observed after each phase of the cycling to determine the number of cycles which are required to produce cracks or other indications of failure in the casting. If four of the five specimens complete the 10 cycles, the compound shall be considered as having passed this test.

4.6.7.4 Report. The report shall include the number of cycles each specimen withstands. A one-half cycle shall be reported when specimens fail at the elevated temperature.

MIL-I-16923G

4.6.8 Water absorption.

4.6.8.1 Specimens. Three specimens 1 by 3 inches by one-eighth inch shall be cut from slabs cast in accordance with 4.5. The cut edges shall be made smooth by finishing with No. "000" or finer sandpaper or emery cloth.

4.6.8.2 Procedure. The procedures of method 7031 of FED-STD-406 (Immersion Procedure A) shall be used.

4.6.8.3 Report. The report shall contain the average percentage increase in weight due to the water immersion calculated as follows:

$$\frac{\text{Wet weight} - \text{dry weight}}{\text{dry weight}} \times 100$$

4.6.9 Hydrolytic stability.

4.6.9.1 Specimens.

4.6.9.1.1 Hardness specimens. Four hardness specimens, approximately 2 inches in diameter and 1/4 inch thick shall be prepared.

4.6.9.1.2 Volume resistivity specimens. Six specimens 4 inches in diameter and approximately 0.075 inches thick shall be prepared for volume resistivity tests.

4.6.9.2 Conditioning. Two hardness specimens and three volume resistivity specimens shall be maintained for 120 days at each of the following conditions:

25°C. and 50 percent R.H.
71°C. and 95 percent R.H.

4.6.9.3 Procedure. The specimens shall be tested for hardness and volume resistivity after 0, 28, 56, 84 and 120 days. The 71°C. specimens shall be held at 25°C. and 50 percent R.H. for 2 hours prior to testing. The instantaneous hardness shall be determined using a Shore D durometer, in accordance with Method No. 1083 of FED-STD-406. Volume resistivity tests shall be conducted in accordance with Method No. 4041 of FED-STD-406 using a Beckman Megohmmeter Model L-8 or equivalent instrument with a test voltage of 500 volts. Readings shall be made 1 minute after application of current. Lead foil electrodes shall be a disk 2 inches in diameter, centrally located on one face of the specimen. The guard electrode shall be a concentric ring of 2.281 inches inside diameter and with an outside diameter equal to that of the specimen. The unguarded electrode shall be a foil disk 4 inches in diameter applied to the opposite side of the specimen. The test current shall be introduced to the guarded electrode, the guard electrode, and the unguarded electrode by means of a brass disk 2 inches in diameter by 1 inch in thickness, a brass ring 2.313 inches inside diameter by 4 inches outside diameter by 0.125 inch thick, and a brass disk 4 inches in diameter, respectively.

4.6.9.4 Report. The report shall contain the average volume resistivity calculated as follows:

$$r = \frac{RA \times 10^6}{t}$$

Where:

r = volume resistivity in ohm-centimeters.

R = volume resistance in megohms.

A = $\pi (r_0)^2$, effective area of guarded electrode in square centimeters (see fig. 2).

t = average thickness of specimens in centimeter.

4.7 Inspection of preparation for delivery. Packaging, packing, and marking shall be inspected to determine conformance with the requirements of section 5.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements.)

MIL-I-16923G

5.1 Packaging.

5.1.1 Level C. Packaging shall be sufficient to afford adequate protection against deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

5.2 Packing.

5.2.1 Level C. The subject commodity packaged as specified herein shall be packed in accordance with the Uniform Freight Classification Rules or other carrier regulations as applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required (see 6.2), shipments shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Compounds covered by this specification are intended for use in embedding and encasing of electronic parts. The maximum use temperature should not exceed 130°C.

6.1.1 The selection of a compound for any application should be such that the curing process used shall have no harmful effects on the parts or materials embedded.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Mold, if other than specified (see 4.5.1).
- (c) Test conditions, if other than specified (see 4.6.1).
- (d) Special marking, if required (see 5.3).

6.3 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL-16923 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 Naval Ship Engineering Center, Prince George's Center, Center Building, Hyattsville, Maryland 20782, and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4).

6.4 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.5 Toxicology. Certain of the unreacted monomers and catalysts are known to be able to cause some toxic effects if no precautions are taken. In general, the use precautions which have been suggested are as follows:

- (a) Handle only in well-ventilated areas.
- (b) Prevent skin contact.
- (c) Wear protective clothing when contact can be anticipated (Caution - protect eyes from curing agent.)
- (d) Cleanse the skin regularly with a mild soap and warm water.
- (e) Reassign the few employees allergic to these materials.

Because of the range of possible effects among the chemicals involved, users should inquire of their suppliers concerning specific precautions applicable to the system involved.

6.6 International interest. Certain provisions of this specification are the subject of international standardization agreement as cited in ABC-NAVY-STD-17. When amendment, revision or cancellation of this specification is proposed which will effect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

6.7 Replacement data. Types A, B, C, and D insulating compounds of MIL-I-16923E have been incorporated into a general purpose casting and potting compound (see 1.1).

MIL-I-16923G

6.8 THE MARGINS OF THIS SPECIFICATION ARE MARKED "*" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST ISSUE.

Custodians:

Army - EL
Navy - SH
Air Force - 11

Review activities:

Army - EL, MI, MU
Navy - SH, AS, EC
Air Force - 11, 80

Preparing activity:

Navy - SH
(Project 5970-0383)

International interest (see 6.6)

MIL-I-16923G

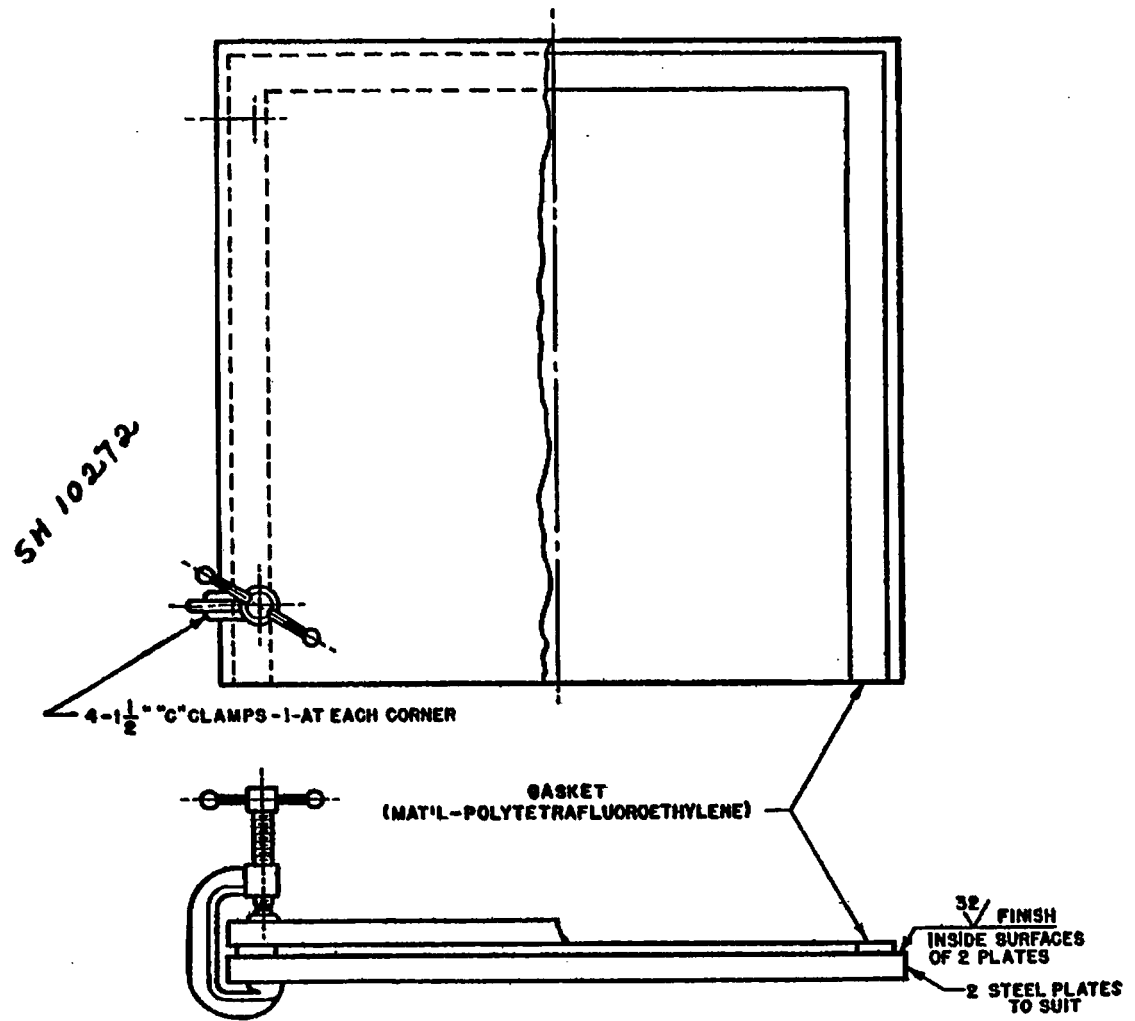
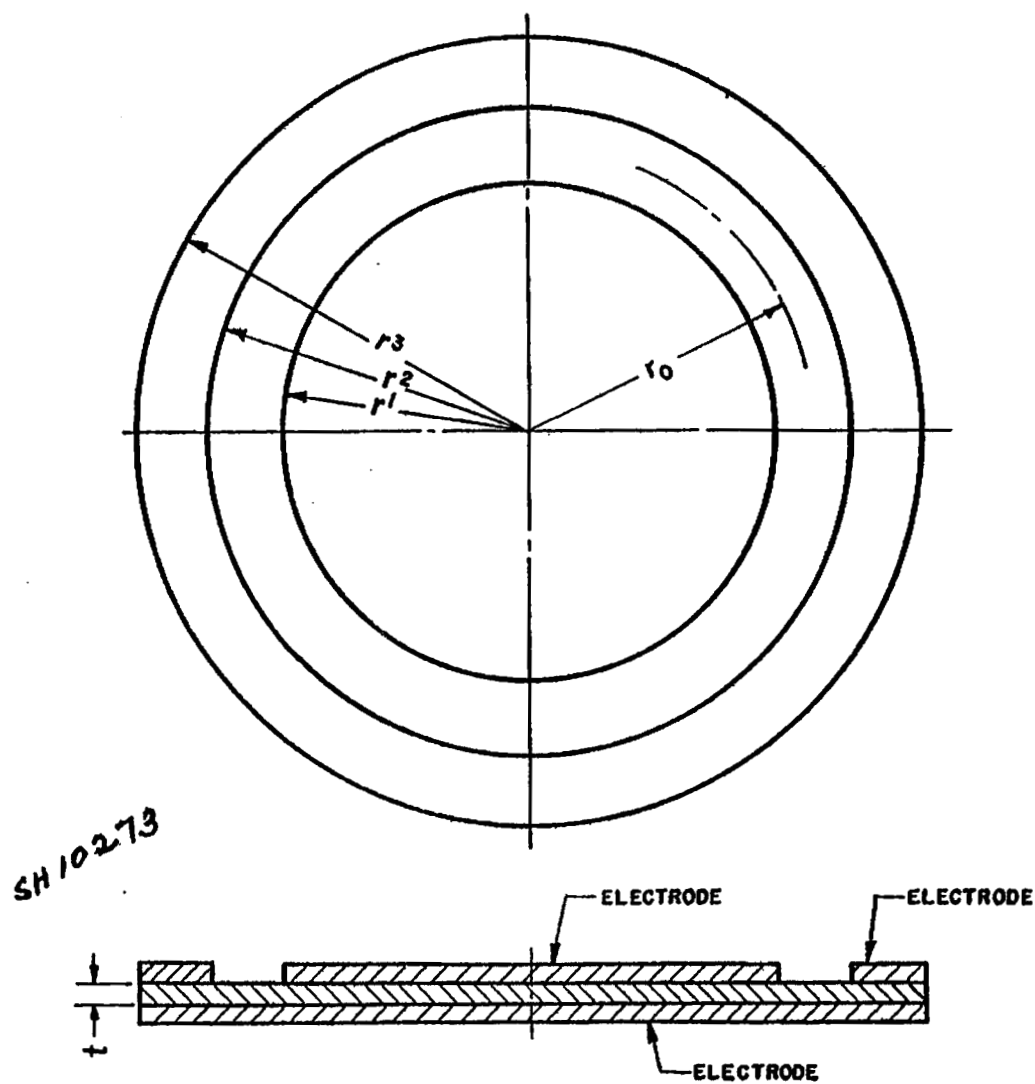


Figure 1 - Mold for casting sheet specimen.

MIL-I-16923G



$$r_0 = \frac{r_1 + r_2}{2}$$

Figure 2 - Volume resistivity specimen.

MIL-I-16923G

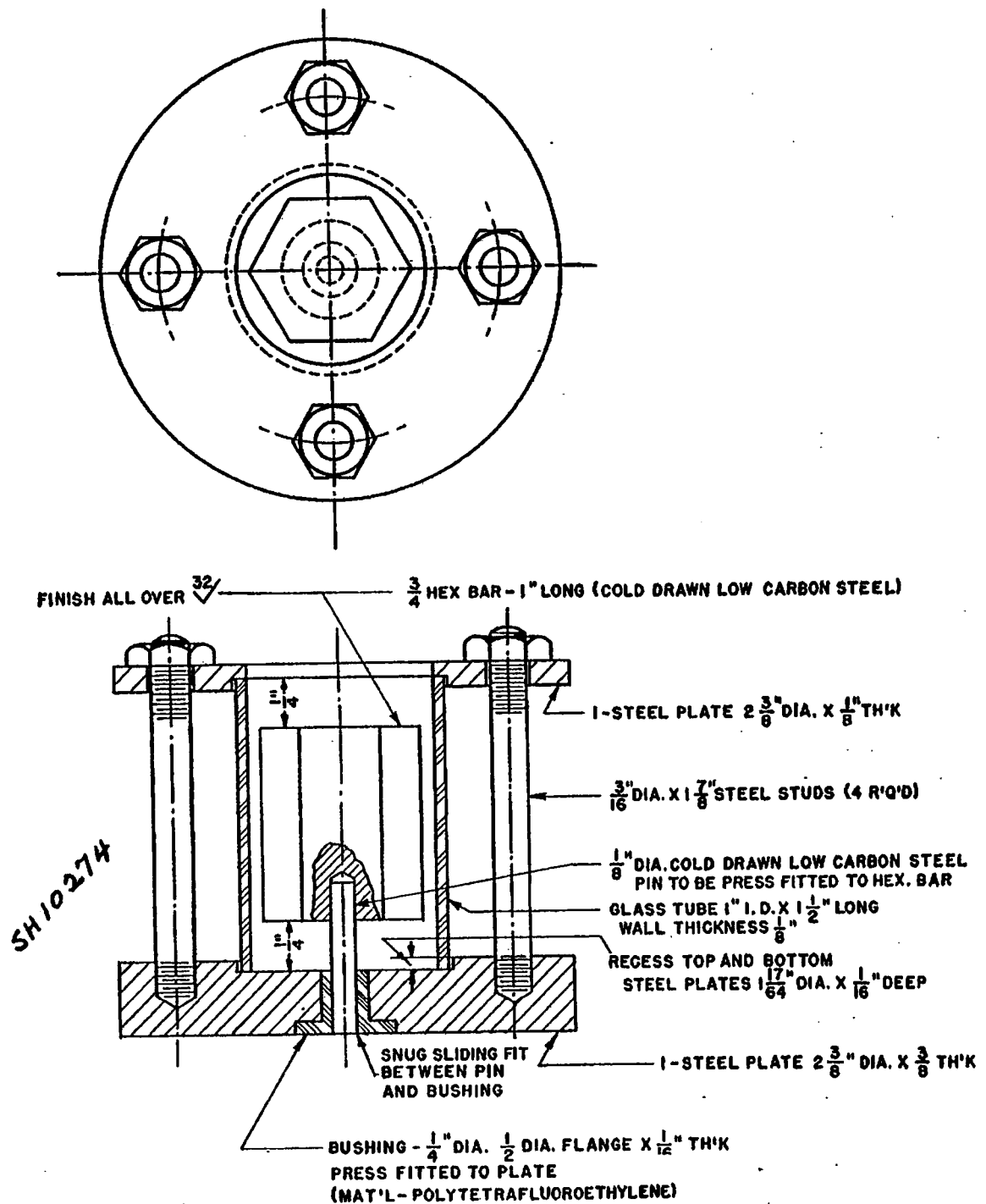


Figure 3 - Mold for thermal shock specimen.