MILITARY SPECIFICATION

INSULATING COMPOUND, ELECTRICAL, EMBEDDING, REVERSION RESISTANT SILICONE

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 requirements for two types of a two-part, transparent, reversion resistant flexible insulating compound, to provide resilient, environmental, and electrical insulation of components in systems in temperature range -65° to +200°C (-85° to +392°F).

1.2 Classification. The insulating compound covered by this specification shall be of the following types, as specified (see 6.2.1):

Type I - Room temperature curing
Type II - Heat curing

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

J-C-30	-	Cable and Wire, Electrical (Power, Fixed Installation).
QQ-A-250/13	-	Aluminum Alloy Alclad 7075, Plate and Sheet.
PPP-B-585	-	Box, Wood, Wirebound.

PPP-B-601	-	Box, Wood, Cleated Plywood.
PPP-B-621	-	Box, Wood, Nailed and Lock Corner.
PPP-B-636	-	Boxes, Shipping, Fiberboard.
PPP-C-96	-	Can, Metal, 28 Gauge and Lighter.

STANDARDS

FEDERAL

FED-STD-313	-	Material Safety Data Sheets Preparation and Submission of.

MILITARY

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	-	Marking for Shipment and Storage.
MIL-STD-810	-	Environmental Test Methods.

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein.

CODE OF FEDERAL REGULATIONS

49 CFR 171-178	-	Regulations for the Transportation of Explosives and Other Dangerous Articles by Land and Water.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20370.)

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the document which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 149	-	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
ASTM D 150	-	A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials.
ASTM D 257	-	D-C Resistance or Conductance of Insulating Materials.
ASTM D 471	-	Rubber Property-Effect of Liquids.
ASTM D 635	-	Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
ASTM D 2240	-	Rubber Property-Durometer Hardness.

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

UNIFORM CLASSIFICATION COMMITTEE AGENT

Uniform Freight Classification Rules

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

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Qualification. The insulating compounds 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 6.3).

3.2 Material. The insulating compound shall be supplied as a two-component transparent, reversion resistant, flexible silicone rubber, consisting of the base compound and the curing agent. Components shall be of the highest quality and shall be homogeneous and free of pigments, and foreign matter. The material shall contain no solvents.

3.2.1 Primer. A primer specified by the manufacturer shall be used in all tests where required.

3.2.2 Suitability. The compound shall protect the electrical components of the equipment to which it is applied by sealing against such environmental conditions as moisture, dirt, fumes, fungus or other deleterious substances. It shall not cause deterioration or corrosion of materials used in the encapsulated parts.

3.2.3 Toxicity. 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 appropriate departmental medical service who will act as an advisor to the contracting agency.

3.3 Characteristics and performance.

3.3.1 Color. The mixed compound shall be transparent and shall range from colorless to light straw.

3.3.2 Viscosity. The viscosity of the uncatalyzed base compound, determined in accordance with 4.8.2, shall be 70 poises maximum.

3.3.3 Specific gravity. The specific gravity of cured compound, when tested as specified in 4.8.3, shall be in the range of 1.00 to 1.08.

3.3.4 Application life. The application life of the catalyzed compound, when tested in accordance with 4.8.4, shall be a minimum of 2 hours for type I and 5 hours for type II and allows the compound for each type to reach a maximum of 750 poises at 25°C ± 1.1°C (77° ± 2°F).

3.3.5 Curability. The material, when tested as specified in 4.8.5, shall cure throughout to a firm, rubber-like state. Specimens shall be cured in accordance with 4.7 and shall meet the following hardness requirements:

Type I - 20 minimum durometer Shore Type A-2
Type II - 40 minimum durometer Shore Type A-2

3.3.6 Flammability. A specimen shall not burn more than 1 inch and shall extinguish within 20 seconds upon removal of flame when tested in accordance with 4.8.9.

3.3.7 Heat resistance. Specimens shall withstand temperatures in accordance with 4.8.11 without cracking, softening, blistering, flowing, distorting, or charring. Changes in weight, volume and hardness, after conditioning in accordance with 4.8.11, shall not exceed 3 percent by weight, 5 percent by volume and 10 points increase in hardness.

3.3.8 Fungus resistance. The cured compound shall not support the growth of fungus when tested in accordance with 4.8.10.

3.3.9 Adhesion. The adhesion of the type I and type II compounds, when cured in accordance with 4.7 and tested in accordance with 4.8.12, shall be 2 pound minimum/per inch width.

3.3.9.1 Repairability. The repairability of the type I and type II compounds, when cured in accordance with 4.7 and tested in accordance with 4.8.12.2, shall be as follows:

As received - 2 pounds minimum
Heat aged at 204° ± 3°C (400° ± 5°F) for 72 ± 2 hours - 2 pounds minimum

3.3.10 Thick section cure. The compound shall cure in sections of unlimited thickness, either exposed to air or completely sealed as specified in 4.8.16. The hardness (Shore Type A-2 durometer) at both top and bottom of the test unit shall be no less than the original as received cured durometer hardness (see 3.3.5).

3.3.11 Reversion resistance. The hardness (Shore Type A-2 durometer) of the compound shall decrease no more than 5 points from the original sample when measured on a confined specimen after conditioning for 168 hours at 200° ± 3°C (392° ± 5°F) (see 4.8.16.2).

3.3.12 Electrical properties. The electrical properties of both types of material, after conditioning, shall conform to the values listed in Table I when tested as specified in 4.8.6, 4.8.7 and 4.8.8.

3.3.13 Thermal shock. The compound shall not rupture when subjected to 10 cycles from 155° ± 1°C (311° ± 2°F) to -55° ± 1°C (-67° ± 2°F) (see 4.8.17).

3.3.14 Water absorption. The weight change of the compounds shall be not more than 2 percent after 72 hours immersion in water at 60° ± 1.1°C (140° ± 2°F) when tested in accordance with 4.8.14. Change in volume shall be not greater than 3 percent, and change in hardness shall be not more than ± 10 points.

3.3.15 Shrinkage. When cured in accordance with 4.7 and tested in accordance with 4.8.13, the shrinkage of type I and type II compounds shall be as follows:

Type	After cure, percent, maximum	After 7 days at 204° ± 3°C (400° ± 5°F), percent, maximum
I	2	4
II	4	7

3.3.16 Corrosion. The cured compound shall cause no visual evidence of corrosion on the metal surface when tested in accordance with 4.8.15.

3.3.17 Hydrolytic stability. The material, when tested in accordance with 4.8.18, shall meet the minimum hardness requirements for type I and type II as specified in 3.3.5.

3.3.18 Shelf storage life. After being stored as specified in 4.8.19, the viscosity of the base compound shall not increase by more than 15 percent of the "as received" viscosity, and cured specimens made from the stored compound shall exhibit a hardness within ± 5 points of the "as received" hardness.

3.3.19 Workmanship. Workmanship shall be in accordance with high grade practice for this type of material.

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 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 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 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 consist of all the tests specified in table II.

4.3.1 Qualification test sample. Qualification test samples shall consist of eight 1-pound cans of compound and the applicable amount of curing agent. The compound and curing agent shall be furnished in containers of the type to be used in filling contract or purchase orders. Samples shall be forwarded to the Qualifying Laboratory: Commander, Naval Air Development Center, Attention: Aircraft Crew Systems Technical Directorate (Code 6062), Warminster, PA 18974. The samples shall be plainly and durably marked with the following information:

Samples for qualification test.
INSULATING COMPOUND, ELECTRICAL, EMBEDDING, REVERSION RESISTANT SILICONE
MIL-I-81550C
Type
Date of shipment
Name and address of manufacturer
Manufacturer's identification (base and curing agent, as required)
Submitted by (name) (date) for qualification test in accordance with the requirements of MIL-I-81550C under authorization (reference authorizing letter) (see 6.3)

4.3.2 Manufacturer's data.

4.3.2.1 Test reports. Two copies of the manufacturer's test report, containing complete test data showing that material submitted for qualification conforms to the requirements of this specification, shall be submitted with the qualification sample. Location and identity of the plant which produced the sample tested shall also be supplied. Material safety data sheets on toxicity (see 3.2.3) shall be prepared in accordance with FED-STD-313 and submitted to the qualifying laboratory (see 4.3.1).

4.3.2.2 Instructions for use. Duplicate copies of the manufacturer's instructions for use of the compound shall be furnished at the time the sample is submitted for test for qualification.

4.3.3 Retention of qualification. In order to retain qualification of a product approved for listing on the Qualified Products List (QPL), the manufacturer shall verify by certification to the qualifying activity that the manufacturer's product complies with the requirements of this specification. The time of periodic verification by certification shall be in two-year intervals from the date of original qualification. The Government reserves the right to re-examine the qualified product whenever deemed necessary to determine that the product continues to meet any or all of the specification requirements.

4.4 Quality conformance inspection.

4.4.1 Lot formation. Unless otherwise specified herein or in the contract or purchase order, a lot shall consist of all the insulating compound formulated from the same components, under essentially the same conditions, forming part of one contract or order, and submitted for inspection at one time.

cause of the evaporation ... vacuum (shrink) to its pre-determined size. Rec

4.4.2 Sampling.

4.4.2.1 Sampling for tests. A sufficient number of containers shall be selected at random to allow preparation of specimens for the tests specified in Table III. The samples shall be examined and tested as specified in 4.4.3.1.

4.4.2.2 Sampling for packaging.

4.4.2.2.1 Unit containers. A random sample of filled containers shall be selected from each lot in accordance with Inspection Level I of MIL-STD-105 and examined as specified in 4.4.3.2. The lot size shall be the total number of containers.

4.4.2.2.2 Shipping containers. Shipping containers, just prior to closure, shall be randomly selected from each lot in accordance with Inspection Level I of MIL-STD-105 for examination as specified in 4.4.3.2. Lot size shall be the number of shipping containers.

4.4.3 Testing and examination of quality conformance inspection samples.

4.4.3.1 Testing. The sample selected in 4.4.2.1 shall be tested to the requirements specified in table III. Nonconformance of a test specimen to a single requirement (see table III) shall be cause for rejection of the lot represented by the sample.

4.4.3.2 Packaging examination. Samples selected in accordance with 4.4.2.2.1 and 4.4.2.2.2 shall be visually examined to the requirements in table IV and all other applicable container specification requirements to determine conformance to Section 5 of this specification. The Acceptable Quality Level (AQL) for this inspection shall be 2.5 percent defective, except that the unit containers with "fill" defects may be corrected. In addition, shipping containers fully prepared for delivery shall be inspected for closure defects.

4.5 Test conditions.

4.5.1 Standard conditions. Standard laboratory conditions shall be 25° ± 1°C (77° ± 2°F) and relative humidity (RH) of 50 ± 5 percent. Unless otherwise specified herein, all mixing and testing of the sealing compound shall be at standard conditions.

4.6 Preparation of test specimens. Except as specified herein, specimens shall be cast in a suitable mold, 6 by 6 by 0.075 inch, to provide specific test specimens for the tests of 4.8. Separate molded panels shall be prepared for flammability (4.8.9) to provide specimens 6 by 0.5 by 0.5 inch, and for fungus resistance (4.8.10) to provide specimens 4 by 4 by 0.125 inch. The compound ingredients shall be mixed in accordance with the manufacturer's directions, then poured into the molds and cured as specified in 4.7.

4.7 Curing conditions. Unless otherwise specified herein, all test specimens shall be cured as follows:

a. Type I - 168 hours at 25° ± 1.1°C (77° ± 2°F).

b. Type II - 1 hour at 149° ± 2°C (302° ± 4°F).

All specimens shall be removed from the molds after completion of the above curing schedule and shall be conditioned in accordance with 4.5.1 for 1 to 7 days, prior to cutting samples or conducting tests.

4.8 Test methods.

4.8.1 Color. The mixed compound shall be visually examined to the requirement in 3.3.1.

4.8.2 Viscosity. The viscosity of the base compound shall be determined by a Model RVF Brookfield Viscometer using the no. 2 spindle, operated at 4 RPM. Equivalent viscometers using appropriate spindles and speeds may be employed. Conformance to 3.3.2 shall be noted.

4.8.3 Specific gravity. Three specimens, 0.075 by 1 by 2 inches, shall be cured as specified in 4.7. The specimens shall be weighed in air and then in water using an analytical balance. The specific gravity shall be computed as follows:

$$\text{Specific gravity} = \frac{\text{Weight in Air}}{\text{Weight in Air} - \text{Weight in Water}}$$

4.8.4 Application life. A 200-gram sample of mixed compound shall be used to determine application life, which shall commence at the end of a 5-minute mixing period. A standard one-pint can with its retaining flange removed (approximate size 2.750 inches in diameter by 2.750 inches in height) shall be utilized for mixing and testing in conjunction with a Model RVF Brookfield Viscometer, or equivalent, equipped with a no. 5 spindle and operated at 4 RPM. Consistency shall be determined at the end of 2 hours for type I and 5 hours for type II, respectively. Supplementary readings may be made at 1-hour intervals for type I and 3-hour intervals for type II until a reading of 750 poises is attained which shall be considered the end of the application life test. The spindle shall not be withdrawn from the compound during the test. Readings shall be taken when the pointer on the viscometer dial first assumes a steady position after a minimum of three revolutions (see 3.3.4).

4.8.5 Curability. Three cast specimens, each 2 by 1 by 0.075 inch, shall be cut from panels prepared and cured in accordance with 4.7. The specimens shall be placed one upon the other to form a sample 0.225 inch thick. Five instantaneous measurements of hardness shall be made on this sample using the Shore Type A-2 durometer in accordance with ASTM D 2240. Hardness values shall be in accordance with 3.3.5.

4.8.6 Dielectric strength. Three disk specimens, not less than 3 inches in diameter and approximately 0.075 inch thick, shall be cut from panels, molded and cured in accordance with 4.7. Dielectric strength determinations shall be made in accordance with ASTM D 149, or equivalent. Electrodes, 0.250 inch in diameter, shall be used and the test shall be made under oil at a frequency not exceeding 100 Hertz (Hz). The voltage shall be increased uniformly at the rate of 500 volts per second to determine sample conformity with the requirement in table I.

4.8.7 Volume resistivity. Three disk specimens, 4 inches in diameter and approximately 0.075 inch thick, shall be cut from panels prepared and cured as specified in 4.7. Resistivity tests and calculations shall be conducted in accordance with ASTM D 257, or equivalent, using a General Radio Type 544B bridge, 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 disks, 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.

4.8.8 Dielectric constant and dissipation factor. Three disk specimens, 4 inches in diameter and approximately 0.075 inch thick, shall be cut from panels prepared and cured as specified in 4.7. Tests shall be conducted in accordance with ASTM D 150, or equivalent. Lead foil electrodes shall be used and applied to the specimen. The electrodes shall consist of two lead foil disks; the upper disk shall be 2 inches in diameter and 1 inch in thickness, and the lower disk shall be 4 inches in diameter. The test current shall be introduced to the foil through two brass disks. The specimens shall be tested at frequencies of 1 kilohertz (KHz), 1 megahertz (MHz) and 10 MHz. Calculation shall include corrections for edge and ground capacitance effects (see Table I).

4.8.9 Flammability. Three specimens, 6 by 0.5 by 0.5 inch, cut from panels cured in accordance with 4.7, shall be tested in accordance with ASTM D 635, except that the specimens shall be placed directly on the wire mesh and the flame applied only once (see 3.3.6).

4.8.10 Fungus resistance. Three specimens, 4 by 4 by 0.125 inch, shall be cured as specified in 4.7. Tests shall be conducted in accordance with MIL-STD-810, except that distilled water with a pH 5.8 to 7.2 at 22° to 32°C (72° to 89°F) may be used in spore suspension preparation and test conditions shall be 30° ± 2°C (86° ± 4°F) with an RH of 95 ± 5% for 28 days. (See 3.8.8)

4.8.11 Heat resistance. Heat resistance tests shall be conducted on the specimens used for the hardness test, except that type I specimens shall be conditioned one hour at 100°C ± 1°C (212° ± 2°F) and the resulting hardness value used as the initial hardness. All specimens (4.8.5) shall be placed in an air circulating oven and conditioned for 168 hours at 200° ± 3°C (392° ± 5°F). The specimens shall be removed from the oven and returned to 25° ± 1°C (77° ± 2°F) in a desiccator and examined. Changes in weight and volume shall be determined in accordance with ASTM D 2240 (see 3.3.7).

4.8.12 Adhesion.

4.8.12.1 Preparation of panels. A coating of compound, 0.150 ± 0.025 inches thick, shall be applied to the primed side (as recommended by the manufacturer) of a 3 by 6 by 0.0625 inch aluminum alloy panel conforming to QQ-A-250/13 (see Figure 1). One strip, 3.750 inch wide, of a thin flexible metallic foil or tape (primed as specified by the manufacturer) shall be placed primed side down on the surface of the freshly applied compound. The strip shall be placed so that it covers the mold and compound (Figure 1)

leaving a 6-inch tail. Two panels shall be prepared and cured as specified in 4.7. One panel shall be oven aged for 72 ± 1 hour at 204° ± 3°C (400° ± 5°F).

4.8.12.1.1 Testing of panels. The panels shall be individually tested in an autographic testing machine whose capacity shall be such that the tension at failure is not more than 85 percent nor less than 15 percent of the full scale load. If the machine is of the pendulum type, the weight shall swing as a free pendulum without engagement of the pawls. The rate of separation of the jaws shall be 2 inches per minute. Two 1-inch wide strips shall be cut lengthwise through the metallic foil or tape and compound to the panel surface and extended the full length of the loose end of the metallic foil or tape. The edges of the panel shall not he used as an edge of the test strip. Specimens shall be mounted in the machine so that the loose end of the 1 inch wide metallic foil or tape strip shall be folded 180 degrees as it is pulled from the panel. Each strip shall be pulled as follows: A cut through the compound to the panel at the junction of separation shall be made at an angle of 45 degrees in the direction of separation. If the compound separates from the metallic foil or tape, similar 45-degree cuts shall be made to promote separation of the compound from the panel. A minimum of 5 cuts shall be made. The adhesion in pounds shall be automatically recorded on a chart as a continuous curve. The adhesion value shall be calculated by averaging the maximum force required to separate the compound from the panel (see 3.3.9).

4.8.12.2 Repairability. A coating of compound, approximately 0.150 ± 0.025 inch thick, shall be applied to the primed side (as specified by the manufacturer) of two 3 by 6 by 0.0625 inch aluminum alloy panels conforming to QQ-A-250/13 (see Figure 1). Two panels of the type undergoing test shall be prepared and cured as specified in 4.7. One cured panel shall act as control, the other shall be oven aged for 72 ± 2 hours at 204° ± 3°C (400° ± 5°F). The surface of all panels shall be scuffed with fine sandpaper. All panels shall then be recoated with newly mixed compound, approximately 0.125 ± 0.030 inch thick. One strip, 3.750 inches wide, of a thin flexible metallic foil or tape (primed as specified by the manufacturer) shall be placed primed side down on the surface of the freshly applied compound. The strip shall be placed so that it covers the mold and compound (see Figure 1) leaving a 6-inch long tail. The panels shall be cured as specified in 4.7, and tested in accordance with 4.8.12.1.1 (see 3.3.9.1).

4.8.13 Shrinkage. A cubical mold, with cover, approximately 1.0 inch on each side, shall be constructed. Its volume at 25° ± 1.1°C (77° ± 2°F) shall be determined. It shall be utilized for the preparation of a cured compound specimen as specified in 4.7. After filling the mold cavity, and then placing the cover on the compound, the specimen shall be subjected to cure, and then placed in a circulating air oven at 204° ± 3°C (400° ± 5°F) for 7 days. It shall then be removed, cooled, examined, and its volume at 25° ± 1°C (77° ± 2°F) determined by the water displacement method. The percent shrinkage shall be calculated as follows (see 3.3.15):

$$\text{Percent shrinkage} = \frac{(V_1 - V_2) \times 100}{V_1}$$

Where:

V_1 = volume of mold

V_2 = final volume of sealing compound

4.8.14 Water absorption. Three specimens, measuring 1 by 2 by 0.075 inch, cut from slabs cured in accordance with 4.7, shall be immersed in distilled water for 72 hours at 60 ± 1 C (140 ± 2 F), except that type 1 specimens shall be conditioned 1 hour at 100 ± 1 C (212 ± 2 F) and the resulting hardness used as the initial value. The specimens shall be tested for changes in hardness in accordance with ASTM D 2240. Change in weight and volume shall be determined in accordance with ASTM D 471 (see 3.3.14).

4.8.15 Corrosion. Prepare two 1.5-inch lengths of AWG size 10 copper wire conforming to J-C-30, by first removing all insulation and then cleaning with a degreasing agent and buffing if necessary to a bright copper finish. A previously cured section of the same silicone compound undergoing test shall be placed in the mold as a support for the wires. The wires used for this test shall not be treated with a primer. Encapsulate these two wire specimens centrally into a suitable mold 1 by 2 by 0.5 inch thick (see Figure 2). Compounds for type I and type II shall be cured in accordance with 4.7. Place the specimen along with an unpotted 1.5 inch length of the above specified wire (control) into an environment of 95 to 98 percent RH and 49° ± 1°C (120° ± 2°F) for 28 days. At the end of this period, the mold shall be slit open and the encapsulated wire compared with the control for compliance with the requirement specified in 3.3.16.

4.8.16 Thick section cure and reversion resistance.

4.8.16.1 Thick section cure. The container for the confinement of the catalyzed compound shall be a metal tube 4.250 ± 0.005 inches long, threaded at both ends, having an inner diameter of 2.5 inches and a wall thickness suitable for threading. Metal screw caps and aluminum foil gaskets which provide an air-tight seal shall be used for end closures and designed so that the total inside height of the capped tube does not exceed 4.250 ± 0.005 inches. Cap one end of the tube and pour the mixed and deaerated catalyzed sealing compound to a depth of 3.250 ± 0.032 inches. Allow the material to cure as specified in 4.7 with the container top uncapped. Remove the bottom cap, and obtain the hardness in the center area of the surface in accordance with ASTM D 2240 (see 3.3.10). Immediately following the hardness determination, recap both ends of the tube and condition the test fixture at 200° ± 3°C (392° ± 5°F) for 7 days for the test of 4.8.16.2.

4.8.16.2 Reversion resistance. At the expiration of the heat aging period, in accordance with 4.8.16.1.1, allow the test fixture to cool at standard conditions for 24 ± 1 hour. Obtain hardness readings in the same area of the bottom area where the original hardness was determined in accordance with ASTM D 2240. Tests shall be made in duplicate. If the compound fails in only one specimen, repeat the test. A second failure shall be cause for rejection (see 3.3.11).

4.8.17 Thermal shock.

4.8.17.1 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 155° ± 2°C (311° ± 5°F).

b. An isopropyl alcohol dry ice bath maintained at -55° ± 2°C (-67° ± 2°F).

4.8.17.2 Specimens. Five specimens shall be cast in molds similar to the molds shown in Figure 3. In preparing the mold, the glass tube shall be coated with a release agent and the one inch long, 0.750 inch cold drawn low carbon steel hex bar shall be polished with number "0" emery cloth and washed with a 50:50 xylene/isopropyl alcohol mixture. The curing procedure shall be as specified in 4.7.

4.8.17.3 Procedure. Cured specimens shall be placed in the oven for 30 (- 0,+1) minutes, at the specified temperature, removed, then immediately plunged into the dry ice alcohol bath and left for 10(-0, +1) 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 the test (see 3.3.13).

4.8.18 Hydrolytic stability, physical.

4.8.18.1 Specimen preparation. Sufficient base compound and curing agent shall be mixed to prepare 3 molded test specimens, 2-1/2 inches in diameter by 1/2 inch thick, cured as specified in 4.7. Instantaneous hardness shall be determined using a Shore Type A-2 durometer in accordance with ASTM D 2240. Hardness shall be determined at the same locations before and after exposure.

4.8.18.2 Procedure. After determining hardness before exposure, the specimens shall be placed vertically in a suitable holder, on a tray in a suitable glass desiccator (250 mm). The desiccator shall contain glycerine (22 percent by weight) in water solution in the bottom which will produce a RH of 95 percent at the test temperature. The desiccator, containing the specimens, shall be closed and inserted into an air circulating oven maintained at 71° ± 1°C (160° ± 3°F) for a period of 120 days. At the end of the exposure period, the desiccator shall be removed from the oven and cooled to standard conditions (see 4.5.1) for 16 to 24 hours. Hardness shall be determined as specified in 4.8.18.1 and the obtained values for each specimen shall be in accordance with the requirements in 3.3.17.

4.8.19 Shelf storage life. One pint of the base compound together with its curing agent shall be stored separately in their "as received" containers for 4 months (time shall be counted from date of shipment). The storage temperature shall be as specified by the manufacturer, but shall not be below conditions of 4.7. At the end of the storage period, the compound shall be tested for viscosity (4.8.2), and hardness (4.8.5) to determine conformance to the requirements of 3.3.18.

5. PACKAGING

5.1 Preservation-packaging. Preservation-packaging shall be Level A or Commercial, as specified (see 6.2.).

5.1.1 Level A.

5.1.1.1 Unit protection. The base compound, curing agent and primer shall each be packaged in their own containers. Each curing agent container shall be packaged with one base compound container with a suitable separator between the two containers, in a manner which will prevent accidental separation but which will permit easy separation for mixing purposes. The ratio of the quantity contained in the base compound container to quantity contained in the attached curing agent container shall be the same as the recommended mixing ratio of the base compound and curing agent.

5.1.1.2 Unit package. The base compound shall be furnished in 1-pint multiple friction top cans, conforming to Type V, Class 2 of PPP-C-96. The amount of base compound contained in each can shall fill the container to approximately threefourths of its capacity. The proper amount of curing agent and 4 ounces of primer shall be furnished in glass or plastic jars having smooth vertical inside walls, with projections or lips not exceeding 1/16 inch. The inside bottom shall be approximately horizontal. The jars shall have one rolled thread such that the cap will turn a minimum of 1/4 revolution to fully secure. The jars shall be provided with enameled metal or plastic screw type caps.

5.1.2 Commercial. The base compound, curing agent and primer shall be packaged in accordance with the manufacturer's commercial practice.

5.2 Packing. Packing shall be Level A, B or Commerical, as specified (see 6.2.).

5.2.1 Level A. Base compound, curing agent and primer, packaged in accordance with 5.1, shall be packed in an Overseas Exterior Type container conforming to PPP-B-585, PPP-B-601, PPP-B-621 or PPP-B-636. Weight of the contents shall conform to the weight limitations of the applicable box specification and shall not exceed a total weight of 200 pounds. PPP-B-601 boxes shall be surface treated in accordance with requirements of the specification. Containers shall be closed and sealed in accordance with the appendix of the applicable specification.

5.2.2 Level B. The base compound, curing agent and primer, packaged as specified in 5.1, shall be packed in Exterior Domestic Type containers conforming to PPP-B-585, PPP-B-601, PPP-B-621 or PPP-B-636. Weight of the contents shall conform to the limitations of the applicable box specification.

5.2.3 Commercial. Base compound, curing agent and primer, packaged in accordance with 5.1, shall be packed to afford protection against damage during direct shipment from the source of supply to the first receiving activity for immediate use. Containers shall comply to the Uniform Freight Classification Rules or other regulations applicable to the mode of transportation.

5.3 Marking.

5.3.1 Packages.

5.3.1.1 All component packages. All component packages shall be marked in accordance with the Code of Federal Regulations, Title 49, Section 171-178.

5.3.1.2 Base compound container. Each base compound container shall be durably and legibly marked as specified in MIL-STD-129 and shall include the following information:

INSULATING COMPOUND, ELECTRICAL, EMBEDDING, REVERSION RESISTANT SILICONE
MIL-I-81550C
Type, as applicable
Curing agent for (insert product designation for base compound, when applicable)
Primer identification (when applicable)
Date of shipment
Manufacturer's name and address
Manufacturer's product designation
Manufacturer's batch identification or lot number
Contract number/purchase order number
Expiration date
Manufacturer's recommended storage temperature
Net contents
Stock number

5.3.1.3 Exterior shipping containers. Each exterior shipping container shall be marked as specified in 5.3.1.2, and in accordance with MIL-STD-129.

5.4 Instructions for use. The supplier of the silicone compound shall furnish instructions with each shipment, which contain:

a. Storage stability, uncatalyzed, indicating the optimum storage temperature and conditions of storage to obtain maximum stability.

b. Complete mixing information to provide for optimum product performance when the material is cured at the manufacturer's time and temperatures.

6. NOTES

6.1 Intended use. The insulating compound covered by this specification is intended for embedding, potting or encapsulation of electrical and electronic components in systems where tear resistance is not critical at temperatures ranging from -65° to +200°C (-85° to +392°F). These transparent compounds allow visual circuit and part identification and facilitates part replacement and repairs.

6.1.1 Type I. Type I compound is intended for general purpose potting and embedding of electronic equipment where it is not convenient to heat the equipment. Type I material has low dielectric losses that do not change appreciably over a temperature range of -55° ± 1°C (-67° ± 2°F) to +155° ± 2°C (311° ± 2°F). It is intended for use where protection from thermal cycling, mechanical shock, vibration and moisture is required.

6.1.2 Type II. Type II compound is intended for the same uses as type I and shall have the same properties when cured. Type II is used when the electronic parts can be heated and provides faster processing during the embedding procedure.

6.1.2.1 Heat cure. Heat curing of type II materials may be accomplished at lower temperatures and correspondingly longer times, such as 4 hours at 65° ± 1°C (149° ± 2°F).

6.1.3 Thermal expansion. Because of high temperature expansion, type I and II compounds shall not completely fill a given closed container.

6.1.4 Adhesion. To obtain adhesion, the primer recommended by the manufacturer shall be applied to surfaces to which a bond is required.

6.1.5 Inhibition of cure. Some insulation material may inhibit the cure of MIL-I-81550 compounds. Inhibition causing materials can be amine epoxy curing agents, sulfur containing rubbers, organotin catalyst cured silicone rubbers and certain nitrogen compounds. To prevent inhibition, the materials can be coated with a sealer recommended by the manufacturer. Sealers and primers should have equivalent electrical insulating properties as the basic compound since primer and sealer films can contribute to electrical leakage in a potted or incapsulated unit.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Type required (see 1.2).

c. Quantity desired (see 5.1.1).

d. Level of packaging-preservation and packing required (see 5.1 and 5.2).

e. Any special marking required (see 5.3).

6.3 Qualification. 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 Qualified Products List (QPL-81550) 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 Air Systems Command, Washington, DC 20361; however, information pertaining to qualification of products and letter of authorization for submittal of sample may be obtained from the Naval Air Development Center, Attention: Aircraft and Crew Systems Technology Directorate (Code 6062) Warminster, PA 18974, Attention: ACSTD (6062).

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

Custodians:
Army - ER
Navy - AS
Air Force - 20

Review activities:
Army - AV, MI
Navy - EC
Air Force - 85, 99
DLA - GS

User activities:
Navy - MC

Preparing activity:
Navy - AS

(Project 5970-0593)

TABLE I. Electrical properties of cured compounds.

Test	Type I and Type II
Dielectric strength volts/mil (min)(see 4.8.6)	450
Volume resistivity 1/ OHM-CM (min)(see 4.8.7):	
At standard conditions (4.5.1)	10^{13}
At 204° ± 3°C (400° ± 5°F)	10^{12}
Dielectric constant (max) 2/(see 4.8.8):	
1 KHz	3.5
1 MHz	3.8
10 MHz	5.0
Dissipation factor (max) 2/ (see 4.8.8):	
1 KHz	0.005
1 MHz	0.003
10 MHz	0.005

1/ Median values should be recorded.

2/ Cure conditioning shall be in accordance with 4.7.

TABLE II. Qualification inspection.

Property	ASTM method	Paragraph	
		Test	Requirement
Color	---	4.8.1	3.3.1
Viscosity	---	4.8.2	3.3.2
Specific gravity	---	4.8.3	3.3.3
Application life	---	4.8.4	3.3.4
Hardness	D 2240	4.8.5	3.3.5
Flammability	D 635	4.8.9	3.3.6
Heat resistance:	---	4.8.11	3.3.7
Change in hardness	D 2240	4.8.11	3.3.7
Change in weight	D 471	4.8.11	3.3.7
Change in volume	D 471	4.8.11	3.3.7
Fungus resistance	---	4.8.10	3.3.8
Adhesion	---	4.8.12	3.3.9
Repairability	---	4.8.12.2	3.3.9.1
Thick section cure	D 2240	4.8.16.1	3.3.10
Reversion resistance	D 2240	4.8.16.2	3.3.11
Dielectric strength	D 149	4.8.6	Table I
Volume resistivity	D 257	4.8.7	Table I
Dielectric constant	D 150	4.8.8	Table I
Dissipation factor	D 150	4.8.8	Table I
Thermal shock	---	4.8.17	3.3.13
Water absorption:	---	4.8.14	3.3.14
Change in hardness	D 2240	4.8.14	3.3.14
Change in weight	D 471	4.8.14	3.3.14
Change in volume	D 471	4.8.14	3.3.14
Shrinkage	---	4.8.13	3.3.15
Corrosion	---	4.8.15	3.3.16
Hydrolytic stability	---	4.8.18	3.3.17
Shelf storage life	---	4.8.19	3.3.18

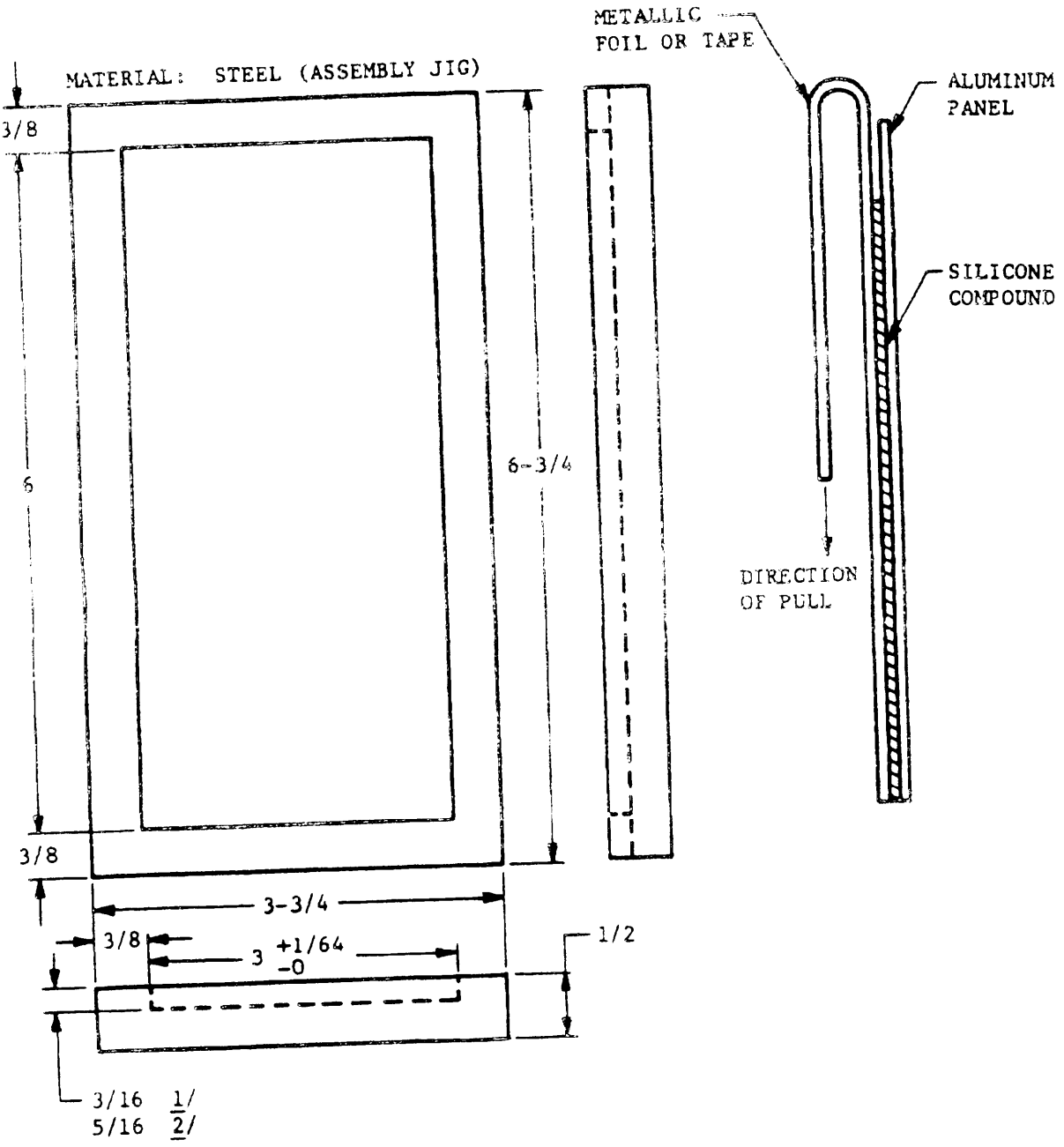
TABLE III. Quality conformance tests.

Tests	Applicable paragraph	Applicable types
Color	4.8.1	I, II
Viscosity	4.8.2	I, II
Specific gravity	4.8.3	I, II
Application life	4.8.4	I, II
Curability	4.8.5	I, II
Dielectric strength 1/	4.8.6	I, II
Volume resistivity 1/ 2/	4.8.7	I, II

1/ Test data from every 5th lot of material is acceptable.
2/ Room temperature only.

TABLE IV. Packaging examination.

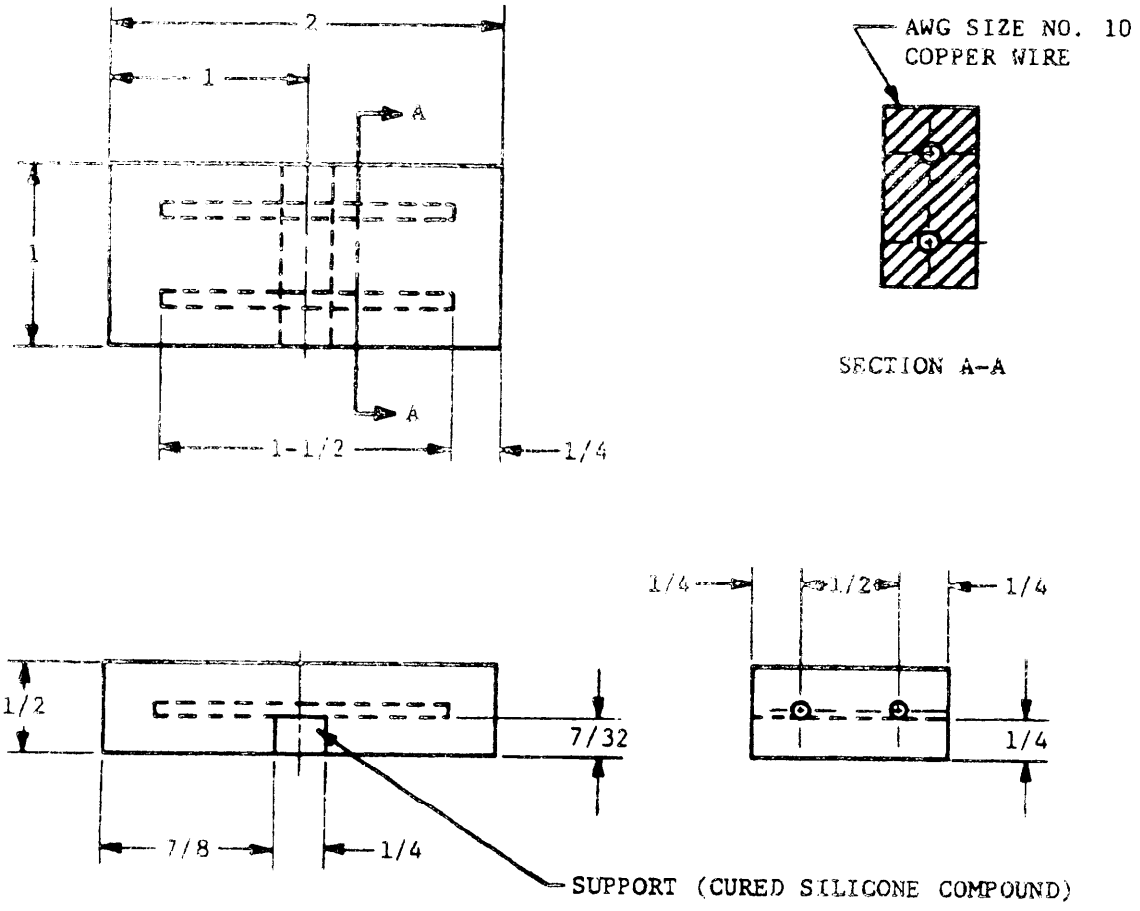
Examination	Defect
Unit container:	
Fill	Not volume specified in contract or purchase order.
Packaging	Wrong size containers. Primer package not as specified or missing. Material or construction not as specified. Components damaged or missing. Intermediate package closure incomplete or damaged. Not level required by contract or purchase order.
Shipping container:	
Packing	Not level required by contract or purchase order. Any nonconforming component or incomplete closure. Bulged or damaged shipping containers.
Count	Less than specified or indicated quantity per shipping container.
Markings	Unit and intermediate packaging and packing, omitted, illegible, incorrect, incomplete or not in accordance with contract or purchase order requirements.



DIMENSIONS IN INCHES.

1/ 3/16 - THICKNESS FOR ADHESION.
2/ 5/16 - THICKNESS FOR REPARABILITY.

FIGURE 1. Adhesion assembly jig and test specimen.



UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

FIGURE 2 Location of the wire specimens in the silicone casting.

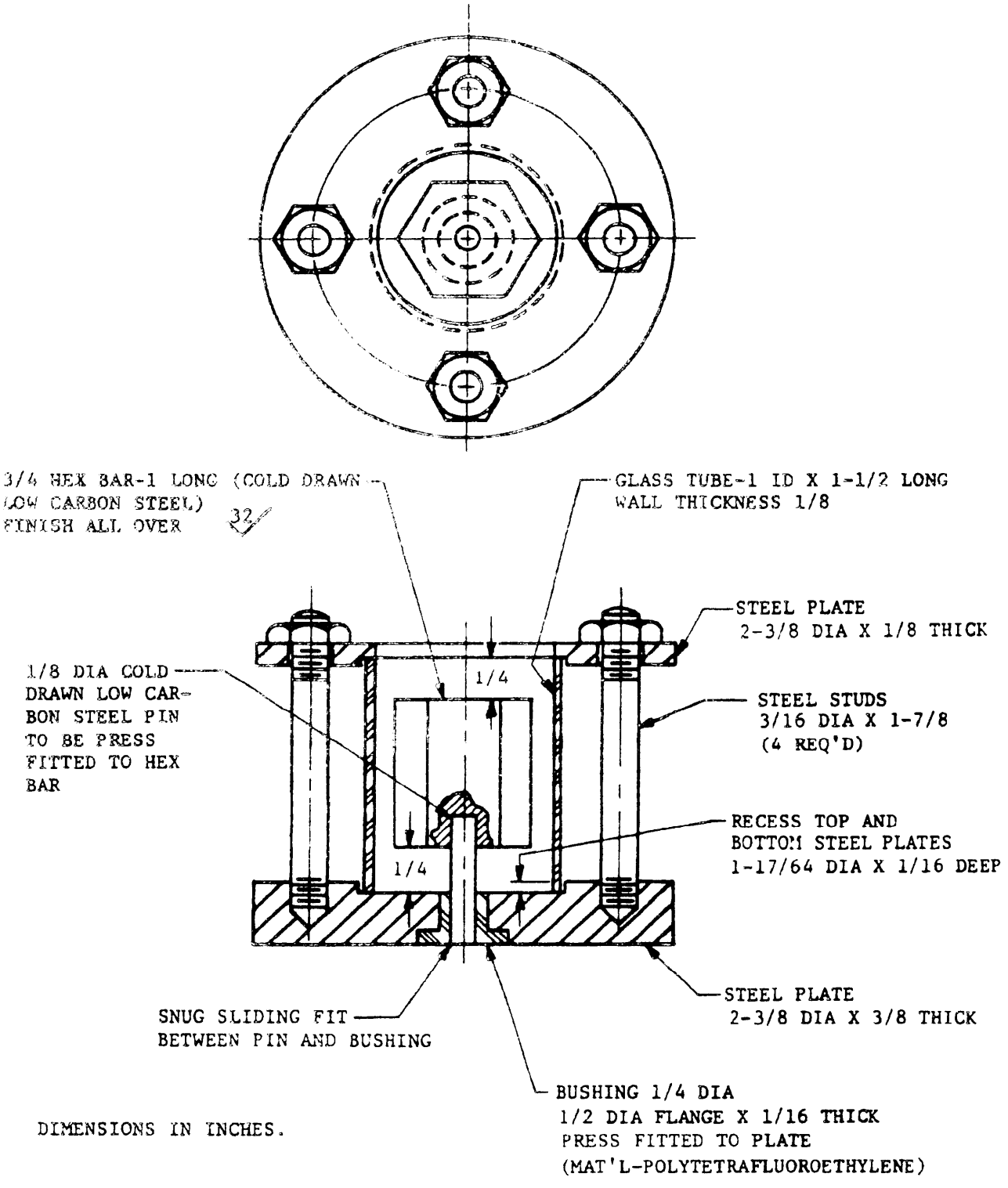


FIGURE 3. Mold for thermal shock specimen.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-I-81550C	INSULATING COMPOUND, ELECTRICAL, EMBEDDING, REVERSION RESISTANT SILICONE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
3b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* - Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* - Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* - Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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