The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3726B

Issued 1 OCT 1983
Revised 1 JAN 1993

Superseding AMS 3726A

Submitted for recognition as an American National Standard

SHIMS, FILLED RESIN COMPOUND

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of July, 1992. It is recommended, therefore, that this specification not be specified for new designs.

This cover sheet should be attached to revision "A" of the subject specification.

"NONCURRENT" refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division, however, does not recommend these as standard materials for future use in new designs. Each of these "NONCURRENT" specifications is available from SAE upon request.

PREPARED UNDER THE JURISDICTION OF AMS COMMITTEE "CP".

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SHIMS, FILLED RESIN COMPOUND

1. SCOPE:

1.1 Form:

This specification covers filled, resinous, thermosetting compounds capable of being applied and cured in place between the surfaces of mechanically fastened (joined) structures.

1.2 Application:

These products have been used typically as molded shims during assembly of aircraft components and parts requiring good flatwise compression properties and adhesion to metallic or nonmetallic materials, but usage is not limited to such applications. In most applications, the compound will be required to adhere to only one of the mating surfaces; i.e., the compound is not intended to be an adhesive.

1.3 Classification:

The filled resin compound shall be classified by application and processing criteria specified in each detail specification.

1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP1524	Surface Preparation and Priming of Aluminum Alloy Parts for High Durability Structural Adhesive Bonding, Phosphoric Acid Anodizing
AMS 2825	Material Safety Data Sheets
AMS 3091	Mold Release Agent
AMS 3667	Polytetrafluoroethylene Sheet, Molded, General Purpose Grade, As Sintered
AMS 3894/2	Carbon Fiber Tape and Sheet, Epoxy Resin Impregnated, G150,000 (1034) Tensile, 20,000,000 (138) Modulus, 175 (347)

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 117	Salt Spray (Fog) Testing
ASTM D 696	Coefficient of Linear Thermal Expansion of Plastics
ASTM D 792	Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 1002	Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)
ASTM D 1151	Effect of Moisture and Temperature on Adhesive Bonds
ASTM D 1655	Aviation Turbine Fuels
ASTM D 2240	Rubber Property - Durometer Hardness
ASTM D 3165	Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies
ASTM D 3530	Volatiles Content of Carbon Fiber-Epoxy Prepreg

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
AN960	Washer, Flat
MS21042	Nut, Self Locking, 450 Deg. F, Reduced Hexagon, Reduced Height, Ring Base, Non-Corrosion Resistant Steel (ASG)
MS21084	Nut, Self Locking, 220 ksi Ftu, 450 Deg. F, Flanged, MS33787 Wrenching Element
MS21085	Nut, Self Locking, 260 ksi Ftu, 450 Deg. F, Flanged, MS33787 Wrenching Element

2.3 U.S. Government Publications (Cont.):

MS21296	Bolt, Tension, Steel, 260 ksi Ftu, 450 Deg. F, External Wrenching, Spline Drive, Flanged Head
MS21297	Bolt, Tension, Steel, 220 ksi Ftu, 450 Deg. F, External Wrenching, Spline Drive, Flanged Head
MS33787	Wrenching Element, External Spline, Dimensions For
MS35650	Nut, Plain Hexagon, Machine Screw, UNF2B
MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

2.4 NAS Publications:

Available from National Aerospace Standards Industry Association, Inc., 1321 14th Street, Washington, DC 20005.

NAS 1580 Bolt, 100 Deg. Flush Reduced Head

3. TECHNICAL REQUIREMENTS:

3.1 Detail Specifications:

The requirements for a specific resin compound shall consist of all requirements specified herein in addition to requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and an applicable detail specification, requirements of the detail specification shall govern.

3.2 Material:

Shall be an epoxy or modified epoxy based polymer with a hardener or curing agent. Each may contain fillers or other ingredients necessary to meet the requirements of this specification and the applicable detail specification. Filler materials shall not include asbestos products and shall not cause corrosion of metallic parts.

3.2.1 Storage Life: The resin base and hardener shall meet the requirements of this specification at any time up to one year from date of receipt by purchaser when stored below 4 °C (39 °F) in the original unopened containers.

3.2.1.1 When furnished as a premixed material, refrigerated shipping and storage is required. Refer to the applicable detail specification for specific requirements.

3.2.2 Working Life: When resin base and hardener are mixed in accordance with manufacturer's instructions, the compound shall have a usable working life of 30 to 60 minutes. The working life of compound supplied as frozen premixes shall not be less than 30 minutes following thawing in accordance with manufacturer's instructions.

3.2.2.1 Rapid thawing (within 10 to 15 minutes) of frozen premixed compound will be required to prevent loss of work life. The purchaser should recognize that a facility to accomplish a rapid thaw will be required near the assembly area.

3.2.3 Viscosity: The compound shall be a workable paste and shall not sag or drip when applied to a vertical or overhead surface in thickness up to 0.05 inch (1.3 mm).

3.2.4 Volatile Content: The compound shall be essentially 100% solids, determined in accordance with ASTM D 3530. A measurable volatile content (weight loss) of up to 0.5% is acceptable for heat exposure up to 175 °C (347 °F).

3.2.5 Curing Time: The compound when applied up to 0.05 inch (1.3 mm) thickness between metal plates shall have sufficient strength after curing for not more than 5 hours at not lower than 21 °C (70 °F) to permit tightening of 0.375 inch (9.52 mm) diameter bolts to 360 inch-pounds (40.7 N·m) in a typical bolted pattern without cracking or chipping of the shim material, determined in accordance with 4.5.1.

3.3 Cured Properties:

The compound shall have properties as specified in the individual detail specifications. Tests shall be performed at 20 to 30 °C (68 to 86 °F). Values for strength tests shall be the average of five specimens for each test.

3.3.1 Strain compatibility with graphite-epoxy test of the individual detail specifications shall be the responsibility of the purchaser to perform. This test may be waived if purchaser's applications do not include graphite-epoxy laminated parts.

3.4 Quality:

Compound, as received by purchaser, shall be uniform in quality and condition, and free from foreign materials detrimental to usage of the compound.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:
(R)

The vendor of the compound shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the compound conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for specific gravity, working life (3.2.2), viscosity (3.2.3), flatwise compression strength, and quality (3.4) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of compound to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test compound shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing:
(R)

Shall be as follows:

4.3.1 For Acceptance Tests: Each lot shall be sampled at random to provide sufficient compound to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all compound produced in a continuous production run from the same batches of raw materials under the same fixed conditions and presented for vendor's inspection at one time. A lot shall not exceed 1000 pounds (454 kg) of compound and may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and
(R) vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6.1 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample compound shall be approved by purchaser before compound for production use is supplied, unless such approval be waived by purchaser. Results of tests on production compound shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures and processes, and methods of inspection on production compound which are essentially the same as those used on the approved sample compound. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample compound. Production compound made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

Shall be in accordance with the following:

4.5.1 Curing Time: Prepare two QQ-A-250/4-T851 aluminum alloy plates 3 x 3 x 0.250 inch (76 x 76 x 6.35 mm) thick. Drill four holes through the plates for installation of MS21297-06008 or MS21296-06008 bolts. Hole size shall be 0.375/0.380 inch (9.525/9.652 mm). The hole centerlines shall be located 0.75 inch (19.0 mm) from the two nearest panel edges. The dimension between adjacent holes shall be 1.5 inch (38 mm) referenced dimension. Refer to Figure 1. Deburr all holes and panel edges. Prepare plates for application of compound in accordance with ARP1524. The faying surface of one plate and the bolts shall be coated with AMS 3091 or other suitable release agent. Apply the compound to a thickness of approximately 0.05 inch (1.3 mm) to the other plate. Assemble the two plates. Install bolts and nuts. Use MS35650-202 nuts at this stage. Tighten all nuts sufficiently to make contact with aluminum plates but not to force compound from assembly. Clean compound displaced by installation of bolts prior to hardening. Allow compound to set at room temperature for 5 hours ± 0.2 from time of application of resin. Remove nuts and replace with MS21084L06 or MS21085L06 nuts. Tighten bolts to 360 inch-pounds (41 N·m). Observe compound at edges for cracks or chipping. Disassemble panels and observe compound for interior cracks, chips, or crushing. The compound is acceptable if there are no visible signs of cracking, chipping, or crushing due to the tightening of the bolts.

4.5.2 Strain Compatibility With Aluminum: Prepare two QQ-A-250/4-T31 aluminum alloy sheets 3.5 x 6.0 x 0.160 inch (89 x 152 x 4.06 mm) thick. Prepare sheets for application of compound in accordance with ARP1524. The faying surface of one plate shall be coated with a suitable release agent. Apply the compound to a thickness of approximately 0.015 inch (0.38 mm) to the opposite plate in an area 1.50 inch (38.1 mm) wide parallel to the reference 4.95 inch (125.7 mm) dimension. Assemble the plates such that the area coated with release agent of one plate overlaps the compound. Refer to Figure 2. Apply uniform pressure of 10 psi (69 kPa). Clean compound squeezed from overlap area from assembly prior to hardening. Allow compound to set at room temperature for 5 hours ± 0.2 prior to further preparation. Keeping plates clamped tightly, drill two lines of 8 holes parallel to the long panel dimension. Edge and side distance for holes shall be 0.375 inch (9.52 mm) from hole centerline to edge (or side) of plate. The holes shall be drilled to have seven equal spaces between holes. The hole size shall be 0.1895/0.1930 inch (4.813-4.902 mm) and shall be countersunk on the side of the assembly to which the compound is bonded to accept a NAS 1580A3T6 bolt. The maximum diameter of the countersink shall be 0.305 inch (7.75 mm). Disassemble the panels, deburr holes, and check compound for cracks or chips. The presence of cracks or chips is unacceptable and cause for rejection. Reassemble panels. Install 16 bolts using MS21042L3 nuts and AN960 washers. Tighten bolts to 50 inch-pounds (5.65 N·m). Cut the panel into four equal width coupons normal to the reference 4.95 inch (125.7 mm) dimension. An individual coupon shall be an overlap bolted joint with four bolts per coupon. Refer to individual coupon dimensions of Figure 2. The coupons shall be loaded in tension-tension (constant amplitude) cycling for 20 cycles at -55 °C (-67 °F) at a deflection rate of 0.10 inch (2.5 mm) per minute. The load levels shall be set for a maximum stress (outside of the joint area) of 20.0 ksi (138 MPa) and a minimum stress of 2.0 ksi (13.8 MPa). The test is acceptable if there is no failure of the compound under cyclic loading.

4.5.3 Strain Compatibility With Graphite-Epoxy: This coupon is prepared and tested following the steps of 4.5.2 with the following exceptions:

4.5.3.1 A graphite-epoxy laminate shall be used in place of one of the aluminum plates.

4.5.3.1.1 The graphite epoxy laminate shall be premade according to purchaser's production processing step. When AMS 3894/2 graphite tape is used, a 30-ply laminate of the following stacking orientation is recommended:

$$[(\pm 45°)_2, (0°/\pm 45°)_3, (\pm 45°)]_S$$

where the 0° dimension is parallel to the reference 3.5 inch (89 mm) dimension. The laminate shall be scuff sanded using aluminum-oxide cloth, and blown free of sanding residue prior to application of the shim compound.

4.5.3.2 The shim compound material shall be bonded to the laminate.

4.5.3.3 The aluminum plate shall have a release agent applied to prevent bonding.

4.5.3.4 The coupons shall be prepared individually by cutting and drilling the laminate and aluminum plate in separate operations. The bolt countersink shall be in the laminate. Refer to Figure 3.

4.5.3.5 The load levels for the tension-tension cycling shall be 17.0 ksi (117 MPa) maximum to 1.7 ksi (11.7 MPa) minimum, based on the stress in the aluminum plate outside of the joint area.

4.5.4 Flatwise Compressive Strength: Prepare two QQ-A-250/4 aluminum alloy details, one detail to be a 4 x 6 x 0.500 inch (102 x 152 x 12.7 mm) thick -T851 plate and the other to be 1 x 5 x 0.125 inch (25 x 127 x 3.18 mm) thick -T851 sheet. Prepare the details in accordance with ARP1524. Apply release agent to faying surface of the plate. Apply shim compound layer to the sheet detail approximately 0.015 inch (0.38 mm) thick and assemble to the plate such that the centerlines of the plate and sheet coincide (See Figure 4). Apply a pressure of 10 psi (69 kPa) uniformly to the sheet. Allow assembly to set at room temperature for 24 hours ± 0.5 prior to loading. Apply compression load at centerline of assembly, bearing directly upon sheet material over a 1 square inch (645 mm^2) area. The load shall be 30.0 ksi (207 MPa). The assembly shall be examined for failure of the compound. Cracking, chipping, or crushing of the compound is unacceptable.

4.5.5 Shim-Torque Panel: The test panel shall be prepared using 4 x 6 x 0.25 inch (102 x 152 x 6.4 mm) thick QQ-A-250/4-T851 aluminum alloy plates. The assembly will require NAS 1580A4T8 bolts, MS21042L4 nuts, and AN960 washers. An AMS 3667 polytetrafluoroethylene spacer, 0.040 inch (1.02 mm) thick, will also be required. Wipe the bonding surface with a suitable solvent to remove all surface dye and foreign materials. Apply a parting agent to one of the plates. To the other plate, apply a shim compound layer approximately 0.050 inch (1.27 mm) thick by 1.0 inch (25 mm) wide along the reference 6 inch (152 mm) dimension. Assemble the plates as shown in Figure 5, using the spacer at each end of the overlap. The plates are to be firmly clamped during cure. The assembly shall be set at room temperature until the resin is tack free but not more than 5 hours. Drill the assembly to a hole size of 0.250/0.255 inch (6.35/6.48 mm) on 0.50 inch (12.7 mm) centers as shown in Figure 5. The maximum diameter of the countersink shall be 0.502 inch (12.75 mm). Disassemble and deburr. Reassemble, installing bolts and nuts. Tighten the bolts to 125 inch-pounds (14 N·m). Allow the panel to set at room temperature for not less than 7 days prior to testing. The panel shall be cooled to -55°C (-67°F) until the thermocouple monitored glueline temperature reaches equilibrium temperature, then immediately moved into a circulating hot-air oven set to permit a glueline temperature of 132°C ± 2 (270°F ± 4). The panel shall be held at 132°C ± 2 (270°F ± 4) for 60 minutes ± 6. The assembly shall then be allowed to cool to room temperature. Check the breakaway torque of each fastener using the same torque wrench used to tighten them originally. Breakaway torque is the torque necessary to begin to move the nut when it is turned in the direction to tighten it. Each nut shall require at least 50% of the original torque to start nut movement.

4.6 Reports:

The vendor of the compound shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the compound conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3726A and the applicable detail specification number and revision letter, vendor's material designation, date of manufacture, and quantity.

4.6.1 A material safety data sheet conforming to AMS 2825, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of compound for production use. Each request for modification of compound formulation shall be accompanied by a revised data sheet for the proposed formulation.

4.7 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the compound may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the compound represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 The base compound/hardener shall be furnished as a kit packaged in individual containers, unless otherwise described in the detail specification.

5.1.2 Each unit package and each intermediate and exterior shipping container shall be legibly marked with not less than AMS 3726A and the applicable detail specification number, manufacturer's identification, lot number, quantity, date of manufacture, and any directions for mixing and use and precautions for handling and storage of toxic and hazardous materials.

5.1.3 Each exterior shipping container in the shipment shall contain the same type, number, and size of unit packages (or two-unit packages) supplied to the same purchase order number.

5.1.4 (R) Containers of compound shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the compound to ensure carrier acceptance and safe delivery.

5.1.5 (R) For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Commercial Level, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number and the applicable detail specification number and their revision letters, if any, in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Compound not conforming to this specification and the applicable detail specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia:

The (R) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Properties and dimensions in inch/pound units and the Celsius temperatures are primary; properties and dimensions in SI units and the Fahrenheit temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification and the applicable detail specification number
Size of base compound containers desired
Quantity of compound desired
Level A packaging, if required (See 5.1.5).

8.4 Similar Specifications:

MIL-S-83474 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.5 Compound meeting the requirements of this specification has been classified under Federal Supply Classification (FSC) 9330.

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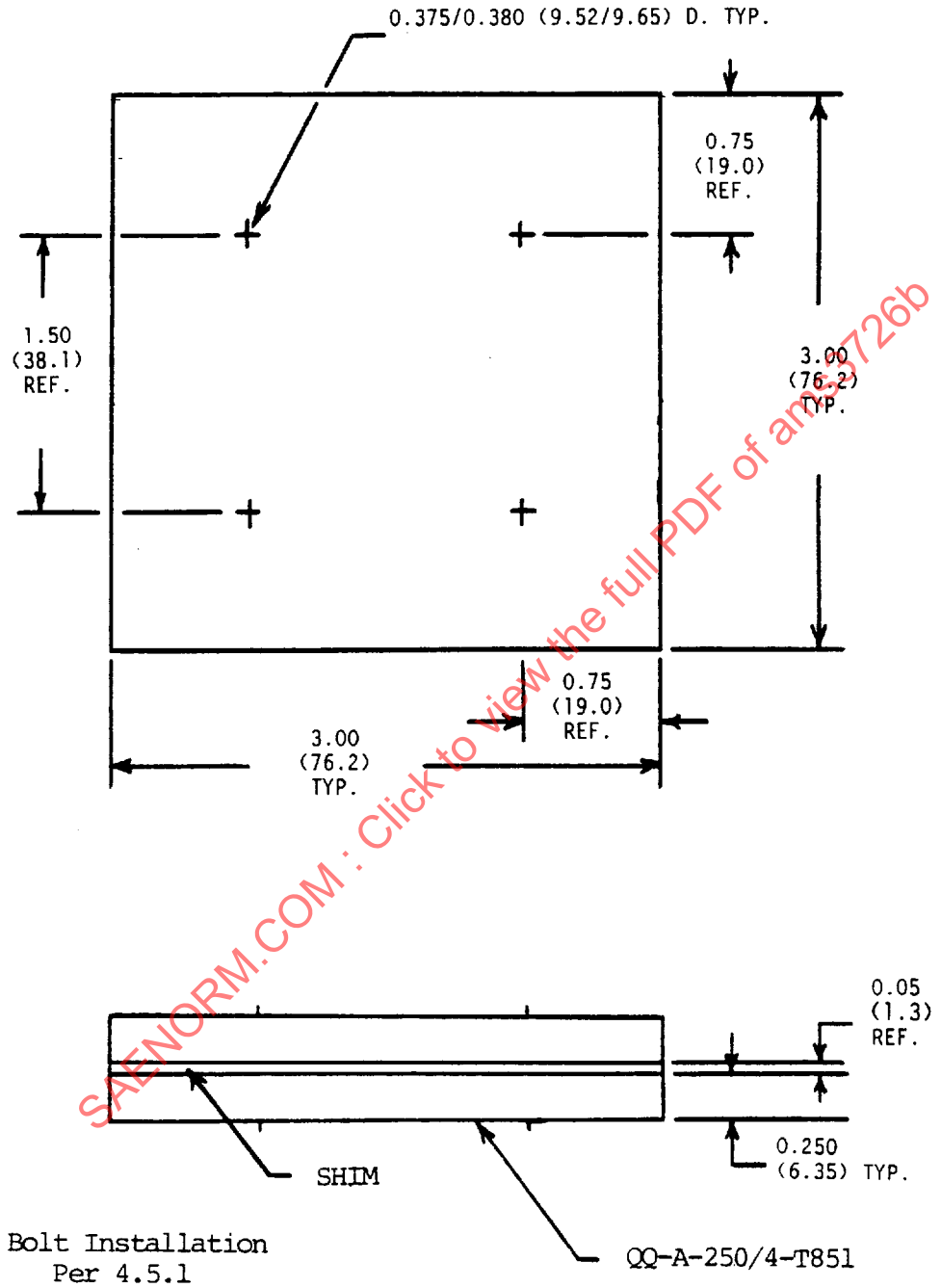

Dimensions are in inches (millimeters)

Figure 1. Test Panel for Curing Time