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Superseding AMS3726C

Shims, Filled Resin Compound

RATIONALE

OEM requested rapid, thin cross section, Curing Class 1 material to expedite production rate.

1. SCOPE

1.1 Form

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

1.2 Application

These products have been typically used 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. Each application should be considered individually.

1.3 Classification

Resin compounds covered by this specification are classified as follows:

Class 1: Two part epoxy or modified epoxy base with separate hardener or curing agent.

Type 1: Two part epoxy or modified epoxy, normal Cure cycle material: 5 hours after mixing at 75 °F ± 5 to reach Shore D Durometer Hardness of 55, determined in accordance with ASTM D 2240. At Shore D Durometer hardness of 55, fastener holes may be drilled and assemblies containing AMS3726D Class 1 Type 1 material may be disassembled without damage to the material.

Type 2: Two part epoxy or modified epoxy rapid cure cycle material: 2 hours after mixing at 75 °F ± 5 to reach Shore D Durometer hardness of 55, determined in accordance with ASTM D 2240. At Shore D Durometer hardness of 55, fastener holes may be drilled and assemblies containing AMS3726D Class 1 Type 2 material may be disassembled without damage to the material.

Class 2: Precatalyzed epoxy or modified epoxy base polymer supplied in sheet form.

Class 3: Precatalyzed epoxy or modified epoxy base polymer supplied as a liquid in a tube or other suitable container.

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## 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 issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

### 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

ARP1524	Surface Preparation and Priming of Aluminum Alloy Parts for High Durability Structural Adhesive Bonding
AMS3091	Mold Release Agent
AMS3167B	Solvents, Wipe for Cleaning Prior to Application of Primer and Top Coat Materials, or Sealing Compounds
AMS3667	Polytetrafluoroethylene (PTFE) Sheet, Molded, General Purpose Grade, As Sintered
AMS3894/2	Carbon Fiber Tape and Sheet, Epoxy Resin Impregnated, G 150,000 (1034) Tensile, 20,000,000 (138) Modulus, 175 (347)
AMS-QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet

### 2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

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	Apparent Shear Strength of Single-Lap-Joint by Tension Loading (Metal to Metal) Adhesively Bonded Metal Specimens
ASTM D 1151	Effect of Moisture and Temperature on Adhesive Bonds
ASTM D 2240	Rubber Property - Durometer Hardness
ASTM D 3165	Strength Properties of Adhesives in Shear by Tension Loading of Single-Lap-Joint Laminated Assemblies
ASTM D 3530	Volatiles Content of Carbon-Fiber-Epoxy Prepreg

### 2.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MS33787 Wrenching Element, External Spline, Dimensions For

### 2.4 NAS Publications

Available from Aerospace Industries Association, Inc., 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, [www.aia-aerospace.org](http://www.aia-aerospace.org).

NAS 1580 Bolt, 100 Deg. Flush Reduced Head

NAS 1149 Washer, Flat (Inactive for Design)

NASM21042 Nut, Self Locking, 450 Deg.F, Reduced Hexagon, Reduced Height, Ring Base, Non Corrosion Resistant

NASM 21084 Nut, Self Locking, 220 ksi Ft<sub>u</sub>, 450 Deg. F, Flanged, MS33787 Wrenching Element

NASM 21085 Nut, Self Locking, 260 ksi Ft<sub>u</sub>, 450 Deg F, Flanged, MS33787 Wrenching Element

NASM21296 Bolt, Tension, Steel, 260 ksi Ft<sub>u</sub>, 450 Deg F, External Wrenching , Spline Drive, Flanged Head

NASM21297 Bolt, Tension, Steel, 220 ksi Ft<sub>u</sub>, 450 Deg. F , External Wrenching, Spline Drive, Flanged Head

NASM35650 Nut, Plain Hexagon, Machine Screw, UNF2B

## 3. TECHNICAL REQUIREMENTS

### 3.1 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. Filler materials shall not include asbestos products and shall not cause corrosion of metallic parts.

3.1.1 Class 1 Type 1 and Type 2 materials shall be a two part liquid epoxy or modified epoxy base polymer supplied with a separate hardener or curing agent.

#### 3.1.1.1 Storage Life

Compound shall meet the requirements of this specification at any time up to one year from the date of receipt by purchaser when stored as two separate components in the original, unopened containers.

3.1.2 Class 2 shall be pre-catalyzed epoxy or modified epoxy base polymer supplied in sheet form.

#### 3.1.2.1 Storage Life

Sheets shall meet the requirements of this specification at any time up to six months from the date of receipt by purchaser when stored below -37 °C (-35 °F) in the original, unopened containers.

3.1.2.2 Refrigerated shipping is required consistent with storage requirements.

3.1.2.3 The precatalyzed sheet shall be kept frozen at all times until immediately prior to application.

3.1.2.4 Compound which has thawed shall not be refrozen.

3.1.3 Class 3 shall be a pre-catalyzed epoxy or modified epoxy base polymer supplied as a liquid in a tube or other suitable container.

#### 3.1.3.1 Storage Life

Precatalyzed liquid shall meet the requirements of this specification at any time up to six months from the date of receipt by purchaser when stored below  $-37\text{ }^{\circ}\text{C}$  ( $-35\text{ }^{\circ}\text{F}$ ) in the original, unopened containers.

3.1.3.2 Refrigerated shipping is required consistent with storage requirements.

3.1.3.3 The pre-catalyzed compound shall be kept frozen at all times until immediately prior to application.

3.1.3.4 Compound which has been thawed shall not be refrozen.

#### 3.1.4 Working Life

When resin base and hardener of Class 1, Type 1 material are mixed in accordance with manufacturer's instructions, the compound shall have a usable working life of 30 to 60 minutes at  $75\text{ }^{\circ}\text{F} \pm 5$ . When resin base and hardener of Class 1 Type 2 material are mixed in accordance with manufacturer's instructions, the compound shall have a usable working life of 15 to 25 minutes at  $75\text{ }^{\circ}\text{F} \pm 5$ . The working life of Class 2 and Class 3 compounds supplied as frozen premixes shall not be less than 30 minutes following thawing in accordance with manufacturer's instructions.

3.1.4.1 Rapid thawing (within 10 to 15 minutes) of Class 2 and Class 3 frozen premixed compounds will be required to prevent loss of working life. The purchaser should recognize that a facility to accomplish a rapid thaw will be required near the assembly area.

#### 3.1.5 Viscosity

Class 1, Type 1 and Type 2 and Class 3 liquids shall be workable and spreadable pastes and Class 2 sheet shall be tacky when thawed and now shall not sag or drip when applied to a vertical or overhead surface in thickness up to 0.05 inch (1.3 mm).

#### 3.1.6 Volatile Content

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  $175\text{ }^{\circ}\text{C}$  ( $347\text{ }^{\circ}\text{F}$ ).

#### 3.1.7 Curing Time

The product 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  $21\text{ }^{\circ}\text{C}$  ( $70\text{ }^{\circ}\text{F}$ ) 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.

### 3.2 Cured Properties

The product shall conform to the requirements of Table 1 and 3.2.9. Tests shall be performed at  $20\text{ to }30\text{ }^{\circ}\text{C}$  ( $68\text{ to }86\text{ }^{\circ}\text{F}$ ), unless otherwise specified. Values for strength tests shall be the average of five specimens for each test.

TABLE 1

Paragraph	Property	Requirement	Test Method
3.2.1	Hardness, Durometer D or equivalent, min average	92	ASTM D 2240
3.2.2	Specific Gravity, max	1.60	ASTM D 792
3.2.3	Coefficient of Linear Thermal Expansion, max average -62 to +93 °C (-80 to +199 °F)	5.4 x 10 <sup>-5</sup> mm/mm per °C (3.0 x 10 <sup>-5</sup> inch/inch per °F)	ASTM D 696
3.2.4	Lap Shear Strength, min average	13.8 MPa (2000 psi)	ASTM D 1002
3.2.5	Lap Shear Residual Strength, Exposed, min average		
3.2.5.1	Salt Spray, 30 days at 50 °C ± 2 (122 °F ± 2)	10.3 MPa (1500 psi)	ASTM B 117
3.2.5.2	Condensing Humidity, 30 days at 60 °C ± 1 (140 °F ± 2)		ASTM D 1151
3.2.5.2.1	Classes 1 and 2	11.7 MPa (1700 psi)	
3.2.5.2.2	Class 3	12.4 MPa (1800 psi)	
3.2.5.2.3	JP-4 Fuel, 7 days at 60 °C ± 1 (140 °F ± 2)	12.4 MPa (1800 psi)	ASTM D 3165
3.2.6	Strain Compatibility, Tensile, Constant Amplitude Cycling		
3.2.6.1	Aluminum alloy	20 cycles without failure at -55 °C ± 1 (-67 °F ± 2)	4.5.2
3.2.6.2	Graphite-epoxy laminate	20 cycles without failure at -55 °C ± 1 (-67 °F ± 2)	4.5.3
3.2.7	Flatwise Compressive Strength, min	30.0 ksi (207 MPa) stress without failure	4.5.4
3.2.8	Shim-Torque Test, breakaway torque, individual bolt, min.	50% of initial applied torque	4.5.5

3.2.1 Strain compatibility test with graphite-epoxy test coupon 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.

### 3.3 Quality

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

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The manufacturer shall supply all samples and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

### 4.2 Classification of Tests

#### 4.2.1 Acceptance Tests

Requirements shown in Table 2 are acceptance tests and shall be performed on each lot.

TABLE 2 - ACCEPTANCE TESTS

Requirements	Paragraph Reference
Working Life	3.1.4
Viscosity	3.1.5
Specific Gravity	3.2.2
Flatwise Compression Strength	3.2.7

#### 4.2.2 Preproduction Tests

All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of compound by the manufacturer. Any 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 When material from Class 2 is used for preproduction testing, the thickness shall be as specified by the specific test method. The total thickness for test purposes may be obtained by stacking sheets of lesser thickness.

#### 4.3 Sampling and Testing

##### 4.3.1 For Acceptance Tests

Sufficient product shall be taken at random from each lot 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 from the same batches of raw materials processed in one continuous run and presented for manufacturer's inspection at one time.

4.3.1.2 A statistical sampling plan acceptable to purchaser, may be used in lieu of sampling as in 4.3.1.

##### 4.3.2 For Preproduction Tests

Acceptable to purchaser.

#### 4.4 Approval

4.4.1 Sample product shall be approved by purchaser before product 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. Production compound made by the revised procedure shall not be shipped prior to receipt of reapproval. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample compound.

4.4.2 Manufacturer 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.

#### 4.5 Test Methods

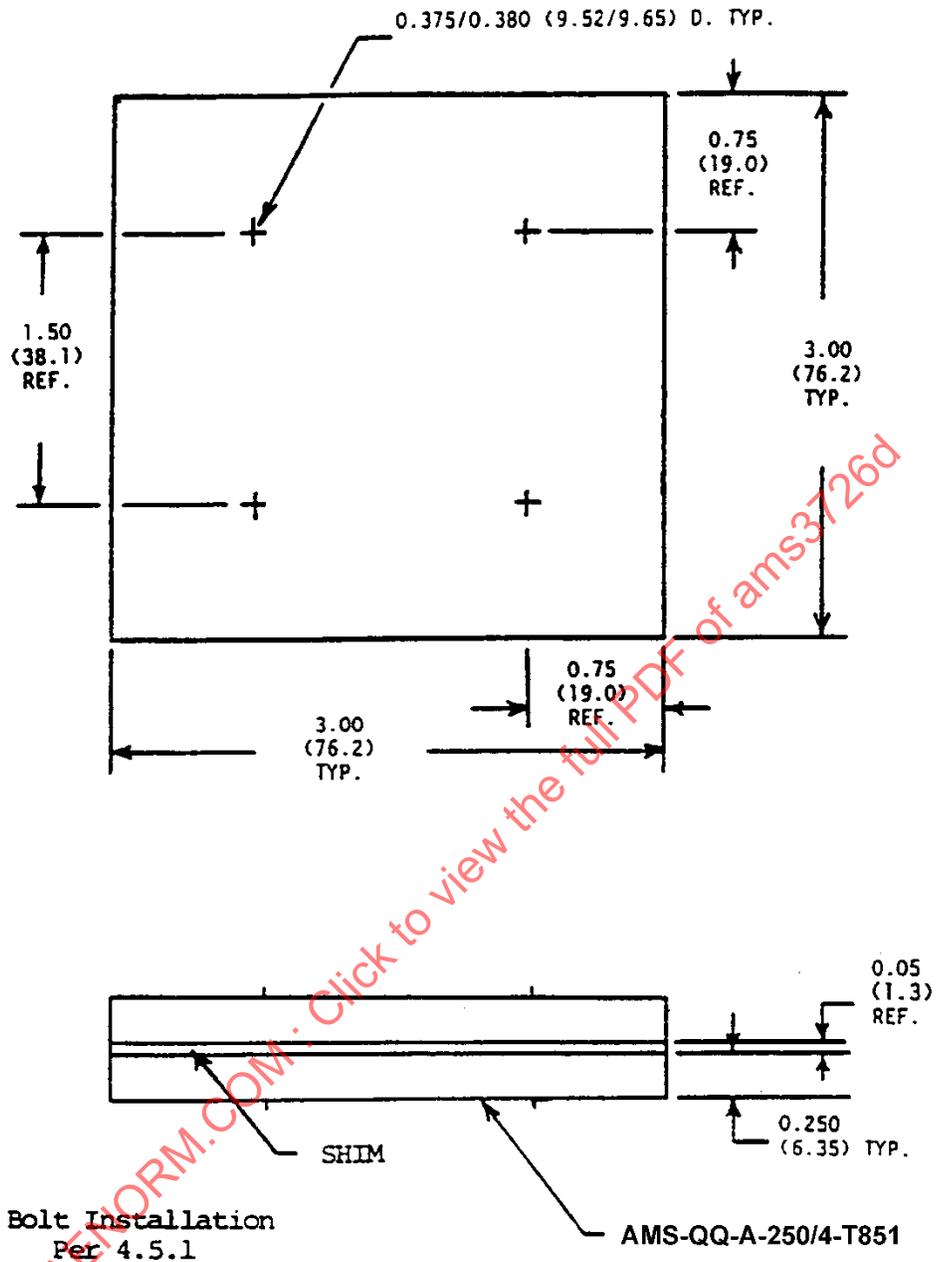
Shall be in accordance with Table 1 and the following:

##### 4.5.1 Curing Time

Prepare two AMS-A-250/4-T851 aluminum alloy plates 76 x 76 x 6.35 mm (3 x 3 x 0.250 inch). Drill four holes through the plates for installation of MS21296-06008 or MS21297-06008 bolts. Hole size shall be 9.525/9.652 mm (0.375/0.380 inch). The hole centerlines shall be located 19.0 mm (0.75 inch) from the two nearest plate edges. The dimension between adjacent holes shall be 38 mm (1.5 inch) referenced dimension. Refer to Figure 1. Deburr all holes and plate edges. Prepare plates for application of compound in accordance with ARP1524. The faying surface of one plate and the bolts shall be coated with AMS3091 or other suitable release agent. Apply the compound to a thickness of approximately 1.3 mm (0.05 inch) 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  $\pm$  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 plates 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 AMS-QQ-A-250/4-T81 aluminum alloy plates 89 x 152 x 4.06 mm (3.5 x 6.0 x 0.160 inch). Prepare for application of compound in accordance with ARP1524. The faying surface of one plate shall be coated with AMS3091 or other suitable release agent. Apply the compound to a thickness of approximately 0.38 mm (0.015 inch) to the opposite plate in an area 38.1 mm (1.50 inch) wide parallel to the 152 mm (6 inch) long edge (See Figure 2). 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 69 kPa (10 psi). Clean compound squeezed from overlap area from assembly prior to hardening. Allow compound to set at room temperature for 5 hours  $\pm$  0.2 prior to further preparation. Keeping plates clamped tightly, drill two lines of 8 holes parallel to the long plate dimension. Edge and side distance for holes shall be 9.52 mm (0.375 inch) 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 4.813/4.902 mm (0.1895/0.1930 inch) 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 7.75 mm (0.305 inch). Disassemble the plates, deburr holes, and check compound for cracks or chips. The presence of cracks or chips is unacceptable and cause for rejection of the specimen. Reassemble plates. Install 16 NAS 1580A3T6 bolts using MS21042L3 nuts and AN 960 washers. Tighten bolts to 5.65 N·m (50 inch-pounds). Cut the plates into four equal width coupons as shown in Figure 2. 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 2.5 mm (0.10 inch) per inch per minute. The load levels shall be set for a maximum stress (outside of the joint area) of 138 MPa (20.0 ksi) and a minimum stress of 13.8 MPa (2.0 ksi). The test is acceptable if there is no failure of the compound under cyclic loading.



Dimensions are in inches (millimeters)

FIGURE 1 - TEST PANEL FOR CURING TIME

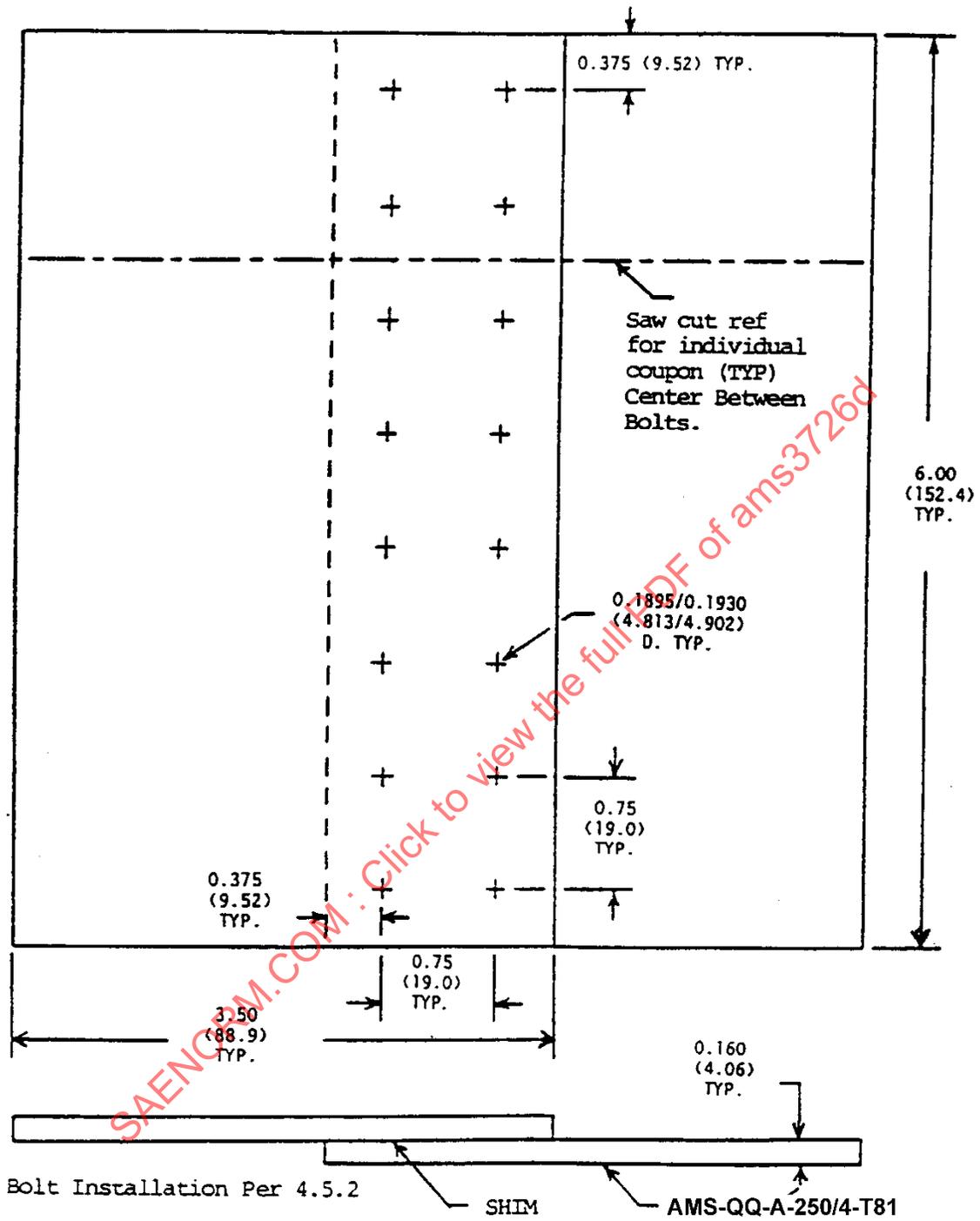


FIGURE 2 - TEST PANEL FOR STRAIN COMPATIBILITY COUPONS

#### 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 provided according to purchaser's production processing steps. When AMS3894/2 graphite tape is used, a 30-ply laminate of the following stacking orientation is recommended:

$$[(\pm 45^\circ)_2, (0^\circ/\pm 45^\circ)_3, (\pm 45^\circ)]_s \quad (\text{Eq. 1})$$

where the  $0^\circ$  dimension is parallel to the reference 89 mm (3.5 inch) 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.

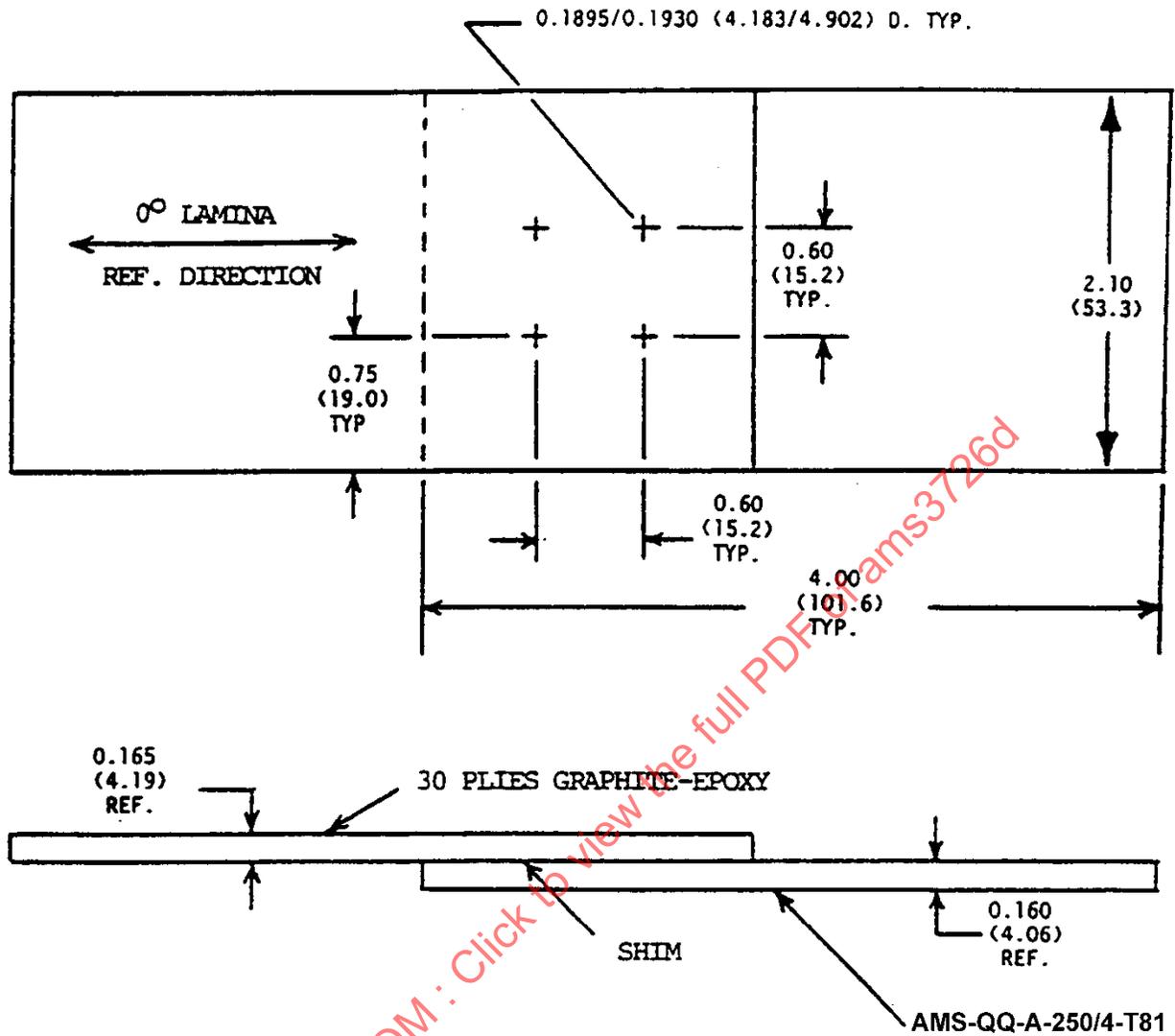
4.5.3.3 The aluminum plate shall have a release agent applied to prevent bonding.

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 117 MPa (17.0 ksi) maximum to 11.7 MPa (1.7 ksi) minimum, based on the stress in the aluminum plate outside of the joint area.

#### 4.5.4 Flatwise Compressive Strength

Prepare two AMS-QQ-A-250/4 aluminum alloy plates, one to be a 102 x 152 x 12.7 mm (4 x 6 x 0.500 inch) -T851 plate and the other to be 25 x 127 x 3.18 mm (1 x 5 x 0.125 inch) -T81 sheet. Prepare the plates in accordance with ARP1524. Apply AMS3091 or other suitable release agent to faying surface of the plate. Apply shim compound layer to the sheet approximately 0.38 mm (0.015 inch) thick and assemble to the plate such that the centerlines of the plate and sheet coincide (See Figure 4). Apply a pressure of 69 kPa (10 psi) uniformly to the sheet. Allow assembly to set at room temperature for 24 hours  $\pm$  0.5 prior to loading. Apply compression load at centerline of assembly, bearing directly upon sheet material over a 645 mm<sup>2</sup> (1 square inch) area. The load shall be 207 MPa (30.0 ksi). The assembly shall be examined for failure of the compound. Cracking, chipping, or crushing of the compound is unacceptable.



Dimensions are in inches (millimeters)

Prepare Laminate Per 4.5.3  
Bolt Installation Per 4.5.2

FIGURE 3 - LAMINATE STRAIN COMPATIBILITY COUPON

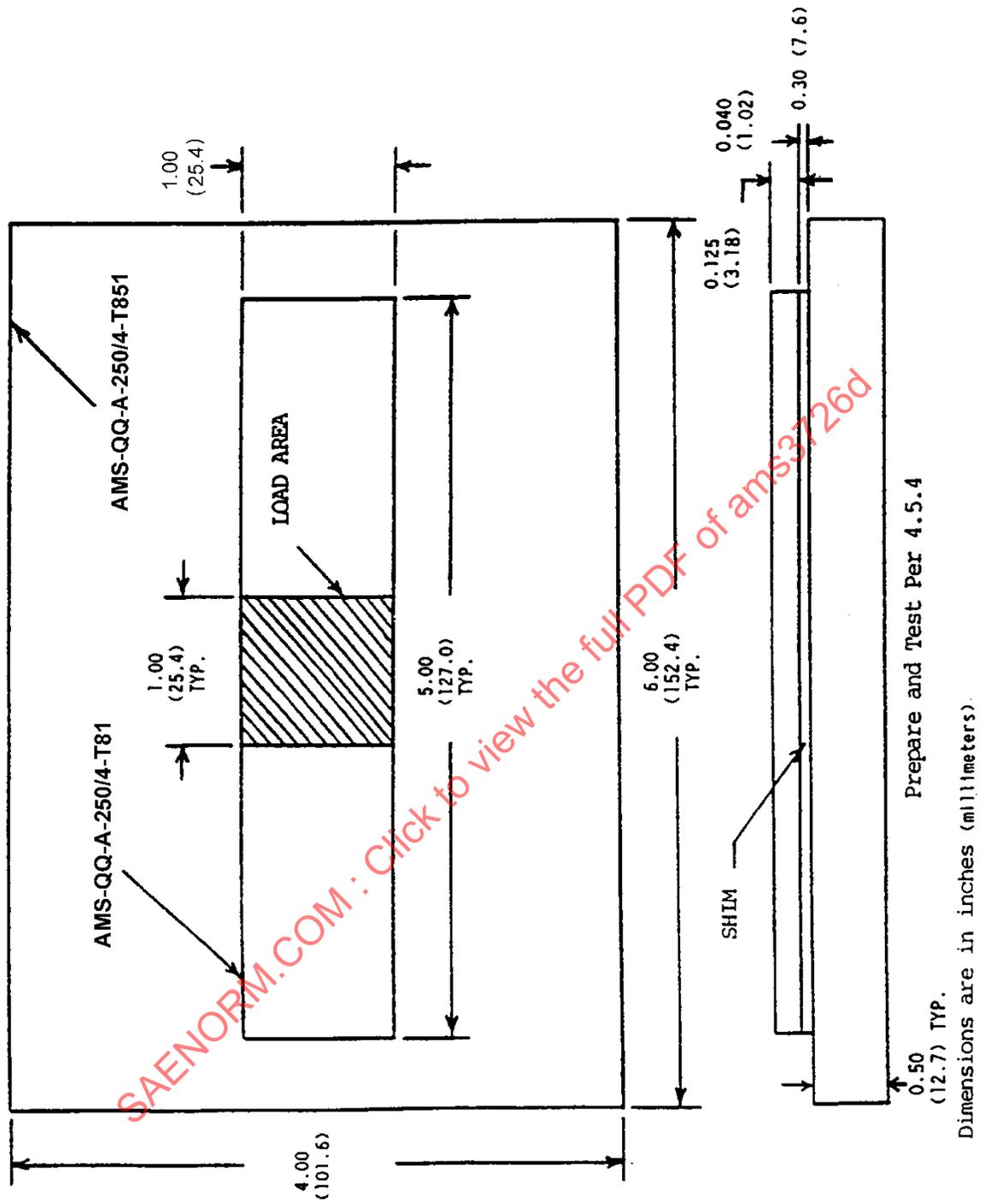


FIGURE 4 - FLATWISE COMPRESSIVE STRENGTH COUPON