SAE The Engineering Resource For Advancing Mobility
400 COMMONWEALTH DRIVE WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 3726

Issued 10-1-83
Revised

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: Primarily for use as a molded shim during assembly of aircraft components and parts with good flatwise compression properties and adhesion to metallic or nonmetallic materials. 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.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Recommended Practices (ARP) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
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 (Graphite) Fiber Tape and Sheet, Epoxy Resin Impregnated, G150,000 (1034) Tensile, 20,000,000 (138) Modulus, 175 (350)

2.1.2 Aerospace Recommended Practices:

ARP 1524 - Surface Preparation and Priming of Aluminum Alloy Parts for High Durability Structural Adhesive Bonding, Phosphoric Acid Anodizing

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM D696 - Coefficient of Linear Thermal Expansion of Plastics
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D1002 - Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)
ASTM D1151 - Effect of Moisture and Temperature on Adhesive Bonds
ASTM D1655 - Aviation Turbine Fuels
ASTM D2240 - Rubber Property - Durometer Hardness
ASTM D3165 - Strength Properties of Adhesives in Shear by Tension Loading of Laminated Assemblies
ASTM D3530 - Volatiles Content of Carbon Fiber-Epoxy Prepreg

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Specifications:

QQ-A-250/4 - Aluminum Alloy 2024, Plate and Sheet

2.3.2 Military Specifications:

MIL-S-83474 - Shims, Molded, Filled Resin Compound and Sheet Prepreg

2.3.3 Military Standards:

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
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

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

NAS 1580 - Bolt, 100 Deg. Flush Tension Head, Sep 71 W/DOD Exceptions

3. TECHNICAL REQUIREMENTS:

3.1 Detail Specifications: The requirements for a specific filled resin compound shall consist of all the requirements specified herein in addition to the requirements specified in the applicable detail specification. In case of conflict between the requirements of this basic specification and an applicable detail specification, the 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 (40°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 Work Life: When resin base and hardener are mixed in accordance with manufacturer's instructions, the compound shall have a usable work life of not shorter than 30 min. and not longer than 1 hour. The work life of compound supplied as frozen premixes shall be not less than 30 min. following thawing in accordance with manufacturer's instructions.

3.2.2.1 Rapid thawing (within 10 to 15 min.) 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 in. (1.25 mm).

3.2.4 Volatile Content: The compound shall be essentially 100% solids. A measurable volatile content (weight loss) of up to 0.5% is acceptable for heat exposure up to 175°C (350°F).

3.2.5 Curing Time: The compound when applied up to (1.25 mm) 0.05 in. thickness between metal plates shall have sufficient strength after curing for not more than 5 hr at not lower than 21°C (70°F) to permit tightening of 0.375 in. (9.55 mm) diameter bolts to 360 in.-lb (40.7 N·m) in a typical bolted pattern without cracking or chipping of the shim material.

3.3 Cured Properties: The compound, prepared in accordance with the test methods specified in 4.5 or the detail specification, shall have properties as specified in the individual detail specifications. Unless otherwise specified, tests shall be performed at 20° to 30°C (70° to 85°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 the 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, clean, and free from foreign materials detrimental to usage of the compound.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the compound shall supply all samples for vendor's tests and shall be responsible for performing all required tests, unless otherwise noted. Results of such tests shall be reported to the purchaser as required by 4.6. 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 to determine conformance to requirements for specific gravity, work life, viscosity, flatwise compression strength, and quality (3.4) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification and the applicable detail specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of compound to a purchaser, when a change in material or processing, or both, 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, the contracting officer, or the request for procurement.

4.3 Sampling: 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 450 kg (1000 lb) of compound and may be packaged in smaller quantities under a basic lot approval provided the lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) for the compound have been agreed upon by purchaser and 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 material or processing, or both, 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:

Requirement	Test Method
Viscosity	3.2.3
Volatile Content	ASTM D3530
Curing Time	4.5.1
Hardness	ASTM D2240
Specific Gravity	ASTM D792
Thermal Expansion	ASTM D696
Lap Shear Strength	ASTM D1002
Residual Lap Shear Strength, Salt Spray	ASTM B117
Residual Lap Shear Strength, Humidity	ASTM D1151
Residual Lap Shear Strength, JP-4	ASTM D3165
Strain Compatibility, Aluminum	4.5.2
Strain Compatibility, Graphite-epoxy	4.5.3
Flatwise Compression Strength	4.5.4
Shim-Torque Panel	4.5.5

4.5.1 Curing Time: Prepare two QQ-A-250/4-T851 aluminum alloy plates 3.00 x 3.00 x 0.250 in. (75 x 75 x 6.25 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 in. (9.525/9.652 mm). The hole centerlines shall be located 0.75 in. (19.0 mm) from the two nearest panel edges. The dimension between adjacent holes shall be 1.50 in. (38 mm) referenced dimension. Refer to Fig. 1. Deburr all holes and panel edges. Prepare plates for application of compound in accordance with ARP 1524. 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 in. (1.25 mm) to the other plate. Assemble the two plates. Install bolts and nuts. Use MS35640-202 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 hr ± 0.2. Remove nuts and replace with MS21084L06 or MS21085L06 nuts. Tighten bolts to 360 in.-lb (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 3.50 x 6.00 x 0.160 in. (90 x 150 x 4 mm) thick. Prepare sheets for application of compound in accordance with ARP 1524. The faying surface of one plate shall be coated with a suitable release agent. Apply the compound to a thickness of approximately 0.015 in. (0.38 mm) to the opposite plate in an area 1.50 in. (38 mm) wide parallel to the reference 4.95 in. (125 mm) dimension. Assemble the plates such that the area coated with release agent of one plate overlaps the compound. Refer to Fig. 2. Apply uniform pressure 10 psi (0.069 MPa). Clean compound squeezed from overlap area from assembly prior to hardening. Allow compound to set at room temperature for 5 hr ± 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 in. (9.50 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 in. (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 in. (7.75 mm). Disassemble the panels, deburr holes, and check compound for cracks or chips which are unacceptable and cause for rejection. Reassemble panels. Install 16 bolts using MS21042L3 nuts and AN 960 washers. Tighten bolts to 50 in.-lb (5.65 N·m). Cut the panel into four equal width coupons normal to the reference 4.95 in. (125.0 mm) dimension. An individual coupon shall be an overlap bolted joint with four bolts per coupon. Refer to individual coupon dimensions of Fig. 2. The coupons shall be loaded in tension-tension (constant amplitude) cycling for 20 cycles at -65°F (-55°C) at a deflection rate of 0.10 in./min. (2.5 mm/min). The load levels shall be set for a maximum stress (outside of the joint area) of 20,000 psi (138 MPa) and a minimum stress of 2,000 psi (13.8 MPa). The test is acceptable if there is no failure of the compound under cycling 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 in. (87.5 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 Fig. 3.

4.5.3.5 The load levels for the tension-tension cycling shall be 17,000 psi (117 MPa) maximum to 1,700 psi (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 in. (100 x 150 x 12.5 mm) thick -T851 plate and the other to be 1 x 5 x 0.125 in. (25 x 125 x 3 mm) thick -T851 sheet. Prepare the details in accordance with ARP 1524. Apply release agent to faying surface of the plate. Apply shim compound layer to the sheet detail approximately 0.015 in. (0.35 mm) thick and assemble to the plate such that the centerlines of the plate and sheet coincide (See Fig. 4). Apply a pressure of 10 psi (0.069 MPa) uniformly to the sheet. Allow assembly to set at room temperature for 24 hr ± 0.5 prior to loading. Apply compression load at centerline of assembly, bearing directly upon sheet material over a 1 sq in. (645 mm^2) area. The load shall be 30,000 psi (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 in. (100 x 150 x 6.2 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 in. (1.0 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 in. (1.25 mm) thick by 1.0 in. (25 mm) wide along the reference 6 in. (150 mm) dimension. Assemble the plates as shown in Fig. 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 for not more than 5 hours. Drill the assembly to a hole size of 0.250/0.255 in. (6.35/6.45 mm) on 0.50 in. (12.5 mm) centers as shown in Fig. 5. The maximum diameter of the countersink shall be 0.502 in. (12.75 mm). Disassemble and deburr. Reassemble, installing bolts and nuts. Tighten the bolts to 125 in.-lb (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 (-65°F) until the thermocouple monitored glueline temperature reaches equilibrium temperature, then immediately moved into a hot-air-circulating oven set to permit a glueline temperature of 270°F ± 5 (132°C ± 2). The panel shall be held at 270°F ± 5 (132°C ± 2) for 60 min. ± 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 three copies of 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 of this specification and the applicable detail specification. This report shall include the purchase order number, AMS 3726 and applicable detail specification number, vendor's material designation, lot number, 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 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 and no additional testing shall be permitted. 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 3726 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 Containers 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. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.5 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1, 5.1.3, and 5.1.4 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and the applicable detail specification number 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:

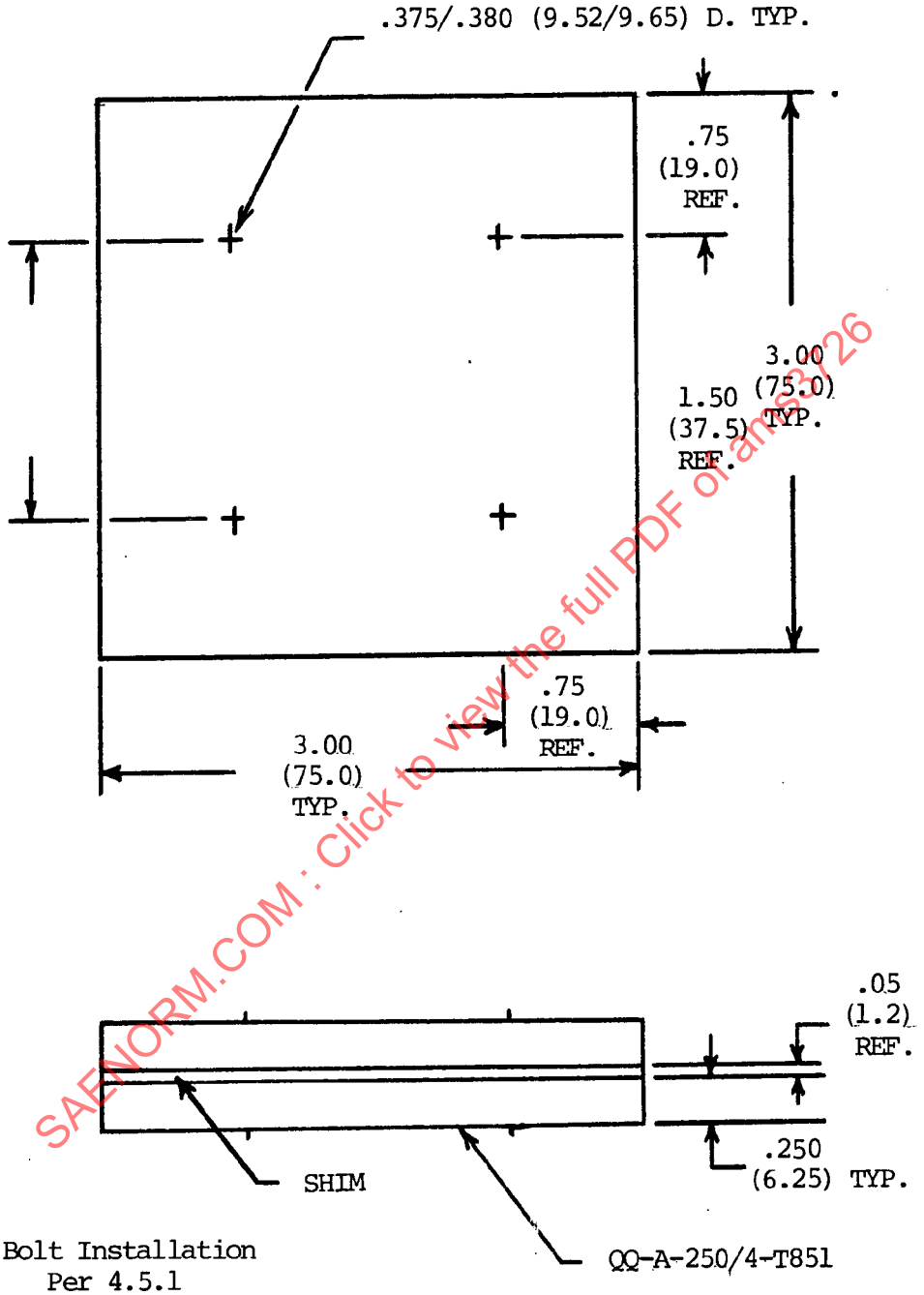
8.1 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification and the applicable detail specification number
Size of base compound containers desired
Quantity of compound desired
Applicable level of packaging (See 5.1.5)

8.2 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.

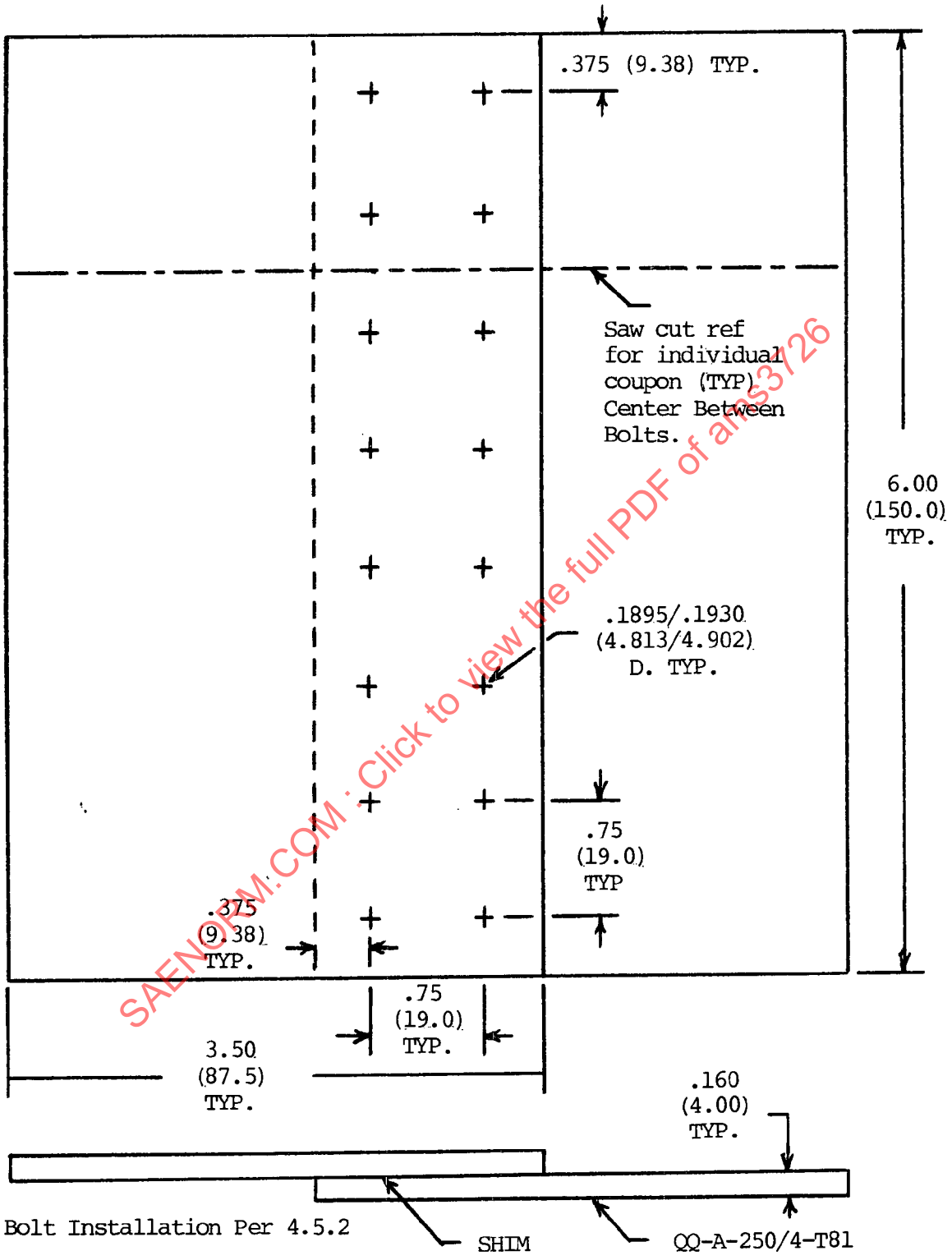
8.3 Compound meeting the requirements of this specification has been classified under Federal Supply Classification (FSC) 9330.

This specification and its detail specifications are under the jurisdiction of AMS Committee "C" (NOMETCOM).



Dimensions are in inches (millimetres)

Figure 1. Test Panel for Curing Time



Dimensions are in inches (millimetres)

Figure 2. Test Panel for Strain Compatibility Coupons