

INCH-POUND

MIL-A-62473B(AT)
30 November 1992
 SUPERSEDING
 MIL-A-62473A(AT)
 30 March 1984

MILITARY SPECIFICATION

ARMOR: ALUMINUM-ARAMID, LAMINATE COMPOSITE

This specification is approved for use by the US Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the bonding of an aluminum plate to an aramid laminate pad to form a composite armor plate.

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 MILITARY

MIL-C-5541	- Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-S-8802	- Sealing Compound, Temperature-Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion.
MIL-P-23377	- Primer Coatings: Epoxy-Polyamide; Chemical and Solvent Resistant.
MIL-A-46027	- Armor Plate, Aluminum Alloy, Weldable 5083 and 5456.
MIL-P-46593	- Projectiles, Calibers .22, .30, .50, and 20mm, Fragment-Simulating.
MIL-L-62474	- Laminate: Aramid-Fabric-Reinforced, Plastic.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 9535

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STANDARDS
MILITARY

- MIL-STD-372 - Welding, Gas Metal-Arc and Gas Tungsten-Arc, Aluminum Alloys, Readily Weldable for Structures, Excluding Armor.
- MIL-STD-662 - V₅₀ Ballistic Test for Armor.

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

2.2 Non-Government publications. The following documents form part of this document to the extent specified herein. Unless otherwise specified, the issue of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issue of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D897 - Standard Test Method for Tensile Properties of Adhesive Bonds.

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

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents may also be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified, the contractor shall furnish test-size armor plates (see 3.3.2) which shall be subjected to first article inspection (see 4.3). First article samples, properly marked with identifying information shall be representative of the unit to be furnished to the Government. All subsequent armor plates delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes. Any change in type or manufacturer of the bonding agent or change in the method of bonding shall require a resubmittal of the first article.

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3.2 Materials. Materials shall be as specified herein and in referenced specifications, standards, and drawings. Materials shall be free of defects which adversely affect performance or serviceability of the finished product (see 4.1.2).

3.2.1 Qualified products. The contractor shall be responsible for using materials from Qualified Products Lists (QPLs) when applicable. Contractor's inspection records shall specifically list all QPL items by number and date of the QPL, name of supplier, and part or drawing number(s). When materials are approved as qualified products, but not yet listed on the QPL, the contractor shall list the products by number and date of the approved document and name of supplier(s) (see 4.1.2).

3.2.2 Aluminum component. The aluminum component of the armor plate shall be aluminum alloy 5083 conforming to MIL-A-46027 (see 4.1.2).

3.2.3 Aramid laminate component. The aramid fabric-reinforced plastic laminate component of the armor plate shall conform to MIL-L-62474 (see 4.1.2).

3.2.4 Bonding agent. The sealing compound used to bond the aluminum component to the aramid laminate component shall conform to type I or II, class B-2 of MIL-S-8802 (see 4.1.2).

3.3 Construction (fabrication).

3.3.1 Aluminum plate surface preparation. All surfaces of the aluminum alloy plate shall be thoroughly cleaned to remove all traces of surface contaminants. Subsequently the plate shall be prepared as follows (see 4.4.3):

a. Sand-blasting the bonding surface or

b. (1) Clean and treat the aluminum plate in accordance with class 1A of MIL-C-5541.

(2) Prime with epoxy conforming to MIL-P-23377. Dry film thickness shall not be less than 0.0010 inch [0.025 millimeters (mm)] and not more than 0.0015 inch (0.038 mm).

3.3.1.1 Cleanliness. After preparation in accordance with 3.3.1, the aluminum plate shall be kept in a dust, dirt, and moisture-free environment. The surface to be bonded shall not come in contact with hands or fingers (see 4.4.3).

3.3.2 Component dimensions.

3.3.2.1 Test component dimensions.

a. Ballistic test samples. Test components shall be bonded

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armor plate. The aramid pad, 20 inch by 20 inch (508mm by 508mm), shall be bonded to the aluminum plate, 24 inch by 24 inch (610mm by 610mm), so that there is a 2-inch (51mm) border all around. The thickness of the aluminum plate and number of aramid plies shall be as specified on the drawing or order (see 6.2).

- b. Bondind pull test samples. Test components shall be prepared to the dimensions shown in figure 1 using the bonding procedures of 3.3.3. The number of plies shall be as specified on the drawing or order (see 6.2).

3.3.2.2 Production component dimensions. Component dimensions for armor plates produced for delivery under the contract shall be as specified on the drawing or acquisition document (see 6.2).

3.3.3 Bonding of components.

3.3.3.1 Time element. The aramid laminate pad shall be bonded to the aluminum plate within 24 hours of surface treatment (see 4.4.3).

3.3.3.1.1 Peel-ply removal. The peel-ply is to be removed from the bonding surface of the aramid laminate pad just prior to application of the bonding agent conforming to 3.2.4 (see 4.4.3).

3.3.3.2 Surfaces. Bonding surfaces shall be re-checked for cleanliness prior to application of bonding agent. Either mating surface shall have a uniform thickness, 0.06 inch +0.03, -0 inch (1.5mm +0.76, -0mm), of the bonding agent applied over the entire area of the bonding surface. The bonding agent shall have been thoroughly mixed in accordance with manufacturer's instructions (see 4.4.3).

3.3.3.3 Mating. The components shall be mated and placed under pressure in a holding device capable of exerting a uniform pressure on the assembly (see 4.4.3).

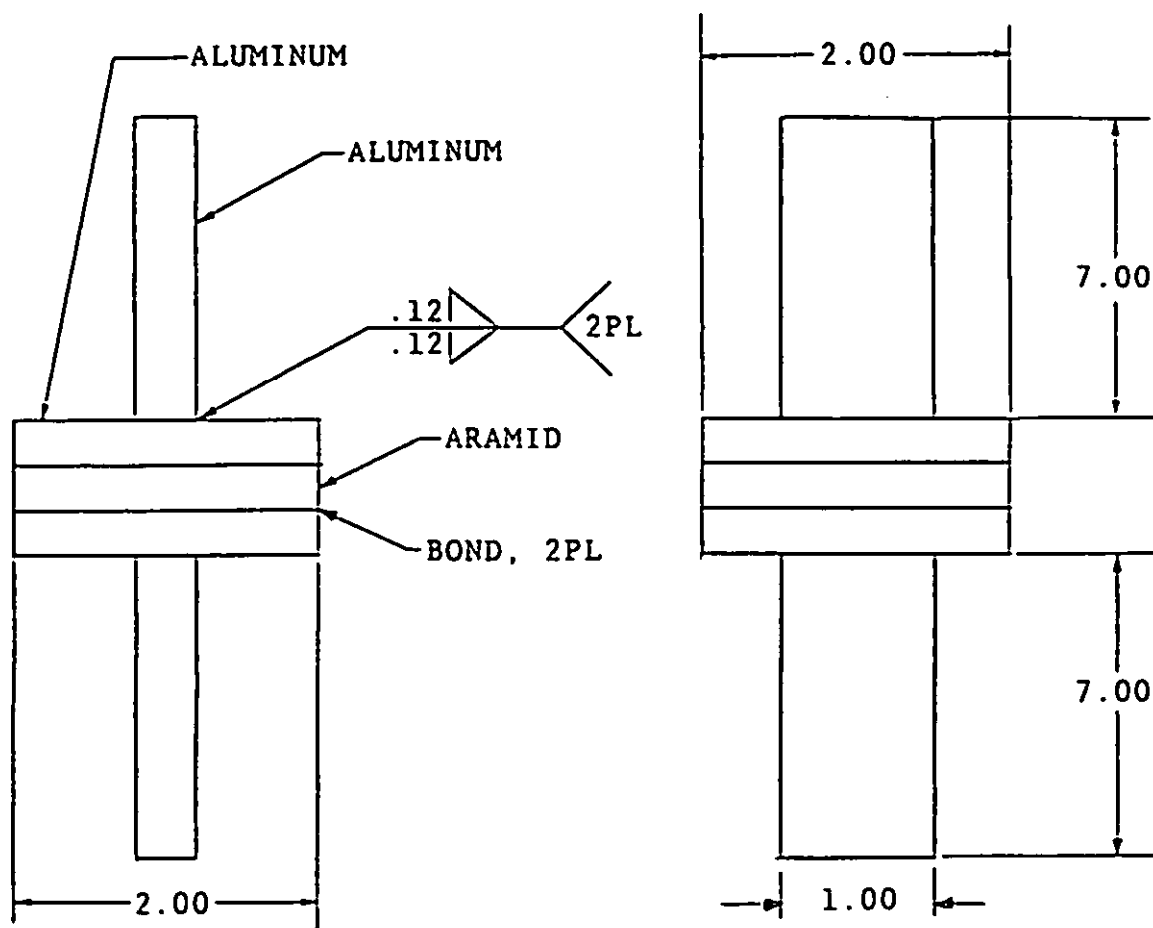
3.3.3.4 Curing. The mated parts shall be kept under pressure as specified in the applicable drawing in the holding device and cured for not less than 24 hours, in ambient conditions of 77 degrees Fahrenheit ($^{\circ}\text{F}$) $\pm 2^{\circ}\text{F}$ [25 degrees Celsius ($^{\circ}\text{C}$) $\pm 1^{\circ}\text{C}$]. Higher temperatures up to 130 $^{\circ}\text{F}$ (54 $^{\circ}\text{C}$) may be used to hasten cure, provided ballistic requirements are met (see 3.4.1 and 4.4.3).

3.4 Performance.

3.4.1 Ballistic resistance. The aluminum-aramid composite armor, for the thickness and plies indicated, shall meet the ballistic requirements of table I (see 4.4.4).

3.4.2 Bonding strength. The bonding pull test samples shall exhibit a minimum strength of 340 pounds, without separation of the bonding agent from either the aluminum or aramid surfaces or adhesive failure.

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NOTE: ALL ALUMINUM 3/8 THICK, WELD PER MIL-STD-372, CLASS OPTL

Figure 1. Bending Full Test Sample

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TABLE I. Ballistic Requirements.

Minimum required Ballistic Limits CAL .50 (207 Grains) Fragment Simulating Projectile (FSP)* at 0° obliquity Aluminum-Aramid Composite Armor, aluminum thickness 0.375 in (9.53mm).					
Aramid (Plies)	V ₅₀	Protection Ballistic Limit**	Aramid (Plies)	V ₅₀	Protection Ballistic Limit**
26		2619	31		2843
27		2665	32		2886
28		2710	33		2928
29		2755	34		2970
30		2799	35		3011
* In accordance with MIL-P-46593					
** Average of three ballistic limits, each made on a separate composite armor specimen.					

3.5 Finished armor. There shall be no visual evidence of improperly bonded areas in the completed product (see 4.4.2.1).

3.6 Workmanship. Workmanship shall be of such quality as to assure that armor plates furnished under the specification are free of defects that compromise, limit, or reduce performance in intended use (see 4.4.2.1).

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 (examinations and test) 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 the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility-for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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4.1.2 Materials. To determine conformance to 3.2 through 3.2.4, inspection and material certification records shall be maintained by the contractor. Records shall be subject to review by the Government and shall include date, part, or characteristic identification, inspection results, and disposition of lot (accepted or rejected). Corrective action taken on noted defects shall be subject to approval by the Government.

4.1.3 Parts and components. Components and assemblies shall be inspected for conformance to requirements of applicable drawings, specifications and standards. When applicable, inspection shall also be in accordance with Quality Assurance Provisions (QAPs).

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. First article inspections (see 4.3).
- b. Quality conformance inspection (see 4.4).
 - 1. Examination (see 4.4.2).
 - 2. In-process examination (see 4.4.3).
 - 3. Control test (see 4.4.4).

4.3 First article inspection. First article inspection shall be performed on preproduction or initial production samples as specified (see 6.2). Approval of the first article sample by the Government shall not relieve the contractor of the obligation to supply armor plates that are fully representative of those inspected as a first article sample. First article inspection shall be carried out on 4 test-sized samples having the dimensions specified in 3.3.2.1. The contractor shall conduct all in-process examinations as specified in the written application inspection procedure (see 4.4.3), as well as visual examination for proper workmanship (see 4.4.2.1). The samples will then be forwarded to the test site designated by the acquisition activity (see 6.2). The Government will test the ballistic samples against the requirements of 3.4.1 in accordance with 4.4.4.1 except that each first article sample must meet the V protection ballistic limit. Bonding pull test samples will be tested in accordance with ASTM D897. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.3.1 First article inspection failure. Failure of any first article sample to pass specified examinations or tests shall be cause for refusal by the Government to accept the product or conduct additional inspections until the faults identified have been corrected on all armor plates produced.

4.4 Quality conformance inspection.

4.4.1 Sampling.

4.4.1.1 Lot formation. An inspection lot shall consist of all the armor plate assemblies of one type and part number, from an

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identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.4.1.2 Sampling for examination. All armor plate assemblies shall be examined (see 4.4.2.1).

4.4.2 Quality conformance examination.

4.4.2.1 Visual examination. To determine conformance to 3.5 and 3.6, armor plate assemblies shall be visually examined for proper workmanship.

4.4.2.2 Examination failure. If any armor plate fails to pass any examination specified herein, the Government will stop acceptance until evidence has been provided by the contractor that corrective action has been taken.

4.4.3 In-process examination. To determine conformance to 3.3.1 through 3.3.3.4, the contractor shall initiate, perform and document on an essentially continuous basis, an in-process procedure consisting of process controls and examination criteria satisfactory to the Government.

4.4.4 Control test. During each 4-month interval of armor fabrication, the contractor shall provide three ballistic test samples and three bonding pull test samples having the dimensions specified in 3.3.2.1. Upon successful completion of all other quality conformance examinations, the contractor shall forward the samples to the test site designated by aquisitioning activity (see 6.2). The Government will test the ballistic test samples against the requirements of 3.4.1 and the bonding pull test samples against the requirements of 3.4.2.

4.4.4.1 Ballistic test. The ballistic resistance test shall be conducted in accordance with MIL-STD-662. Test projectile shall be the caliber 0.50 (207 grain) fragment simulating projectile conforming to MIL-P-46593 fired at 0 obliquity. The V_{50} protection ballistic limit reported shall be the average of three determinations, each made on a separate composite armor specimen. Each determination shall be a six round V_{50} ballistic limit with a maximum velocity spread of 125 ft/sec.

4.4.4.2 Bonding pull test. The bonding pull test shall be conducted in accordance with ASTM D897. The bond strength reported shall be the average of three determinations.

4.4.4.3 Control test failure. Failure of the control samples to meet the requirements of the control test shall be cause for the Government to stop acceptance of armor plate until the cause of failure(s) is identified, corrective action is taken by the contractor and approved by the Government.

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5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking. Preservation, packing, and marking shall be in accordance with the applicable packaging standard or packaging data sheet specified by the acquisitioning authority (see 6.2).

6. NOTES

6.1 Intended use. The aluminum-aramid composite furnished under this specification is intended for use as an armor system for the Armored Combat Earthmover, M9 ACE.

6.2 Ordering data. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. If first article shall be preproduction or initial production (see 4.3).
- c. Name and address of Government test site (see 4.3 and 4.4.4).
- d. Selection of applicable levels of preservation, packaging, packing and marking (see 5.1).
- e. Thickness of aluminum and number of plies of aramid for test components (see 3.3.2).

6.3 Definitions.

6.3.1 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 6.3.2).

6.3.2 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from community activities. It does not include solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (source: Federal Acquisition Regulations, section 23.402).

6.3 Subject term (key word) listing.

Ballistic resistance
Bonding strength
Component

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6.4 AMC policy on AQLs/LTPDs. This specification is certified to be in compliance with current Army Materiel Command (AMC) policy for the elimination of AQLs/LTPDs (Acceptable Quality Levels/Lot Tolerance Percent Defectives) from military specifications.

Custodian:
Army - AT

Preparing activity:
Army - AT

(Project 9535-A035)