

MIL-A-46864A(MI)
 20 December 1983
 SUPERSEDING
 MIL-A-46864(MI)
 30 January 1973

MILITARY SPECIFICATION

ADHESIVE, EPOXY, MODIFIED, FLEXIBLE, TWO COMPONENT

This specification is approved for use by Army Missile 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 establishes the requirements for a two component modified epoxy adhesive system capable of curing at room temperature.

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

	L-P-512	Plastic Sheet (Sheeting), Polyethylene
*	O-S-1926	Sodium Chloride, Technical
	QQ-A-250/5	Aluminum Alloy, Alclad 2024, Plate and Sheet
	TT-M-261	Methyl Ethyl Ketone, Technical
*	PPP-B-601	Boxes, Wood, Cleated Plywood
*	PPP-B-621	Box, Wood, Nailed and Lock-Corner
	PPP-B-636	Boxes, Shipping, Fiberboard
	PPP-C-96	Can, Metal, 28 Gage and Lighter

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Missile Command, ATTN: DRSMI-RSDS, Redstone Arsenal, AL 35898 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) at the end of this document or by letter.

MIL-A-46864A(MI)

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-S-8516	Sealing Compound, Polysulfide Rubber, Electric Connectors and Electric Systems, Chemically Cured
MIL-I-23053/1	Insulation Sleeving, Electrical, Heat Shrinkable, Neoprene, Flexible
MIL-I-23053/5	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Flexible, Crosslinked
MIL-P-38714	Packaging and Packing of Two Component Materials in Semkits

STANDARDS

Federal

FED-STD-406 Plastics: Methods of Testing

Military

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-129 Marking for Shipment and Storage

* MIL-STD-1188 Commercial Packaging of Supplies and Equipment

* (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 document(s) form a part of this specification to the extent specified herein. The issues of the documents 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 903 Test Method for Peel or Stripping Strength of Adhesive Bonds

MIL-A-46864A(MI)

ASTM D 1002

Test Method for Strength Properties of
Adhesives in Shear by Tension Loading
(Metal to Metal)

(Applications for copies of ASTM publications should be addressed to The American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(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 First article. When specified, a sample shall be subjected to first article inspection (see 4.3 and 6.2).

3.2 Data. Unless otherwise specified by the procuring activity, no data, other than test reports submitted with the first article sample is required by this specification.

3.3 Materials. The adhesive system shall consist of a modified epoxy base and a curing agent.

3.4 Characteristics and performance.

3.4.1 Properties before curing

- * 3.4.1.1 Flow. When tested as specified in 4.6.1, the measured flow of the mixed compound shall be not greater than 0.5 inch.

3.4.1.2 Application time. The application time (time to 1200 poises) of the mixed adhesive when measured in accordance with 4.6.2 shall be 1 hour minimum.

3.4.2 Properties after cure. Properties after cure shall be as specified in Table I. The cured adhesive shall maintain functional integrity from -67°F (-55°C) to 350°F (+177°C).

3.4.3 Storage properties.

- * 3.4.3.1 Accelerated storage. After the accelerated storage test specified in 4.6.11, the adhesive system shall conform to 3.4.1.1 and the "as cured" peel strength requirements of Table I.

MIL-A-46864A(MI)

3.4.3.2 Shelf life. The manufacturer shall certify that the adhesive system, after storage at 65 to 95°F (18 to 35°C) for a period of 8 months, conforms to all the requirements of this specification. The certification shall accompany the first article sample.

3.5 Workmanship. The adhesive and curing agent shall be free of dirt, foreign material or other contaminants and shall be so formulated to meet the requirements of this specification.

*TABLE I. Properties After Cure

Property	Requirement	Test Paragraph
Peel strength, lbs per inch width, min. <u>1</u> / ¹		
As cured	14	4.6.3
After heat stability	14	4.6.4
After thermal cycle	14	4.6.5
After fluid resistance	10	4.6.6
Tensile shear, psi, min.	1500	4.6.7
Dielectric constant, max.	5.5	4.6.8
Dielectric strength, volts per mil, min.	500	4.6.9
Corrosion	No pitting or blackening of test wire	4.6.10

1/ Values may be less than the stated minimum when cohesive failure occurs.

MIL-A-46864A(MI)

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 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspections and tests of the epoxy adhesive shall be classified as follows:

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

* 4.3 First article inspection. The first article inspection shall be performed on the first lot or order of adhesive furnished to this specification and on any subsequent lot or order when specified by the procuring activity (see 6.2). The first article shall consist of all the tests, inspections and certifications in this specification. The necessary instructions for performance of the first article inspection shall be as specified in 6.2.1.

4.3.1 First article sample. When required, the first article sample shall be submitted in containers of the type specified in Section 5 of this specification. The total weight of the sample shall be approximately 2 pounds and must be furnished in at least 3 containers. The first article sample shall have been processed through the same facilities intended for delivery of the entire contract or order.

4.3.1.1 Instruction sheet. Along with the first article sample, the manufacturer shall forward an instruction sheet detailing the following:

- a. Complete mixing instructions.
- b. Complete instructions for preparation of surfaces to be bonded. When a primer is required, the manufacturer is expected to furnish the primer with the first article.

MIL-A-46864A(MI)

4.4 Quality conformance

4.4.1 Lot formation. Unless otherwise specified, a lot shall consist of all the adhesive of the same batch or production run that forms a part of one contract and is submitted for inspection at one time.

4.4.2 Sampling.

4.4.2.1 For physical property tests. A number of containers, whose total mixed contents when added together weigh approximately 0.5 pounds shall be randomly selected from each lot offered for inspection. The sample shall be inspected and tested in accordance with 4.4.3.1.

4.4.2.2 Preparation for delivery. A quantity of shipping containers fully prepared for delivery, just prior to closure, shall be selected at random from each lot in accordance with Inspection Level S-2 of MIL-STD-105. The lot size for this examination shall be the number of shipping containers.

4.4.3 Inspections.

4.4.3.1 Physical properties. Two specimens for each test shall be prepared from the containers selected in 4.4.2.1. The specimens shall be tested to the requirements of Table II. In addition, the procuring activity may specify any other test herein, when considered necessary to ensure conformance to the specification. Nonconformance of any specimen to the requirements in Table II shall be cause to reject the lot represented by the sample.

*TABLE II. Physical Property Inspection

Property	Test Paragraph	Specimens Tested <u>1/</u>
Flow	4.6.1	2
Application time	4.6.2	2
Peel strength, aluminum to polyethylene; as cured only	4.6.3	2

1/ Results shall be reported as pass or fail

MIL-A-46864A(MI)

4.4.3.2 Preparation for delivery. The containers selected in 4.4.2.2 shall be visually examined to the requirements of Table III and all other applicable requirements to determine conformance to Section 5 of this specification. The Acceptable Quality Level (AQL) for this examination shall be 2.5 percent defective. In addition, shipping containers fully prepared for delivery shall be examined for closure defects.

4.5 Test conditions.

4.5.1 Standard conditions. Unless otherwise specified herein, all mixing and tests shall be conducted at $77 \pm 2^{\circ}\text{F}$ ($25 \pm 1^{\circ}\text{C}$) and 50 ± 5 percent relative humidity (RH).

4.5.2 Mixing. All mixing operations shall be in accordance with the procedures outlined in the manufacturer's instruction sheet (see 4.3.1.1).

4.5.3 Curing procedures. All laboratory specimens shall be cured as follows (see 6.1.1):

- 2 hours \pm 5 minutes @ standard conditions (4.5.1)
- 2 hours \pm 5 minutes @ $225 \pm 2^{\circ}\text{F}$ ($107 \pm 1^{\circ}\text{C}$)
- 24 hours \pm 1 hour @ standard conditions

4.6 Test methods.

- * 4.6.1 Flow. A flow test jig conforming to Figure 1 of MIL-S-8516 shall be placed on a horizontal surface with the front face upward and the plunger depressed to the limit of its travel. The adhesive and curing agent shall be thoroughly mixed for 5 minutes, then transferred into the cavity of the test apparatus. Any excess adhesive shall be removed by leveling with a straight edge. Within 10 seconds after removal of the excess adhesive, the apparatus shall be placed on end and the plunger advanced to the limit of its travel. The apparatus shall remain on end for 10 minutes. Conformance to 3.4.1.1 shall then be noted.

MIL-A-46864A(MI)

*TABLE III. Examination of Preparation for Delivery

Examination	Defect
Packaging	Wrong size containers or kits Material or construction not as specified Components damaged or missing Intermediate package closure incomplete or damaged Adhesive and curing agent not properly separated Not level of packaging required by contract
Packing	Not level required by contract or order Any non-conforming component, incomplete closures Bulged or damaged containers
Marking	Omitted, incomplete, not in accordance with specification, contract or order

4.6.2 Application time (pot life). Application time measurements shall be made using a Brookfield RVF Viscometer equipped with a #6 spindle, or equivalent operated at 10 revolutions per minute (rpm).

- * 4.6.2.1 Procedure. The adhesive shall be mixed and transferred to a standard 1/2-pint can approximately 2-3/4 inches in diameter. The retaining flange of the can may be removed. The volume of mixed adhesive used shall be sufficient to allow immersion of the spindle to its depth mark. The viscosity shall be determined after 1 hour elapsed time. The readings shall be taken after 5 revolutions of the spindle. The viscosity shall be in accordance with 3.4.1.2.

4.6.3 Peel strength.

4.6.3.1 Specimen preparation. The identification and number of adherents needed for peel strength shall be as noted in Table IV.

- * 4.6.3.1.1 Preparation of specimen "A". One aluminum panel, cleaned and primed in accordance with the adhesive manufacturer's recommendations (see 4.3.1.1) shall be evenly coated with freshly mixed adhesive. The coating thickness shall be 0.010 ± 0.001 inch after cure (wire spacers 10 mils in diameter may be used if desired). A strip of polyethylene shall be placed on the coated panel and positioned in a manner that allows a 2-inch plastic overhang at one end. The specimen shall be cured as specified in 4.5.3. A total of 12 "A" specimens shall be prepared in this manner. Two (2) specimens shall be tested "as cured". The remaining specimens shall be used for heat stability, thermocycle stability and fluid resistance tests.

MIL-A-46864A(MI)

4.6.3.1.2 Preparation of specimen "B". The polychloroprene sleeving shall be heat shrunk (see 6.3) onto a 1-inch diameter steel mandrel, 12 inches long. The "recovered" sleeving shall be cooled to standard conditions and the outer surface abraded as noted in footnote 1/ to Table IV. Freshly mixed adhesive shall be evenly applied to the abraded surface to a thickness of approximately 0.020 inch, except that a 3/4 inch wide by 8 inch long section shall be left uncoated. Three pieces of the polyolefin sleeving shall be slipped over the polychloroprene sleeving and evenly spaced on the coated area. The polyolefin shall then be heat shrunk (see 6.3). The assembly shall be cured as specified in 4.5.3, except that the 24 hour conditioning period at standard conditions may be omitted. After curing, the sleeving assembly shall be removed from the mandrel by carefully slitting the sleeving along one edge of the uncoated area. The cut sleeving shall then be laid flat and a 1-inch by 3-inch sections shall be cut from each of the 3 double layers of sleeving. The 3/4 inch uncoated section shall be at one end of each strip. Five sleeving assemblies shall be prepared as described above to yield 15 "B" specimens. Three specimens shall be used for thermocycle stability and fluid resistance.

4.6.3.2 Test procedure. All specimens shall be tested in accordance with ASTM D 903. Results shall be reported as the average of all "A" and "B" specimens.

4.6.4 Heat stability. Two "A" specimens from 4.6.3.1 shall be exposed in an air circulating oven at $300 \pm 2^\circ\text{F}$ ($149 \pm 1^\circ\text{C}$) for 17 hours \pm 15 minutes, cooled to standard conditions 1 to 4 hours, then tested as specified in 4.6.3.2. Each specimen shall meet or exceed the requirement in Table I.

4.6.5 Thermal cycle stability. Two "A" and three "B" specimens from 4.6.3.1 shall be thermally cycled as follows:

	45 minutes @ $350 \pm 4^\circ\text{F}$ ($177 \pm 2^\circ\text{C}$)
	1 minute in tap water @ $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$)
*	15 minutes in a cold chamber @ $-65 \pm 4^\circ\text{F}$ ($-53.9 \pm 1^\circ\text{C}$)
	1 minute in water @ $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$)

The above cycle shall be repeated a total of 8 times. Specimen transfer from a temperature extreme to water shall be accomplished as quickly as possible. After completion of the 8 cycles, the specimens shall be wiped dry and tested within 24 hours. The average values shall conform to Table I requirements.

MIL-A-46864A(MI)

*TABLE IV. Peel Strength Adherents

Adherent	Reference	Size, Inch	Number Required
Aluminum alloy panel	QQ-A-250/5, clad, 2024	1 by 4 by 0.063	12
Polyethylene strip <u>1/</u>	L-P-512	1 by 6 by 0.010	12
Polychloroprene sleeving	MIL-I-23053/1	1.25 dia by 8 <u>2/</u>	4
Polyolefin sleeving <u>1/</u>	MIL-I-23053/5 Class 1	1.50 dia by 1.5 <u>2/</u>	12

1/ The surface of the polyethylene strip, and the inner area of each polyolefin sleeving shall be lightly abraded with number 320 emery cloth, or equivalent and wiped dry with a clean cloth wet with methyl ethyl ketone conforming to TT-M-261.

2/ The diameter of the sleeving is the "as supplied diameter".

4.6.6 Fluid resistance. Two "A" specimens and two "B" specimens shall be totally immersed in each of the fluids listed below.

JP-4 fuel (MIL-T-5624)

Hydraulic Fuel (MIL-H-5606)

* 5% Sodium Chloride in water (O-S-1926)

Immersion time shall be 24 + 1 hour at standard conditions. After immersion, the specimens shall be lightly wiped and air dried for 30 to 60 minutes. The specimens shall be tested in accordance with 4.6.3.2 and average values shall conform to the Table I requirement.

MIL-A-46864A(MI)

4.6.7 Tensile shear. Shear by tensile loading shall be determined on 5 aluminum to aluminum (QQ-A-250/5, clad, 2024, 0.063 inch thickness) specimens overlapped 0.500 ± 0.010 inch with a bond line thickness of 0.0015 ± 0.0005 inch. Preparation of the specimens and testing shall be in accordance with ASTM D 1002.

4.6.8 Dielectric constant. Dielectric constant shall be determined at standard conditions in accordance with method 4020 of FED-STD-406. The test frequency shall be 1000 Megahertz (MHz). Three void free films approximately 4 by 6 inches and 0.010 to 0.015 inch thick shall be prepared and tested.

4.6.9 Dielectric strength. Dielectric strength determinations shall be made at standard conditions in accordance with Method 4031 of FED-STD-406. Tests shall be conducted under oil using the short time procedure. Three specimens shall be tested.

- * 4.6.10 Corrosion. Freshly mixed adhesive shall be used to encapsulate a 3-inch length of clean, bare, brightly buffed copper wire. The encapsulated wire shall be exposed in an air circulating oven for 16 hours at $482 \pm 4^{\circ}\text{F}$ ($250 \pm 1^{\circ}\text{C}$). The adhesive shall then be carefully stripped away, and the wire examined for corrosion. There shall be no pitting or blackening of the wire.
- * 4.6.11 Accelerated storage. The unmixed adhesive shall be stored in an unopened container for seven days at $120 \pm 2^{\circ}\text{F}$ ($49 \pm 2^{\circ}\text{C}$) then cooled to standard conditions for 24 ± 1 hour and tested for conformance to 3.4.3.1.

* 5. PACKAGING

* 5.1 Preservation. Packaging, packing, unitization, and marking shall be Level A, B, or industrial (see 6.2).

* 5.1.1 Level A or B.

* 5.1.1.1 Cans. The adhesive and curing agent shall be packaged in 1-pint, 1-quart, or 1-gallon containers conforming to Type V, Class 4, oblong, of PPP-C-96.

* 5.1.1.2 Sectional cartridges. Pre-measured parts of the adhesive and curing agent shall be packaged in sectional type cartridges conforming to Type I or II, size A or B of MIL-P-38714. Each cartridge shall be individually packaged in snug-fitting intermediate containers as specified in MIL-P-38714.

* 5.1.1.3 Mixer packages. Very small quantities of adhesive and curing agent (2.8 gram when mixed) shall be packaged in individual containers as part of a kit. The kit shall consist of 10 mixer packages for a total of 28 grams.

* 5.1.2 Industrial. Preservation and packaging shall be in accordance with MIL-STD-1188.

MIL-A-46864A(MI)

* 5.2 Packing.

* 5.2.1 Level A. The packaged adhesive shall be packed in containers conforming to PPP-B-601 overseas type, or PPP-B-621, Class 2 as applicable.

* 5.2.2 Level B. The packaged adhesive shall be packed in fiberboard containers conforming to PPP-B-636, Class weather resistant.

* 5.2.3 Industrial. Packing shall be in accordance with MIL-STD-1188.

* 5.3 Marking.

* 5.3.1 Level A or B. Marking shall be in accordance with MIL-STD-129. Additional marking shall include, but not be limited to the following:

ADHESIVE, EPOXY, MODIFIED, FLEXIBLE, TWO-COMPONENT MIL-A-46864(MI)
 Date of manufacture
 Date of packaging
 Manufacturer's name, address and product designation
 Contract No.
 Federal Stock number

* 5.3.2 Instruction sheet. The manufacturer shall include an instruction sheet in each unit package. The instruction sheet shall include all information pertinent to the use of the adhesive system and must include the following:

Mixing instructions
 Curing procedures at room and elevated temperatures
 Shelf life expectations
 Surface preparation of adherents

* 5.3.3 Industrial. Marking shall be in accordance with MIL-STD-1188. Additional markings shall include, but not be limited to the following:

ADHESIVE, EPOXY, MODIFIED, FLEXIBLE, TWO-COMPONENT MIL-A-46864(MI)
 Date of manufacture
 Date of packaging
 Manufacturer's name, address and product designation
 Contract No.
 Federal Stock number

* 5.3.4 Instruction sheet. The manufacturer shall include an instruction sheet in each unit package. The instruction sheet shall include all information pertinent to the use of the adhesive and must include the following:

Mixing instructions

MIL-A-46864A(MI)

Curing procedures at room and elevated temperatures
 Shelf life expectations
 Surface preparation of adherents

6. NOTES

6.1 Intended use. The adhesive is intended primarily for use as a room temperature curing, flexible adhesive and sealant system for heat shrinkable sleeving and molded components. This two part system may also be employed in areas where bonding to rubber, metals, and plastic or combinations thereof is required. Each potential application shall be properly investigated before using the adhesive.

6.1.1 Curing conditions. The curing cycle specified in paragraph 4.5.3 is for laboratory preparation. For field use, the following may be utilized:

<u>Cure Temp °F</u>	<u>Time to Cure (hours)</u>
77	96
180	3
200	1
250	45 minutes

6.2 Information for contracting officer. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Quantity and size required (5.1.1).
- c. Level of packaging and packing (5.1,5.2).
- * d. Shelf life certification (3.4.3.2).
- e. First article inspection, if required (4.3).

6.2.1 First article instructions. When first article is required, the procuring activity shall designate the laboratory to which the first article sample shall be forwarded. The sample size requirement, identification and tests shall be as specified in 4.3.

- * 6.3 Shrinkdown. Recovery for heat shrinkable sleeving in paragraph 4.6.3.1.2 can be accomplished by heating the sleeving to temperatures in excess of 347°F (175°C). The heat shall be continued until shrinkdown occurs. The sleeving may be heated by a suitable hot air thermal gun or in a circulating air oven.

MIL-A-46864A(MI)

6.4 Supersession data. This specification includes the requirements of Missile Interim Specifications MIS-16066 dated 16 March 1967 and MIS-13497 dated 1 March 1972.

6.5 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodian:
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Preparing Activity:
Army-MI

Project Number
8040-A098

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

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3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION <i>(Mark one)</i> <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER <i>(Specify):</i> _____	
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a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER <i>(Last, First, MI) – Optional</i>		b. WORK TELEPHONE NUMBER <i>(Include Area Code) – Optional</i>	
c. MAILING ADDRESS <i>(Street, City, State, ZIP Code) – Optional</i>		8. DATE OF SUBMISSION <i>(YYMMDD)</i>	

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NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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