

MIL-B-48612A (AR)
20 March 1987
SUPERSEDING
MIL-B-48612 (MU)
27 January 1977

MILITARY SPECIFICATION

BONDING WITH EPOXY-ELASTOMERIC ADHESIVE SYSTEM, GLASS TO METAL

This specification is approved for use within the U.S. Army Armament Munitions and Chemical Command, 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 glass optical components to metal for use in military instruments (see 6.1).

1.2 Classification.

1.2.1 Bonding materials. Bonding materials shall be of the following types, as specified:

TYPES

Type I - Bond with Type I Adhesive System, MIL-A-48611.

Type II - Bond with Type II Adhesive System, MIL-A-48611.

1.2.2 Bond quality. The quality of a bonded assembly shall be of the * following grades as specified on the drawing or in the procurement documents:

GRADES

Grade A - Bonds for prism assemblies or similar components where high quality is mandatory.

Grade B - Bonds for non-critical bonded assemblies.

Grade A shall apply to all bonded prism assemblies where grade quality is not specified.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document, should be addressed to: Commander, U.S. Army ARDEC, ATTN: SMCAR-ESC-S, Picatinny Arsenal, New Jersey 07806-5000 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

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FSC 12GP

MIL-B-48612A (AR)

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

MIL-A-48611 - Adhesive System, Epoxy-Elastomeric,
for Glass to Metal.

STANDARDS

MILITARY

MIL-STD-810 - Environmental Test Methods

* 2.1.2 Other Government documents. The following other Government document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of this solicitation.

QUALIFIED PRODUCTS LIST

QPL-48611 - Adhesive System, Epoxy-Elastomeric, for
Glass to Metal

(Copies of specifications, standards and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in the specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Assembly components.

3.1.1 Optical. The optical component shall comply with the requirements specified on the applicable drawing.

3.1.2 Metal. The metal component shall comply with the requirements specified on the applicable drawing.

MIL-B-48612A (AR)

3.1.3 Adhesive bonding materials. The adhesive shall conform to MIL-A-48611 Type I or Type II, as specified. When the Type I system is specified, the bonding process shall include the application of both the primer and the adhesive. When the Type II system is specified, the bonding process shall include the application of the adhesive only. When type is not specified, Type I shall be applied. The adhesive system covered in MIL-A-48611 is a qualified product and as such it is required that the only adhesive system used shall be one listed or approved for listing on the associated QPL, QPL-48611. Alternative adhesives or primers should only be used upon approval of the qualifying activity as identified in MIL-A-48611.

3.2 Bonding process. Assemblies shall be bonded in accordance with the procedures specified herein. Deviation from this procedure is prohibited unless approval is obtained from the procuring activity prior to use in production.

3.2.1 Cleaning.

3.2.1.1 Optical component. Polishing compounds, pencil marks, and other contaminants shall be removed from the bonding surface of the optical component to be bonded. Stubborn contaminants may be removed by scouring with a paste of pumice or calcium carbonate and water; residue shall be removed with deionized or distilled water. The bonding surface shall be thoroughly wiped with chemically pure (CP) acetone using clean cheese cloth or lens tissue. Cotton tipped applicators are not permitted. The lens tissue or cheese cloth shall be moistened (not wet) with the solvent. The component shall be dried before the primer or bonding material is applied.

3.2.1.2 Metal component. Unless otherwise specified, the metal bonding surface shall be free from corrosion products, burrs, surface impregnants, anodic, passivation, oxide, chromate, phosphate and other surface treatments as well as other surface contaminants; such imperfections shall be removed by carefully rubbing using a medium or fine abrasive paper or cloth while at the same time not destroying the physical dimensions and flatness of the bonding surface. The surface shall be wiped with chemically pure (CP) acetone-moistened (not wet) cheese cloth or lens tissue and allowed to dry. Cotton tipped applicators are not permitted. Drying shall be complete before the primer or bonding material is applied.

3.2.2 Primer preparation. The adhesive primer of Type I, MIL-A-46811 shall be prepared as follows:

- a. Mix or agitate the base resin in accordance with manufacturer's instructions to thoroughly disperse any solid portions of these components.
- b. To the base, add one part by volume of the curing agent solution and mix or agitate thoroughly in a closed container. Do not mix less than 50cc of primer as inconsistent bonds may result.
- c. Let stand 0.5 hours in a closed container before using.

MIL-B-48612A (AR)

- d. Discard unused primer 8 hours after mixing.

3.2.3 Primer application. Primer shall be applied as outlined below to an area which is at least as large as the cured bond area shown on the engineering drawing. The primer shall be applied within 2 hours after cleaning, and the primed surface shall be bonded within 30 days after application. Protect the primed surface from contamination by covering with a nondusting wrap or place in covered glass or plastic containers.

a. If practical, warm the glass and metal parts to be primed to 3 to 6 C above ambient temperature to drive off adsorbed moisture on the surface of the part.

b. Shake or stir primer to a homogenous condition and apply one uniform coat to the surfaces of the metal and glass parts either by spraying with an air brush using dry air or dry inert gas; or by brushing using a camel's hair brush. There shall be no puddling or drips, and the primer shall have a smooth uniform color. The primer thickness shall be .005 to .0010 inches as determined by measurement with a micrometer or similar instrument, or by color comparison with standard specimens on the same substrate with known primer thickness.

c. Cure the primer at room temperature (21 to 32 C) for 24 hours or at 71 C for 0.5 hours.

3.2.4 Adhesive preparation. The adhesive of Type I or Type II, MIL-A-48611 shall be prepared as follows:

a. Stir the adhesive components thoroughly in their original containers to achieve a homogenous mix.

b. Weigh out and mix the adhesive parts thoroughly in a metal, plastic or glass container in accordance with the ratio recommended by the adhesive manufacturer, taking care to minimize the inclusion of entrapped air in the mixed adhesive.

c. Discard unused adhesive 1 hour after mixing.

3.2.5 Adhesive application and assembly. The parts shall be assembled within 30 days of priming by one of the following methods:

3.2.5.1 Method I. For metal parts with no adhesive injection holes.

a. Lightly wipe the primed surfaces with lens tissue or cheese cloth moistened (not wet) with reagent grade ethyl or isopropyl alcohol to remove any foreign material. Drying shall be complete before the adhesive is applied.

b. If practical, warm the optical and metal parts to 3 to 6 C above ambient temperature to drive off adsorbed moisture, and apply sufficient adhesive to both adherends with a spatula, glass rod, syringe or other suitable applicator to provide full bonding to the size of bond area shown on the applicable drawing.

MIL-B-48612A (AR)

c. Assemble parts in the bond fixture using suitable means such as non-metallic spacers to maintain the bond line thickness. Unless otherwise specified, the bond line thickness shall be .014 to .016 inches (see 6.2). Metal spacers shall not be used. Unless specifically prohibited, and, at the option of the manufacturer, the space employed with this method may be permanently embedded in the bond line. If spacers are exposed, trim flush to bond line after curing (Caution: see 3.3.1).

d. Clean or wipe away excess adhesive prior to adhesive cure with cotton tipped applicators moistened as required with MEK or acetone.

3.2.5.2 Method II. For metal parts which have adhesive injection holes.

a. Lightly wipe the primer surfaces with lens tissue or cheese cloth moistened (not wet) with reagent grade ethyl or isopropyl alcohol to remove any foreign material.

b. Assemble the optical and metal components in the bond fixture using suitable means, such as non-metallic spacers, to maintain the proper bond line thickness. Unless otherwise specified, the bond line thickness shall be .014 to .016 inches.

c. If practical, the assembly shall be warmed to 3 to 6 C above ambient temperature just before injection to drive off adsorbed water.

d. Fill a clean syringe with freshly prepared adhesive, and inject the adhesive to fill the bond line to the size indicated on the applicable engineering drawing. Inject the adhesive within 2 hours of wiping the primed surfaces with alcohol. Avoid the introduction of air into the adhesive as the bond area will tend to grow during cure and will have void areas in the bond. Unless otherwise specified, spacers used with this method must be removed (see 3.3.1).

e. Clean or wipe away excess adhesive prior to adhesive cure with cotton tipped applicators moistened with MEK or acetone.

3.2.6 Bond fixture. The bond fixture shall be designed to provide mechanical positioning of the components to be bonded to an accuracy compatible with the applicable drawing. Sufficient support shall be provided to protect components of the bonded assembly from scratches or damage during the bonding and curing cycle. The fixture shall be constructed to maintain intimate contact between the metal, glass, and adhesive during the curing cycle.

3.2.7 Adhesive curing. Unless otherwise specified, the adhesive shall be cured as specified in Table I. Cure temperature shall be verified.

MIL-B-48612A (AR)

*

TABLE I. Cure schedule.

TEMPERATURE	TIME IN HOURS (MINIMUM)	
	TYPE I BONDING	TYPE II BONDING
Room Ambient	1	1
20 to 35 C		
plus		
45 \pm 3 C	1	1
plus		
71 \pm 3 C	$\frac{3}{5}$	$\frac{3}{5}$
	TOTAL	
	$\frac{3}{5}$	$\frac{3}{5}$

The bonded assembly may be removed from the fixture after the 45 C cure and prior to 71 C cure provided the optical and mechanical requirements of the bonded assembly are not disturbed by the removal.

3.3 Performance requirements.

3.3.1 Grade A quality bonds. When stabilized at room temperature, the bonded assembly shall meet the alignment, optical quality and optical performance requirements specified on the applicable drawing without failure after the following exposure.

a. Mechanical shock. 250 g's applied parallel to the bonded surfaces in such a direction as to produce the greatest stress on the bond, repeated 3 times. The shock pulse shall have a wave form approximating a half-sine wave with a minimum time duration of 1.5 milliseconds (zero to peak load).

Failure is defined as any separation(s) or void(s) in the bond line in excess of 5% of the original specified bond area; or any fracture, shatter or chipping of the glass component. Area occupied by spacers either embedded in or removed from the original bond area shall be considered as voids.

3.3.2 Grade B quality bonds. The bond line shall be smooth and firm. Total amount of voids, cracks and bubbles shall not exceed 5 percent of the visible bond line area.

3.4 Bond life requirements (Grade A only). Bonded optical assemblies that have successfully withstood the requirements of 3.3.1 shall be capable of exposure to the following requirements in sequence without failure.

3.4.1 Low temperature thermal stability. Bonded optical assemblies shall show no evidence of failure and shall meet the alignment and optical performance requirements of the applicable drawing after exposure to a temperature of $-62.5 \text{ C} \pm 2 \text{ C}$ for a period of four hours. Failure is defined as any separation(s) of the bonded components in excess of 5% of the original bond area, or fracture, shatter or chipping of the glass component.

MIL-B-48612A (AR)

3.4.2 Elevated temperature thermal stability. Bonded optical assemblies shall show no evidence of failure and shall meet the alignment and optical performance requirements of the applicable drawing after exposure to a temperature of 71 ± 2 C for a period of four hours. Failure is defined as any separation(s) of the bonded components in excess of 5% of the original specified bond area; or fracture, shatter, or chipping of the glass component.

* 3.4.3 High mechanical shock stability. Bonded optical assemblies shall be capable of exposure to the following requirements without failure; cumulative shocks consisting of three each at 300 g, and 400 g's applied parallel to the bonded surfaces in such a direction as to produce the greatest stress on the bond. The shock pulse shall have a wave form approximating a half sine wave. For 300 g and 400 g, the shock pulse shall have a time duration of 1.5 milliseconds. Failure is defined as the separation(s) of the bonded components in excess of 5% of the original bond area; or fracture, shatter or chipping of the glass component.

3.5 Workmanship.

3.5.1 Grade A quality bonds. The bonded optical assembly shall be free of excess adhesive and primer; and the components of the bonded assembly shall be free of defects beyond those permitted by the applicable engineering drawing. There shall be no separation of the bond line in excess of 5% of the original bond area.

3.5.2 Grade B quality bonds. The bonded assembly shall be free of excess adhesive and primer.

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

* 4.1.1 Responsibility for compliance. All items must meet all requirements of section 3. 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 assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

MIL-B-48612A (AR)

4.2 Classification of inspection. The inspection and testing of the bonded assemblies shall be classified as follows:

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

4.3 First article inspection. (Grade A quality bonds only). The requirement for first article inspection and the responsibility (government or contractor) for first article testing shall be as specified in the contract (see 6.2). Unless otherwise specified, the sample for first article inspection shall consist of three bonded assemblies. These bonded assemblies shall be tested as specified herein for all the requirements of 3.3 and 3.4. The sample shall be bonded in the same manner, using the same materials, equipment, processes and procedures as used in regular production. All materials shall be obtained from the same source of supply as used in regular production.

4.3.1 Government testing. When the Government is responsible for conducting first article approval tests, the contractor, prior to submitting the sample to the Government, shall inspect the sample to insure that it conforms to all the requirements of the contract except bond life requirements for Grade A quality bonds, and submit a record of this inspection with the sample, including certificates of conformance for materials, as applicable.

4.3.2 Contractor testing. When the contractor is responsible for conducting first article approval tests, the sample shall be inspected by the contractor for all the requirements of the contract. The sample and record of this inspection, including certificates of conformance for materials, shall be submitted to the Government for approval. The Government reserves the right to witness the contractor's inspection.

4.4 Quality conformance tests.

4.4.1 Lot formulation. Unless otherwise specified, a lot shall consist of identical bonded assemblies which have been prepared for curing and cured using the same materials, procedures and curing equipment during four contiguous weeks.

4.4.2 Sampling.

4.4.2.1 Sampling for performance requirements -- Grade A quality bonds. A minimum of 50% of the bonded assemblies in each lot shall be randomly selected and subjected to the mechanical shock test of 4.5.1.

4.4.2.1.1 Failure of performance requirement -- Grade A quality bonds. Should any one bonded assembly fail the mechanical shock performance requirement, the entire lot of bonded assemblies shall be subjected to the requirements of 3.3.1. Defective assemblies shall be screened from the lot.

MIL-B-48612A (AR)

4.4.2.2 Sampling for bond life requirements -- Grade A quality bonds. Four bonded assemblies, or 3%, whichever is greater, randomly selected from each lot shall be subjected to the tests of 4.5.2.

4.4.2.2.1 Failure of bond life requirements -- Grade A quality bonds. Should any one sample fail the bond life test requirements, acceptance of the represented bonded lot shall be suspended by the Government. Disposition of the represented lot in which the failure occurred shall be by the direction of the Procuring Activity. Should bond life test failure occur in a second contiguous bonded lot, all acceptance by the Government shall be suspended until necessary corrections have been made by the contractor. Government acceptance shall not commence until eight successive newly bonded assemblies pass all bond life test requirements specified herein, and the Government is assured that the contractor's materials and processes are under control.

4.4.2.3 Sampling for Grade B bonds. All bonded assemblies shall meet the requirements of 3.3.2 utilizing the test methods specified in 4.5.3.

4.4.2.3.1 Failure of performance requirements -- Grade B bonds. Should any one item of the sample fail to meet the specified test requirements, acceptance of the represented bonded lot shall be suspended by the Government until necessary corrections have been made by the contractor and the resubmitted item has been approved.

4.5 Examination and tests.

4.5.1 Performance test (Grade A quality bonds only).

4.5.1.1 Mechanical shock. The bonded assembly shall be subjected to the shock requirements of 3.3.1 by utilizing the shock test of Procedure I, Method 516 specified in MIL-STD-810 except the pulse shape, peak value, time duration and direction of the shock shall be specified in 3.3.1a. Subsequent to the completion of this test, the bonded assembly shall meet the requirements of 3.3.1.

4.5.2 Bond life test (Grade A quality bonds only).

4.5.2.1 Low temperature thermal stability. The bonded sample shall be subjected to the low temperature thermal stability requirement of 3.4.1 by placing the bonded assembly in a cold box at room temperature and allowing the temperature to drop to -62.5 ± 2 C at a rate not to exceed 20 C per hour. The temperature shall be maintained for 4 hours after which the assembly shall be returned to room temperature at a rate not to exceed 20 C per hour. Upon satisfactory completion of this test, the bonded assembly shall meet the requirements of 3.4.1 after which it shall be subjected to the test specified in 4.5.2.2.

4.5.2.2 Elevated temperature thermal stability. The bonded sample shall be subjected to elevated temperature thermal stability requirement of 3.4.2 by exposing the bonded assembly to a temperature of 71 ± 2 C for 4 hours. Upon satisfactory completion of this test, the bonded assembly shall meet the requirements of 3.4.2 after which it shall be subjected to the test specified in 4.5.2.3.

MIL-B-48612A (AR)

4.5.2.3 High mechanical shock stability. The bonded assembly shall be subjected to the shock requirements of 3.4.2 by utilizing the shock test of Procedure I of Method 516 specified in MIL-STD-810 except the pulse shape, peak value, time duration and direction of shock shall be as specified in 3.4.3. Subsequent to the completion of this test, the bonded assembly shall meet the requirements of 3.4.3.

4.5.3 Bond quality-Grade B quality bonds only. The bond shall be visually examined to determine conformance with 3.3.2.

4.5.4 Workmanship. Each bonded assembly shall meet the requirements of 3.5.

* 5. PACKAGING

5.1 Packaging, packing and marking are not applicable to this specification.

6. NOTES

6.1 Intended use. This specification covers the bonding of optical glass elements to their metallic mounts. Bond line thickness of .014 to .016 inches is recommended for most bonds, especially when aluminum is the metal mounting material; however, other bond line thicknesses can be used. The bonding of mirrors and similar large flat optical components in accordance with this specification are not recommended without confirmatory tests for optical quality.

Bonded optical assemblies are utilized in optical fire control instruments which are subject to gun fire shock, vibration and extremes of temperature.

* Grade A bonds shall be specified and used for all structurally bonded prism and other optical component assemblies in military fire control instruments. Grade B can be used for non-structural applications.

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Type, grade and method.
- c. When first article is required.
- d. Bond area required.
- e. Alternate cure cycles (see 3.2.7 and 6.3).
- * f. When bond line thickness other than .014 to .016 inches is required (see 3.2.5.1c and 3.2.5.2b).
- * g. When method II is utilized, indicate whether spacers, if used, may be left in place (see 3.2.5.2d).

MIL-B-48612A (AR)

6.3 Alternate cures. When specified, the adhesive may be cured at room temperature for 48 hours in non-critical bonded assemblies.

* 6.4 Subject term (key word) listing.

Adhesive system
Bonding
Curing
Epoxy-elastomeric
Glass to metal
Primer

* 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:
Army-AR

Preparing activity:
Army-AR

Review activity:
Army - AV

(Project 12GP-A006)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions – Reverse Side)***1. DOCUMENT NUMBER**

MIL-B-48612A

2. DOCUMENT TITLE

BONDING WITH EPOXY-ELASTOMERIC ADHESIVE SYSTEM, GLASS TO METAL

3a. NAME OF SUBMITTING ORGANIZATION**4. TYPE OF ORGANIZATION (Mark one)** VENDOR USER MANUFACTURER OTHER (Specify): _____**b. ADDRESS (Street, City, State, ZIP Code)****5. PROBLEM AREAS****a. Paragraph Number and Wording:****b. Recommended Wording:****c. Reason/Rationale for Recommendation:****6. REMARKS****7a. NAME OF SUBMITTER (Last, First, MI) – Optional****b. WORK TELEPHONE NUMBER (Include Area Code) – Optional****c. MAILING ADDRESS (Street, City, State, ZIP Code) – Optional****8. DATE OF SUBMISSION (YYMMDD)**