

FEDERAL SPECIFICATION

ADHESIVE, EPOXY, SILVER FILLED, CONDUCTIVE

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the requirements for two types of silver filled, conductive, two-part, room temperature curing adhesives

1.2 Classification. The adhesives shall be of the following types, as specified (see 6.2).

Type I - Volume resistivity 0.010 ohm/cm.
Type II - Volume resistivity 0.003 ohm/cm.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specifications:

QQ-A-250/S - Aluminum Alloy Alclad 2024, Plate and Sheet.
PPP-B-566 - Boxes, Folding, Paperboard.
PPP-B-636 - Boxes, Shipping, Fiberboard.
PPP-B-665 - Boxes, Paperboard, Metal Edged and Components.
PPP-B-676 - Boxes, Setup
PPP-C-96 - Cans, Metal, 28 Gage and Lighter

Federal Standards.

Fed. Std. No. 123 - Marking for Shipment (Civil Agencies).
Fed. Test Method Std. No. 141 - Paint, Varnish, Lacquer, and Related Materials;
Methods of Inspection, Sampling, and Testing
Fed. Test Method Std. No. 175 - Adhesives; Methods of Testing.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standards

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 - Marking for Shipment and Storage.

(Copies of Military Specifications and Standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards

- D 257 - D-C Resistance or Conductance of Insulating Materials
- D 1002 - Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)
- D 2471 - Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins
- D 2651 - Preparation of Metal Surfaces for Adhesive Bonding
- D 2730 - Sag Flow of Highly Viscous Resins.

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

National Motor Freight Traffic Association, Inc., Agent

National Motor Freight Classification

(Application for copies should be addressed to the American Trucking Associations, Inc., Tariff Order Section, 1616 P Street, N.W., Washington, DC 20036.)

Uniform Classification Committee, Agent

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

3. REQUIREMENTS

3.1 Material. The adhesive shall consist of two components, a base polymer and a curing agent, so compounded and formulated that when mixed in accordance with instructions (see 3.5), they shall produce an adhesive meeting the requirements of this specification.

3.1.1 Base polymer. The base polymer shall be of the epoxy type and contain the metallic silver particles, but it shall contain no copper or other metals, and it shall contain no fillers or extenders.

3.1.2 Curing agent. The curing agent shall be of a suitable type, which when mixed as directed (see 3.5), shall produce an adhesive meeting the requirements of this specification. The curing agent shall contain no metals, extenders, or fillers.

3.1.3 Thinner. If required for attainment of specified working characteristics (see 3.2), a thinner compatible with the mixed adhesive components shall be furnished.

3.1.4 Form. The base polymer shall be in paste form. The curing agent shall be a paste or liquid, and the thinner, if required, shall be a liquid but the forms in all cases shall be such as to assure conformance with 3.2.

3.1.5 Color. The mixed adhesive shall have a characteristic silver color.

3.1.6 Solids. The complete adhesive system shall be free of volatile solvents, and the average nonvolatile matter in the adhesive system shall be not less than 99.5 percent when tested as specified in 4.4.2.

3.1.7 Corrosion. The adhesive shall be noncorrosive to metal surfaces when tested as specified in 4.4.3.

3.2 Working characteristics

3.2.1 Application. The adhesive, when mixed according to the manufacturer's instructions (see 3.5), shall be smooth, free of lumps, and of consistency suitable for application. The individual components shall not settle, nor shall the mixed components separate or settle out during normal pot life. The adhesive shall be capable of being applied at room temperatures between 16 to 38°C (60 and 100°F) and at a relative humidity not greater than 75 percent.

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3.2.2 Application life (pot life). The application life of the adhesive, when mixed and ready for use at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$) shall be at least 60 minutes for a 1-ounce mass when tested as specified in table III.

3.2.3 Sag flow. The mixed adhesive shall not exhibit sag flow of more than 0.5 inch when tested as specified in table III and 4.4.4

3.2.4 Curing time. The adhesive shall attain the minimum strength requirements specified herein (see table I) when cured 24 hours at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$). Full cure shall not exceed 7 days.

3.3 Mechanical properties. Mechanical and electrical properties of test specimens, prepared and tested as specified in section 4, shall conform to the respective requirements listed in table I.

TABLE I Mechanical and electrical properties

	Type I	Type II
Tensile shear, psi (minimum)		
at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$)	1200	1200
at $60 \pm 1^\circ\text{C}$ ($140 \pm 2^\circ\text{F}$)	1200	1200
at $-55 \pm 1^\circ\text{C}$ ($-67 \pm 2^\circ\text{F}$)	1200	1200
Volume resistivity, Ohm/cm (maximum)	0.010	0.003

3.4 Storage stability After the separate components are stored as specified in 4.4.5, the prepared adhesive (see 3.5) shall conform to the following requirements

- All requirements of 3.2.1 and 3.2.3.
- Application life shall vary not more than minus 10 percent from the values specified in 3.2.2.
- Curing time shall vary not more than plus 10 percent from the values specified in 3.2.4.
- Tensile shear shall vary not more than minus 5 percent from the values specified in table I.

3.5 Instruction sheet. The manufacturer shall provide instructions for use with each kit of adhesive. The instructions shall include the following information

- Proportions by weight of components to be mixed, mixing instructions, including any controls necessary during mixing, and maximum pot life of the mixed adhesive.
- Application instructions, including spread method, number of coats, weight range, application temperature, and acceptable glue-line (bond) thickness range.
- Typical time, temperature, and pressure for each segment of the complete curing cycle, giving minimum and maximum limits for each condition.
- Instructions for use of thinner and clean-up.
- Necessary safety precautions to be observed throughout all operations.
- Storage, handling, and shelf life information

The instructions may be included as a separate sheet or may be incorporated into the kit label.

4 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 that supplies and services conform to prescribed requirements.

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4.1.1 The supplier shall submit to the contracting officer a certificate of compliance indicating that the adhesive complies with the shelf storage life requirement as specified in 3.4. When certificates of compliance are submitted, the Government reserves the right to check test such items to determine the validity of the certificate.

4.2 Sampling.

4.2.1 Lot. For purposes of sampling, a lot shall consist of all adhesive manufactured as one batch and offered for delivery at one time.

4.2.2 Sampling for inspection of filled containers. A random sample of filled containers shall be selected in accordance with MIL-STD-105 at inspection level I and acceptable quality level (AQL) of 2.5 percent defective to verify compliance with this specification regarding fill, closure, and marking, and other requirements not involving tests.

4.2.3 Sampling for lot acceptance. From each inspection lot, two containers of each component shall be selected at random. From each of the two containers, one pint of the material shall be taken and placed in separate, clean, dry metal or glass containers, sealed, marked, and forwarded to the testing laboratory. Where packaging of the lot is in containers of less than 1-pint capacity, a sufficient number of the smaller size containers shall be selected so that the specified two 1-pint samples of each component are available for forwarding to the testing laboratory.

4.2.4 Sampling for preparation for delivery. A quantity of shipping containers prepared for delivery, just prior to closure, shall be inspected in accordance with inspection level S-2 of MIL-STD-105 and examined in accordance with 4.3.2. The lot size for this inspection shall be the number of containers.

4.3 Inspection.

4.3.1 Inspection of containers. Samples selected in accordance with 4.2.2 shall be examined for defects of construction of the container, and the closure for evidence of leakage and for unsatisfactory markings, each filled container shall also be weighed to determine the amount of contents. Any container in the sample having one or more defects or under required fill shall be rejected, and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

4.3.2 Inspection of preparation for delivery. Samples selected in accordance with 4.2.4 shall be inspected to determine that the preservation, packaging, packing, and marking comply with the requirements of section 5 of this specification. Defects shall be scored in accordance with table II. Defects of closure listed shall be examined on shipping containers fully prepared for delivery. The AQL shall be 4.0 defects per hundred units.

Examine	TABLE II Classification of preparation for delivery defects	Defects
Markings (exterior & interior)		Omitted incorrect, illegible, improper size, location, sequence, or method of application
Materials		Any components missing or damaged
Workmanship		Inadequate application of components such as incomplete closure of container flaps, loose strapping, inadequate stapling Distortion of container, as applicable.
Contents (exterior container)		Number per container is more or less than required. Net weight exceeds requirements.

4.3.3 Lot acceptance tests The samples selected in accordance with 4.2.3 shall be subjected separately to the tests specified in 4.4. If any one of the samples fails to pass any one of the tests specified, the lot represented thereby shall be rejected.

4.4 Test procedures The adhesive, mixed as recommended (see 3.5), shall be tested in accordance with table III. Unless otherwise specified, all tests shall be after curing 24 hours at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$)

Test	TABLE III Test Methods		Paragraph giving further information	Paragraph giving requirement
	Method			
Solids	4041 1/		4.4.2	3.1.6
Corrosion	4031 2/		4.4.3	3.1.7
Application life	D 2471 3/		-----	3.2.2
Sag flow (pot life)	D 2730 3/		4.4.4	3.2.3
Preparation of metal surfaces	D 2651 3/		4.4.1	3.3
Tensile shear	D 1002 3/		4.4.1	3.3
Volume resistivity	D 257 3/		-----	3.3

1/ Federal Test Method Standard No 141 (see 2.1)

2/ Federal Test Method Standard No 175 (see 2.1)

3/ ASTM (see 2.2)

4.4.1 Tensile shear strength. Adhesive shall be tested as specified in 4.4.1.1 for compliance with table I.

4.4.1.1 Specimen preparation. Tensile shear shall be determined using aluminum alloy (QQ-A-250/5, 2024, T3, 0.063-inch thickness) panels that have been cleaned and prepared for bonding in accordance with ASTM D 2651, Method A. Two 2.5 x 10 cm (1 x 4 inch) panels, overlapped 12.5 ± 25 mm (0.500 ± 0.01 inch) with an adhesive bond line having a thickness of 0.25 to 1.25 mm (0.01 to 0.05 inch), shall constitute one test specimen. Fifteen test specimens shall be prepared and cured as specified in 4.4. Testing shall be as specified in ASTM D 1002, at the temperature described below

Temperature	Conditioning time, minutes	Specimens tested
$23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$)	-	5
$60 \pm 1^\circ\text{C}$ ($140 \pm 2^\circ\text{F}$)	30	5
$-55 \pm 1^\circ\text{C}$ ($-67 \pm 2^\circ\text{F}$)	30	5

4.4.2 Solids Prepare approximately 7 grams of the ready-to-use adhesive by mixing proper proportions of base and curing agent which have been conditioned at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$) for 24 hours. The mixture shall be allowed to cool at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$) until exothermic reaction ceases. The specimen shall then be tested for nonvolatile matter by Method 4041 of Fed Test Method Std No 141. Three samples shall be tested, and the average of the three shall be reported as solids in compliance with 3.1.6.

4.4.3 Corrosion. The adhesives shall be tested in accordance with Method 4031 of Fed Test Method Sta No. 175, using copper, steel, and aluminum, for compliance with 3.1.7.

4.4.4 Sag flow Sag flow shall be determined by ASTM Method D 2730 using the 6.25 mm (1/4 inch) channel. Check for compliance with 3.2.3.

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4.4.5 Storage stability. Store separate components in original, unopened containers for 1 year after the date of manufacture at $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$), and 50 ± 4 percent relative humidity, and in the absence of light. Test the adhesive, mixed as recommended (see 3.5), in accordance with methods specified in section 4 for conformance with 3.4. The manufacturer's authorized certification may be accepted in lieu of test data for conformance to 3.4. (See 4.1.1.)

5. PREPARATION FOR DELIVERY

5.1 Packaging. Adhesive shall be packaged in 1/2-ounce, 1-ounce, or 4-ounce jar/tube kit, or may be bulk packaged in pint, quart, or gallon sizes as specified (see 6.2). The kit shall be defined as the sum of the volumes of the base component and curing agent, but not including any thinner (see 3.1.3) which may be furnished. Packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A

5.1.1.1 Small sizes. The base component shall be packaged in a glass or plastic container fitted with a suitable screw-type or pressure sealing lid. Sufficient curing agent shall be packaged in a collapsible metal or plastic tube constructed of a material that will neither affect nor be affected by the activator. One tube of curing agent and one container of base (and one container of thinner, if required) comprising one kit shall be packaged in a close-fitting box conforming to PPP-B-566, PPP-B-665, or PPP-B-676. Boxes shall be secured to prevent accidental opening.

5.1.1.2 Bulk sizes. The base component and curing agent component shall be packaged in individual cans conforming to PPP-C-96, type V, class 2. One can each of base and curing agent (and one container of thinner, if required) comprising one kit shall be packaged in a close-fitting box conforming to PPP-B-636, class weather resistant. Boxes shall be closed in accordance with the appendix to PPP-B-636.

5.1.2 Level C. The base component and the curing agent component shall be kit packaged to afford protection against corrosion, deterioration, and damage from the supplier to the initial destination. The supplier may use his commercial practice providing it fulfills these requirements.

5.1.3 Instruction sheet. The manufacturer's instructions (see 3.5) shall be included in each kit. The instructions may be a separate sheet or may be incorporated in the kit label.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A. The adhesive, kit packaged as specified in 5.1.1 and in quantities as specified (see 6.2), shall be packed in a box conforming to PPP-B-636, class weather resistant. As far as is practical, the container shall be of minimum cube and tare consistent with protection required and contain identical quantities. The box shall be closed in accordance with the appendix to the box specification.

5.2.2 Level B. The adhesive, kit packaged as specified in 5.1.1 and in the quantities specified (see 6.2), shall be packed in a box conforming to PPP-B-636, class domestic. As far as is practical, containers shall be of minimum cube and tare consistent with protection required and contain identical quantities. The box shall be closed in accordance with Method II of the appendix to the box specification.

5.2.3 Level C. The adhesive, kit packaged as specified in 5.1.1 and in the quantities specified (see 6.2), shall be packed in shipping containers in a manner that will insure safe transportation to the point of delivery. Containers shall comply with the Uniform Freight Classification or National Motor Freight Classification.

5.3 Marking. In addition to any special marking required by the contract or order, all marking shall be in accordance with 5.3.1 or 5.3.2 and 5.3.3 as specified (see 6.2).

5.3.1 Civil agencies. Marking shall be in accordance with Fed. Std. No. 123.

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5 3.2 Military agencies. Marking shall be in accordance with MIL-STD-129.

5 3.3 Special marking. In addition to other markings required, individual containers, intermediate packages, and shipping containers shall be marked to show the following information

- a. Date of manufacture (by month and year)
- b. First reinspection date (one year after date of manufacture, by month and year)
- c. Store below 80°F in absence of direct light.
- d. Flash point in degrees centigrade and degrees Fahrenheit.

6. NOTES

6.1 Intended use The adhesives covered by this specification are silver-filled epoxy adhesives used primarily to install static discharger bases to exterior aircraft surfaces. These adhesives are also suited for applications such as conductive paths on circuit boards or grounding and bonding metal components without welding, brazing, or soldering. The adhesives may be used where hot soldering is impractical such as to nichrome wire or conductive plastics, or in locations which cannot be subjected to high temperatures. The adhesives may be used for preparing electrodes or specimens used to measure capacitance and loss characteristics. Cost and conductivity requirements would govern choice of types. Proper surface treatment is necessary for all bonds.

6.2 Ordering data Purchasers should select the preferred options permitted herein, and include the following information in procurement documents

- (a) Title, number, and date of this specification.
- (b) Type of adhesive required (see 1.2).
- (c) Size of kits and type of containers required (see 5.1)
- (d) Quantity required.
- (e) Level of packaging and packing required (see 5.1 and 5.2)
- (f) Special marking required by contract or order (see 5.3)

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