

MATERIALS PROCESSING DOCUMENT

S-313-015

**Adhesive Bonding of Epoxy Fiberglass
Thermal Blanket Fasteners to
Substrate Surfaces**

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**Materials Branch
Office of Flight Assurance
NASA/Goddard Space Flight Center
Greenbelt, MD 20771**

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Space Administration



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Adhesive Bonding of Epoxy Fiberglass Thermal Blanket Fasteners to Substrate Surfaces

| Section | Heading | Page |
|----------------|---|-------------|
| 1.0 | Overview | 1 |
| 2.0 | Purpose | 1 |
| 3.0 | Scope | 2 |
| 4.0 | Approval Requirements | 2 |
| 5.0 | Quality Assurance Requirements | 3 |
| 5.1 | Workmanship Requirements | 3 |
| 5.2 | Thermal Blanket Fastener Final Acceptance Criteria Requirements | 3 |
| 6.0 | Space Flight Materials Control and Use Requirements | 5 |
| 7.0 | Material Supply and Source List | 7 |
| 8.0 | Processing Facility and Essential Equipment Requirements | 9 |
| 9.0 | Substrate Surface Cleaning Process Requirements | 13 |
| 10.0 | Thermal Blanket Fastener Surface Cleaning Requirements | 17 |
| 11.0 | Adhesive Preparation and Application Requirements | 19 |
| 12.0 | Post Cleaning Thermal Blanket Fastener and Substrate Surface Requirements | 23 |
| 13.0 | Epoxy Adhesive Resin Cure Requirements | 23 |
| 14.0 | Accessory Cleaning Requirements | 23 |
| 15.0 | Applicable Documents | 25 |
| 16.0 | Abbreviations | 25 |
| 17.0 | Figures and Tables | 25 |
| 18.0 | Attachments | 25 |

LIST OF FIGURES

| Figure | Title | Page |
|----------------|--|-------------|
| 1 | Typical Adhesive Bonding of Thermal Blanket Epoxy Fiberglass Fastener | 27 |
| 2 | Soxhlet Extractor Assembly-Two Units | 28 |
| Attachment I | Standard Material Certification Form | I |
| Attachment II | Work Request | II |
| Attachment III | Mixing Record | III |

LIST OF TABLES

| Table | Title | Page |
|--------------|--|-------------|
| 1 | Physical Properties Reference of Hysol EA934 NA Epoxy Adhesives | 26 |

1.0 OVERVIEW

A polymeric adhesive bonding material is applied to the interface area between the thermal blanket epoxy fiberglass fastener and the substrate surface for two reasons. First, the adhesive material must provide good adhesive strength between the fastener and the substrate surface. Second, the adhesive material must support the fastener and the thermal blanket material for the duration of the project mission.

This document defines approved procedures for adhesive bonding an epoxy fiberglass fastener used in space flight applications. It specifies, in detail, all essential equipment, necessary materials, cleaning, masking, end item acceptance criteria and approval requirements. The procedures in this document have been developed and proven by testing and actual space flight applications.

Personnel involved in the adhesive bonding of space flight hardware according to the procedures in this document are required to be trained and qualified in all work aspects described by the document, including the precautions and controls associated with handling polymer materials.

2.0 PURPOSE

The procedures outlined in this document are intended to produce uniform, repeatable and consistent results and high quality space flight approved adhesive-bonded fastener end items.

In the adhesive bonding process, a polymeric material is applied between the fastener and the substrate surface and retained in place until the adhesive cures. The adhesive bonding is a common method of attaching large numbers of epoxy fiberglass fasteners quickly to substrate surfaces for thermal blanket attachment on space flight hardware surfaces. A prime objective of the overall process is the production of a finished adhesive bonded fastener to the substrate surface with maximum adhesive strength.

3.0 SCOPE

This document contains the Goddard Space Flight Center (GSFC) approved adhesive bonding procedure for attaching thermal blankets fasteners on space flight hardware surfaces.

This document is available for general use on GSFC or other NASA projects or by contractors, subcontractors, universities or other individuals engaged in building space flight hardware, but its use is subject to the provisions in Section 4.0.

4.0 APPROVAL REQUIREMENTS

Prior approval by the GSFC Materials Assurance Office (GSFC Code 313.A) or the personnel listed on the document sign-off page and the project program for which the work is performed shall be required before use of this document is permitted.

Any polymer or other material substitutes (materials not specified herein, including solvents, wipes, etc.) used in the adhesive bonding of thermal blanket fasteners shall require prior approval by GSFC Code 313.A and the project program for which the work is performed before their use in the space flight adhesive bonding application is allowed.

5.0 QUALITY ASSURANCE REQUIREMENTS

5.1 WORKMANSHIP REQUIREMENTS

Space flight quality adhesive bonding of the thermal blanket epoxy fiberglass fasteners is the result of careful workmanship by qualified personnel performing the work. Personnel involved in the adhesive bonding of space flight hardware according to the procedures in this document shall be trained and shall be certified as qualified and competent in all work aspects encompassed by this document. Certification and training of personnel performing the adhesive work shall be considered a responsibility of the Quality Assurance section of the project organization performing the adhesive bonding.

Upon request, GSFC Code 313.2 personnel may be available for assistance in the adhesive bonding process. It is also strongly recommended that personnel attend the space flight approved polymer training course given at NASA Jet Propulsion Laboratory as part of the certification process.

5.2 THERMAL BLANKET FASTENER FINAL ACCEPTANCE CRITERIA REQUIREMENTS

All visual inspections shall be performed with a lighted magnifier having 10X magnification.

Measured Shore D hardness values shall be recorded in the appropriate documentation associated with the flight hardware.

The thermal blanket fastener and its epoxy adhesive hardness test sample shall meet the following requirements before the fastener is acceptable for space flight use:

- a. The thermal blanket epoxy fiberglass fastener adhesive hardness test sample shall be in a fully cured state as defined herein, tack free to the touch of a plastic probe and shall be tested for Shore hardness. After testing, the hardness test sample shall exhibit a Shore D hardness within ± 5 units of the value measured at the time of material receipt.
- b. The adhesive bonding material around the fastener shall be in a fully cured state as defined herein, and tack free to the touch of a plastic probe.

- c. The fastener adhesive shall have good adhesion and show no evidence of separation or delamination from the substrate surface.
- d. The fastener adhesive shall show evidence of a continuous fillet at the fastener/substrate surface interface.
- e. The exposed adhesive around the fastener edge shall not have any surface air bubbles or voids, nor contain any particulate contamination such as dirt, hair, dust, etc.
- f. The exposed adhesive around the fastener edge should be no more than 1/16 inch (1.6 mm) from the edge and shall not overlap on the fastener flange area.
- g. Excess adhesive spillage or smears shall not be allowed on the fastener and adjacent substrate surface.

6.0 SPACE FLIGHT MATERIALS CONTROL AND USE REQUIREMENTS

There are specific control requirements for space flight approved polymer materials and their use in space flight applications. The requirements shall be as follows:

- a. Upon receipt, the polymer materials shall be verified against the appropriate documentation to ensure that the correct materials were delivered. A **Standard Materials Certification (SMC)** or **Certificate of Compliance (CofC)** form from the manufacturer shall accompany the materials and shall include lot number, cured and uncured properties, date shipped, date manufactured and the manufacturer's expiration date. See Attachment I.
- b. The SMC or CofC and the purchase order shall be filed for record keeping, material property test verification, and traceability of the material.
- c. An inspection label shall be attached to each material container providing information on the material type, date of receipt, date of manufacture, manufacturer's expiration date, lot number, storage requirements, and Shore hardness of the cured resin. A Shore hardness test shall be performed by the receiving laboratory upon receipt of the materials and shall be completed before any adhesive bonding of fasteners on space flight hardware begins. The Shore hardness measured upon receipt of the materials shall be verified against the SMC or CofC test values and recorded on the material inspection label along with the test date. The material shall not be used if it does not exhibit proper cure and Shore hardness of ± 5 units of the manufacturer's specified value.
- d. All space flight materials shall be properly stored in a separate cabinet, refrigerator, or freezer as required by the temperature specifications in the SMC or CofC. This storage cabinet shall be reserved only for space flight materials, and shall be labeled "FOR SPACE FLIGHT USE ONLY", which have not exceeded their expiration date. **Material expiration dates shall be inspected weekly.** Expired materials shall be removed from the space flight material storage cabinet and stored in a separate cabinet. Expired materials shall be labeled "NOT FOR SPACE FLIGHT USE" and disposed of properly.

- e. Materials shall not be used for space flight applications after they have exceeded their manufacturer's expiration date unless an approval for an expiration date extension has been granted. **An extension of the materials expiration date shall require the approval of GSFC Code 313.A personnel.** An extension is generally granted for 30 days. The request for extension shall be submitted in writing 3 weeks prior to the materials expiration date. Approval shall be granted only after the soon-to-expire material has been tested at GSFC and has demonstrated proper uncured (visual inspection - color, lack of solidification, etc.) and cured properties. Any material exceeding the manufacturer's expiration date by more than 90 days shall not be used.
- f. Shelf life may be extended by the contractor, providing that the contractor submits a procedure for shelf life extension approval. This procedure shall be submitted prior to the materials use and approved by the Material Assurance Office, Code 313.A
- g. The preparation and application of polymers for space flight use shall be documented and controlled using a work request and mixing record form. The work request and mixing record shall be fully completed and filed for record keeping. An acceptable example of a work request and mixing record form can be found in Attachments II and III, respectively, of this document.

7.0 MATERIAL SUPPLY AND SOURCE LIST

The following is a list of materials used in the procedure and sources of manufacturers of these items.

| <u>Materials</u> | <u>Source</u> |
|---|---|
| Abrasion Cloth, 320 grit | Local Source |
| Acetone, A-18 | Fisher Scientific Co. Pittsburgh, PA |
| Bag (plastic) clean, Aclar LB 522 (22C) | Clean Facility Products, Inc. Ronkonkoma, NY |
| Beaker, Glass 250 cc | Fisher Scientific Co. Pittsburgh, PA |
| Beaker (Plastic), Polyethylene, 16 oz (454 gms) | Airlite Products Omaha, NE |
| Brush, Sable 1/8 inch & 3/8 inch (3.1 & 9.5 mm) diameter | Local Source |
| Dryer, Forced Air 09-201-5 | Fisher Scientific Co. Pittsburgh, PA |
| Ethyl Alcohol, 200 proof | Midway Grain Products Pekin, IL |
| Face Mask with, Organic Filter, 17-674 | Fisher Scientific Co. Pittsburgh, PA |
| Gloves, Polyethylene 11-394 | Fisher Scientific Co. Pittsburgh, PA |
| Glass Beads, 11-311C | Fisher Scientific Co. Pittsburgh, PA |
| Heptane, 03008 | Fisher Scientific Co. Pittsburgh, PA |
| Hysol EA934NA-A Epoxy | Wolcott-Park, Inc. Rochester, NY |
| Hysol EA934NA-B Epoxy | Wolcott-Park, Inc. Rochester, NY |
| Hysol EA934NA-A/B; | Appli-Tec Inc. |

| | |
|---|--|
| Premixed & Frozen | Newburyport, MA |
| Isopropyl Alcohol, A-417 | Fisher Scientific Pittsburgh, PA |
| Razor Blade, Single Edge | Local Source |
| Swabs, Cotton | Local Source |
| Swabs, Foam, TX-700B | Texwipe Co. Hillsdale, NJ |
| Tape, Kapton, K-102 | Connecticut Hard Rubber New Haven, CT |
| Spatula, Plastic, Part No. 6169-0010 | Nalge Co. Rochester, NY |
| Spatula, Stainless Steel 14-375-10 | Fisher Scientific Co. Pittsburgh, PA |
| Wipes, Cotton, TX-304 | Texwipe Co. Hillsdale, NJ |

8.0 PROCESSING FACILITY AND ESSENTIAL EQUIPMENT REQUIREMENTS

Adhesive bonding of the thermal blanket fasteners shall require the use of a clean facility to control contamination (especially silicones, hydrocarbons, vinyl and particulate contamination). The clean facility shall have a GSFC project approved cleanliness level and shall have good ventilation, good lighting, temperature control between 20° and 25°C, and relative humidity ranging from 30% to 60%.

Work space areas must be sufficiently large to contain the actual adhesive work, essential equipment, instruments and all other required hardware. These items shall be inside the clean facility to minimize contamination during the transfer of flight hardware from one work area to another.

Essential equipment shall include:

- a. A calibrated, laboratory weighing balance, accurate to 0.01 gram, used to control material mixing proportions.
- b. A vacuum chamber or bell jar capable of operating at a vacuum level of 50 microns of mercury (Hg) or less when empty, used to ensure a bubble free end item.
- c. A laminar flow bench clean work station providing a 100 cleanliness class level (per FED-STD-209B) used to prevent contamination. This work station includes a minimum lighting capability of 100 foot candles of illumination (1,076 lumens per square meter).
- d. A health and safety approved exhaust fume hood for exhausting chemical fumes and vapors used to meet OSHA requirements. A minimum of 125 ft/min (38 m/min) exhaust at the hood face is recommended.
- e. A clean, oil free, 0 to 100 psi (0 to 0.69 MPa), nitrogen gas system including hoses, valves, a regulator, and nozzles used to spray clean and blow dry cleaned surfaces. No flexible polyvinyl chloride (PVC) hose such as Tygon shall be allowed. Cleaned nylon, Teflon, polyethylene or Viton hoses are recommended and acceptable.
- f. A lighted magnifier with 10X magnification used for visual inspections.
- g. A Shore D hardness tester, used for verifying proper cured hardness of the epoxy adhesive.
- h. A convection oven, used in the final drying process to dry surfaces.

- i. An ultra-low temperature freezer for premixed and frozen resin. (-40° to -60°C).
- j. A spray apparatus for cleaning surfaces and other hardware.

The following list details the model or part number, size or capacity, and source addresses for the essential equipment*: (This representative list is not meant to constitute an endorsement of these products, only that they were used during the development of this work for space flight hardware on GSFC programs.)

- a-1 Mettler Balance
PC4400
Mettler Instrument Corp.
Highstown, NJ 08520
- b-1 Hotpack Thermal Vacuum Chamber including an
18 CFM Mechanical Pump
Floor Model 273700-13
Hotpack Corp.
Philadelphia, PA 19154
- c-1 Class 100 Laminar Flow Bench
Model 530-CS
Laminaire Corp.
Rahway, NJ 07065
- d-1 Slimline External Air Induction Exhaust Fume Hood
Model ESS-06
Duralab Equipment Co.
Brooklyn, NY 11236
- e-1 Nitrogen gas (99.99% pure or boil off to meet this
specification), Valves, Hoses, Regulator
Pressure Range: 0-100 psi (0-0.69 MPa)
Local Sources
- f-1 Luxo Illuminated Hand Magnifier, 10X
Cat. No. L-03882-40
Cole-Palmer Instrument Co.
Chicago, IL 60648-9930

* Equivalent equipment may be substituted for those listed here.

- g-1 Hardness Tester, Shore D
Shore Instruments & Mfg. Co.
Freeport, NY 11520
- h-1 Blue M Convection Oven
Model POM-588C-3X
Blue M Electric Co.
Blue Island, IL 60406
- i-1 Puffer-Hubbard Freezer
Model ICF-9007-A-O-R
Puffer-Hubbard Manufacturing
350 Park Ave.
New York, NY 10022
- j-1 Binks Model 15 Spray Gun
Binks Mfg. Co.
Franklin Park, IL 60131

9.0 SUBSTRATE SURFACE CLEANING PROCESS REQUIREMENTS

Starting at this point in the procedure, all the following processes shall be performed in a clean facility. Personnel shall wear clean facility approved clothing, clean facility approved gloves (polyethylene) and follow clean facility approved procedures. Only clean facility approved materials and wiping accessories (see Section 14.0) shall be allowed in the clean facility.

In preparation for the cleaning and abrasion operations, bonding areas of the substrate are masked off to prevent the adhesive from contacting any surfaces that are not to be bonded. The epoxy fastener is masked differently and cleaned as described later in the procedure.

In addition to cleaning the fastener and substrate, the spatulas, beakers, blades, and cleaning brushes are to be thoroughly cleaned to minimize any possible contamination from these non-flight items.

All masking shall take place at the laminar flow bench and cleaning shall take place under the exhaust fume hood. Large substrate surfaces should be cleaned in areas designated by the project or Quality Assurance of the section performing the work.

Personnel may need to wear a face mask with an organic filter throughout the cleaning and bonding process for protection from solvents and organic vapors. Personnel must wear a face mask if required by their local health and safety standards.

The substrate surface preparation shall be as follows:

- a. Brush and spray clean the following items: spatulas, blades, containers, straight edge, drip container, and any other non-flight items being used in the cleaning of flight hardware. Use a 1:1 volume mixture of alcohol/heptane and a precleaned sable brush. Brush clean each item for 2 to 3 minutes then spray clean each item for 1 to 2 minutes using a Binks Model 15 spray apparatus. Set the spray apparatus between 40 to 50 psi (0.27 to 0.34 MPa). This ensures that the flow of solvent forces loose any particles adhering to the items and flushes away contaminants. Use a drip container to catch excess solvent. Dry the items per steps j and k as shown below. Store the above items, unless immediately needed, in a clean bag or cabinet free of contaminants such as silicones, vinyls, hydrocarbons and particulates.

- b. Prepare the substrate surface as follows: Mask off the appropriate substrate surface bonding sites per drawing requirements with one inch (25.4 mm) wide Kapton tape. This area shall be approximately 1/16 inch (1.6 mm) larger than the epoxy fiberglass fastener area.
- c. Any surface coatings such as paint must be removed before the abrasion of the substrate surface can begin. Remove the paint by scoring the surface of the coating to be removed (that area within the tape masking) with a sharp blade, being careful not to damage the underlying surface. With a sharpened wedge of nylon or polypropylene placed on the scored edge, push the paint toward the center of the area to be removed. Continue until all the paint has been lifted from this area.
- d. Abrade this area with 320 grit aluminum oxide cloth until fresh, bare aluminum surface is well exposed.
- e. Clean the abraded area very carefully, so that the adjacent coating is not damaged by the cleaning solvents. A precleaned cotton fabric lightly dampened with alcohol is used to remove the debris created by the abrasion process. Clean the area well until a bright metallic surface is exposed and no visible contamination remains on the substrate surface. The Kapton masking tape should remain in place during the cleaning process for adjacent surface protection. Do not allow solvents to get under this tape.
- f. Anodize, iridite and bare aluminum surfaces must also be abraded well to expose a fresh aluminum surface. Use 320 grit aluminum oxide cloth to abrade these surfaces until a fresh surface is well exposed.
- g. Clean the abraded area well with precleaned cotton fabric dampened with acetone to remove the debris created by the abrasion process. Continue cleaning until no visible contamination remains on the surface.
- h. Repeat the surface wiping in steps e and g using precleaned cotton fabrics dampened with alcohol.
- i. Remove the Kapton masking tape and gently clean the taped surface area with precleaned wipes dampened with alcohol to remove tape residue and any debris lodged under the tape as a result of the surface abrasion.

- j. Blow dry the freshly cleaned surfaces. This removes excess solvent and reduces final drying time. Use a clean nitrogen gas system. Set the nitrogen system pressure between 30 and 40 psi (0.21 to 0.27 MPa).

CAUTION: Do not blast the edges of the paint as it may damage or lift the painted surface.

- k. Dry the cleaned surfaces. This final drying removes all cleaning solvents and moisture. Use a convection oven free of contaminants (such as silicones, hydrocarbons, vinyls and particulates). Set the oven temperature between 60° and 65°C. Dry for a minimum of 30 minutes.
- l. Cleaned surfaces which cannot be placed in a convection oven, shall be dried by a warm forced air dryer for 3 to 5 minutes to remove solvents. Do not allow the cleaned substrate surface to heat over 65°C. If the cleaned surface cannot tolerate any heat, let stand at ambient temperature between 20° to 25°C for a minimum of one hour for solvent evaporation.
- m. The substrate surfaces are now clean and ready for bonding. The substrate surface shall be kept clean and free of contaminants such as silicones, hydrocarbons, vinyls, and particulates. The fastener shall be bonded to the substrate within 24 hours.

10.0 THERMAL BLANKET FASTENER SURFACE CLEANING REQUIREMENTS

The adhesive bonding surface area of the epoxy fiberglass fastener must be thoroughly cleaned to provide excellent adhesion between the fastener and the substrate surface. The fastener cleaning process is as follows:

- a. Prepare the thermal blanket fastener's bonding surface by wiping clean the base and its entire surface. Use a clean cotton wipe dampened with acetone. Wipe clean for 1 to 2 minutes. This removes any contamination from the fastener's bonding area.
- b. Grasp the fastener body firmly and then gently abrade the fastener's base back and forth over 320 grit abrasion cloth until the surface has been evenly roughened. Remove only that amount of the fastener's surface necessary to provide a complete abrasion.
- c. Wipe clean the fastener's surface several times with clean cotton wipes that are lightly dampened with acetone to remove the abraded debris.
- d. A final cleaning with clean cotton wipes and alcohol, using several separate areas of the wipes will complete the cleaning process.
- e. Blow dry the freshly cleaned bonding surface of the fastener. This removes excess solvent and reduces the final drying time. Use a clean nitrogen gas system. Set the nitrogen system between 30 and 50 psi (0.121 to 0.34 MPa). Blow dry for 1 to 2 minutes.
- f. Place the fastener in a clean convection oven free of contaminants (such as silicones, hydrocarbons, and vinyls) at 65°C for a minimum of 30 minutes to remove all solvents and moisture.
- g. The fastener is now clean and ready for adhesive bonding. The fastener shall be bonded within 24 hours. Store the fastener, unless needed immediately, in a clean bag or cabinet free of contaminants such as silicones, hydrocarbons and particulates until ready for bonding. Repeat step f when fasteners are not used within 24 hours.

11.0 ADHESIVE PREPARATION AND APPLICATION REQUIREMENTS

Hysol EA934NA epoxy is the recommended adhesive for bonding the epoxy fiberglass fastener to substrate surfaces. This structural epoxy has excellent adhesion to most surfaces with Table 1 providing the lap shear strength and outgassing properties.

This epoxy may be purchased from the manufacturer in two parts and prepared in the laboratory or purchased premixed and frozen; both are acceptable for space flight use. An ultra-low temperature freezer (-40° to -60°C) will be necessary when using premixed frozen materials.

Excess adhesive material from each mixed batch shall be retained as a hardness test sample. The test sample shall be used to verify proper adhesive bonding cure and Shore hardness. The hardness test sample shall be a minimum of 1/4 inch (6.3 mm) thick and approximately 1.5 inches (38.1 mm) in diameter.

The adhesive bonding shall take place at the laminar flow bench or on-site in the case of large flight hardware. The adhesive shall be kept clean and free of contamination because contamination may reduce adhesion properties of the bonded fasteners.

Personnel may need to wear a face mask with an organic filter during the adhesive bonding process because of the epoxy vapors. A face mask shall be used by personnel if required by local health and safety standards.

The bonding epoxy resin formulation, all materials ± 0.05 grams, shall be as follows:

| <u>Material</u> | <u>Function</u> | <u>PBW*</u> |
|-----------------|-----------------|-------------|
| EA934 NA-A | Resin | 50.0 g |
| EA934 NA-B | Curing Agent | 16.5 g |

* Parts By Weight

- a. Weigh the EA934NA-A resin under the air exhaust fume hood. Use a laboratory balance. Measure the amount specified above. Place the materials into a clean glass or polyethylene beaker.

- b. Weigh the EA 934 NA-B curing agent under the air exhaust fume hood. Use a laboratory balance. Measure the amount specified above. Add this material to the EA934NA-A already in the beaker. Stir the materials well for 3 to 5 minutes.
- c. Place the beaker and the epoxy mixture in a vacuum chamber. Vacuum deaerate at an ambient temperature between 20° to 25°C and at a pressure of 100 microns of Hg or less to remove entrapped air from the adhesive mixture. Deaerate the mixture for 6 to 8 minutes.
- d. Remove the beaker with the epoxy mixture from the vacuum chamber after clean air or nitrogen gas back-fill. The epoxy is now ready for application.
- e. To control the adhesive application and thickness, take a 1 or 2 inch (25.4 or 50.8 mm) square of Kapton tape and cut a hole into it that has a 1/8 inch (1.6 mm) larger diameter than the epoxy fiberglass fastener base. Three layers of the Kapton tape should be used to obtain a 0.006 to 0.009 inch (0.15 to 0.22 mm) thickness of wet adhesive. A metal or plastic template of equal size and thickness also works well to control the adhesive.
- f. Place a sufficient amount of the epoxy adhesive into the cut out area of the Kapton tape by use of a brush or spatula.
- g. Spread the wet adhesive uniformly into the cut out area of the Kapton tape by using a spatula or brush. Several passes with a straight edge may be necessary to achieve a smooth uniform layer of adhesive. The epoxy adhesive has a pot life of 45 minutes from the time of mixing or thawing. Fresh adhesive should be prepared if additional material is required.
- h. Remove the tape with tweezers by gently lifting upwards until the tape is removed. Remove the tape carefully so that no adhesive spills on the substrate surface.
- i. Place the fastener on the wet adhesive surface and press down on the fastener center post until it becomes embedded into the epoxy adhesive. Excess adhesive will squeeze out from beneath the fastener. Use a sharp pointed tool to form a fillet between the fastener flange edge and the substrate surface. Figure 1 illustrates the typical adhesive bonding of the fastener.

- j. Tape down the fastener by applying a 1/2 inch (12.7 mm) piece of Kapton tape over the fastener's center post and to the substrate surface. This will prevent the fastener from moving, especially on vertical surfaces. Leave the tape on the fastener for 18 to 24 hours.

12.0 POST CLEANING THERMAL BLANKET FASTENER AND SUBSTRATE SURFACE REQUIREMENTS

Thoroughly remove any adhesive spillage on the fastener or substrate surface. Clean these areas using cotton fabric or foam swabs lightly dampened with alcohol to remove any adhesive or other contamination. A sharpened wedge of nylon or polypropylene works well to remove stubborn contamination.

13.0 EPOXY ADHESIVE RESIN CURE REQUIREMENTS

The EA934NA resin adhesive should be considered in a partially cured state 24 hours after the adhesive application when cured at an ambient temperature between 20° to 25°C.

The EA934NA resin adhesive should be considered in a fully cured state 7 days after the adhesive application when cured at an ambient temperature between 20° to 25°C.

If an elevated temperature cure is desired for the fastener bonding, allow the epoxy application to stand overnight, then cure at 60° to 65°C for 24 hours.

14.0 ACCESSORY CLEANING REQUIREMENTS

Cotton wipes, cotton swabs, and urethane foam swabs are the wiping accessories used in the clean facility, but these items can be potential sources of clean facility contamination if they are not certified for clean facility use.

To be considered certified and suitable for clean facility use, the items listed above require cleaning by a soxhlet extraction method for 48 to 72 hours. Cleaning the items is time consuming, however, it is essential that these strict cleanliness procedures be followed when working with space flight hardware.

Prior to cleaning any material which is to be used in a clean facility, a solvent filled soxhlet extractor system shall undergo a thorough, internal, self-cleaning for about 18 hours of cycling. The used solvent shall be properly discarded upon completion of the internal cleaning, and the system shall be filled with fresh, clean solvent in preparation for the extraction of the materials which are to be used. Fresh, clean solvent shall be totally substituted for the used solvent after every third 48 to 72 hour material extraction period in the process. Glass beads

should be included in the flask for smooth boiling action.

See Figure 2 for a diagram showing two extractors (a 2 or 3 liter glass system is recommended) that are used simultaneously to decrease cleaning times. A single soxhlet extractor may be used in place of the two extractors shown. The extractors should be set up in the clean facility.

The cleaning solvent used in soxhlet extraction is ethyl or isopropyl alcohol. Once extracted with the alcohol, the cleaned items are spread out under a clean operating exhaust fume hood for several hours to air dry. The cleaning materials must be well air dried before placing them in the convection oven. A final drying in a convection oven at 50° to 60°C for 2 hours will complete the process. The cleaned and dried items are stored, unless used immediately, in a bag or cabinet free of contaminants until needed.

To be certified for clean facility use, the extracted items shall have been cleaned in the soxhlet extractor system for 48 to 72 hours. In addition, as part of the certification process, three of the extracted items are randomly chosen as test samples and their cleanliness is verified. Cleanliness of the items is verified by immersing and thoroughly rinsing well the cleaned items in a glass dish containing an alcohol bath, removing the items to allow the alcohol to evaporate, and then testing the alcohol bath residue to determine cleanliness. Testing of the extracted residue is performed through infrared analysis. To be certified for clean facility use, an Infrared Spectrum of the residue extracted from 3 clean samples shall exhibit a transmission curve of 95% minimum throughout the 2.5 to 16 micron range.

An alternative to using the soxhlet extractor system is to purchase clean facility approved materials. Approved materials can be purchased from the Paramax Corporation, Lanham, MD, or from the Coventry Manufacturing Co., Baldwin Park, CA. Only swabs and wipes from their Diamond series are acceptable. A certificate of cleanliness level should accompany the cleaning materials.

15.0 APPLICABLE DOCUMENTS

| | |
|------------------------------------|--|
| OSHA Standards 29 CFR Part 1910 | Occupational Safety and Health Standards |
| ASTM D 2240 | Standard Method of Test for Rubber Property Durometers Hardness |
| MIL-STD-1209B | Clean Room and Work Station Requirements, Control Environment |
| GSFC Training Program | Inspection of Polymeric Application, May 1991 |

16.0 ABBREVIATIONS

| | |
|--------------|----------------------------------|
| GSFC. | Goddard Space Flight Center |
| SMC. | Standard Materials Certification |
| CofC. | Certificate of Compliance |

17.0 FIGURES AND TABLES

The figures from pages 27 and 28 are discussed in this document. Refer to page 26 to review Table I.

18.0 ATTACHMENTS

The referenced attachments are located at the end of this document.

**Table 1. Physical Properties Reference for
Hysol EA934 NA Epoxy Adhesives**

| Material* | Outgassing** % TML % CVC | Tensile Lap Shear Strength PSI (MPa) AL to AL |
|-----------|-----------------------------|---|
| EA934NA | 0.79 0.01 | 3100 (21.2 MPa) |

* Cured at ambient temperature for 7 Days

** ASTM E-595, tested at 125°C, 24 hours, 10⁻⁵ Torr.

Outgassing control number GSC 10592

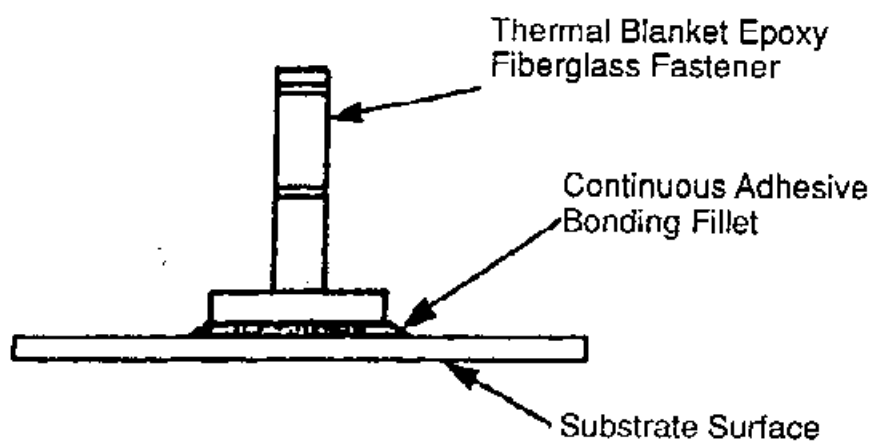
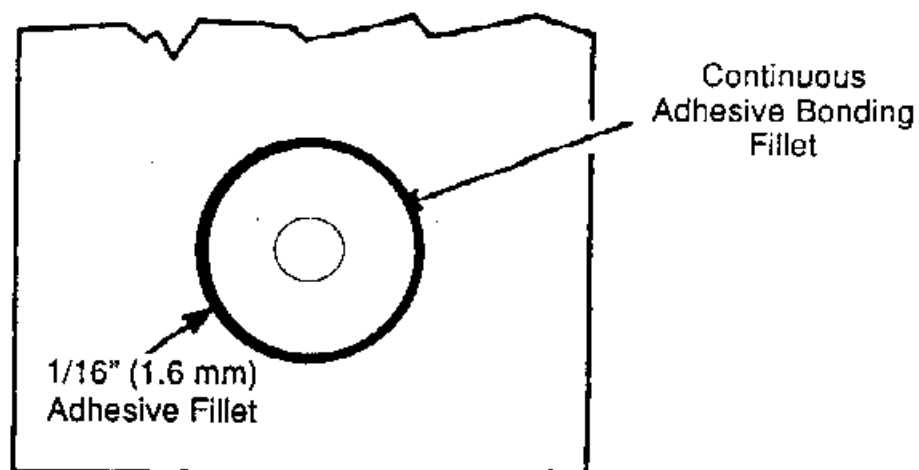


Figure 1. Typical Adhesive Bonding of Thermal Blanket Epoxy Fiberglass Fastener

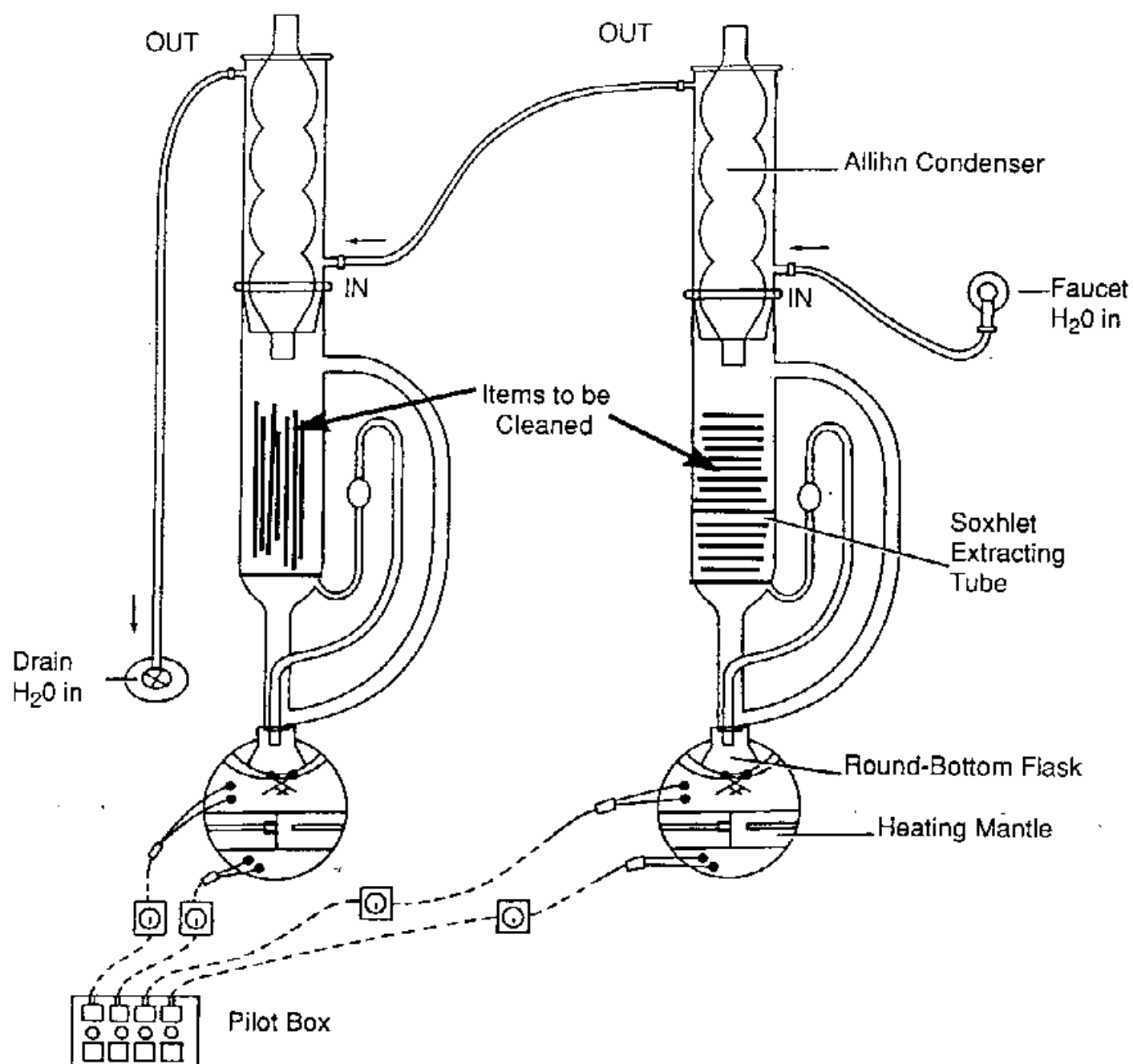


Figure 2. Soxhlet Extractor Assembly - Two Units

STANDARD MATERIAL CERTIFICATION (SMC) FORM*

Customer: _____

Customer Specification Number: _____

Customer Purchase Order No.: _____

Material No.: _____

Lot Number: _____

Date Manufactured: _____

Date Shipped: _____

Quantity Shipped: _____

(Shelf Life: 6 months from date of shipment when stored in original, unopened containers.)

| PROPERTIES | TEST METHOD | SPECIFICATION LIMITS | TEST RESULTS |
|----------------------------|-------------|---|--------------|
| UNCURED: | | | |
| Appearance | TM-002 | White, free of particles, lumps, and gels | _____ |
| Flow (inches, 30 sec.) | TM-019 | 0.5 maximum | _____ |
| Tack Free Time (min.) | TM-005 | 30 maximum | _____ |
| Cure Time (hours) | | 24 maximum | _____ |
| CURED: | | | |
| Specific Gravity | TM-003 | 1.11 ± 0.02 | _____ |
| Durometer, Shore A | TM-006 | 30 minimum | _____ |
| Tensile Strength (psi) | TM-007 | 420 minimum | _____ |
| Elongation (%) | TM-007 | 150 minimum | _____ |
| Tear Strength (Die B, ppi) | TM-009 | 30 minimum | _____ |
| Lap Shear Strength (psi) | TM-010 | 250 minimum | _____ |
| CVCM (%) | ASTM E-595 | 0.10 maximum | _____ |
| TML (%) | ASTM E-595 | 1.0 maximum | _____ |

Retainer Taken: _____

Inspector: _____
 Quality Assurance Manager

Date: _____

Attachment I

EXAMPLES

*McGhan Nusil Corp. Carpinteria, CA -- SMC Form

MATERIALS BRANCH

Work Request #: _____ Date Received: _____

Date Needed: _____

Requested By: _____ Code: _____ Phone: _____

Project _____ Experiment _____ Received by: _____

Component Identification (Manufacturer or Description):

Explain Work Desired: _____

Indicate which polymer material should be used, or check if we are to select materials.: _____

Indicate the maximum and minimum processing temperatures:

MIN: _____ MAX: _____

Contractor: _____

Telephone: _____

Address: _____

Flight Hardware: _____ Non-Flight Hardware: _____

Work Performed by: _____

Date work completed: _____

Picked Up By: _____ Date: _____

Approval of polymer material is needed by 313.A, if manufacturer's date is exceeded.

Signature: _____

MIXING RECORD

POLYMER IDENTIFICATION

MANUFACTURER: _____

| INGREDIENTS | LOT NUMBER | DATE RECV'D. | DATE MFG. | DATE EXP'D | PART BY WEIGHT | AMT. GRAMS |
|-------------|---------------|-----------------|--------------|---------------|-------------------|---------------|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

DEGASSED: YES _____ NO _____ FOR _____ MINUTES

PROPER CURES: YES _____ NO _____

HARDNESS VALUE: _____ CONTROL NUMBER: _____

PREPARATION OF COMPONENTS/SUBSTRATES: _____

DESCRIBE APPLICATION PROCEDURE: _____

CURE TIME: _____ AND TEMPERATURE: _____

WITNESS SAMPLE PREPARED: YES _____ NO: _____

PROCEDURE FOLLOWED: _____

PROJECT: _____ MFGR.: _____ LAB: _____ OTHER: _____

PREPARED BY: _____ DATE: _____