ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ
North American Aviation, Inc.
Downey, California

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FOSTER PUBLISHING COMPANY
Long Beach, California

ADHESIVE MATERIALS,
THEIR PROPERTIES AND USAGE
SUPPLEMENTS

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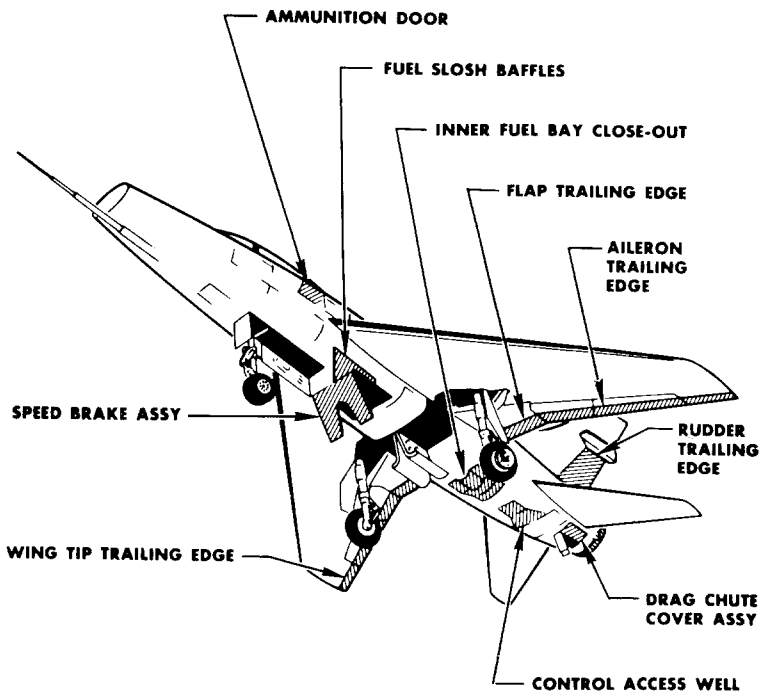

Adhesive Bonded Components in Aircraft.

(Courtesy North American Aviation, Inc.)

Volume 1 Number 1

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IRVING KATZ
North American Aviation, Inc.
Downey, California

JUNE 1965

FOSTER PUBLISHING COMPANY
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To Lucy, Philip, Laurie
Barbara, Morris, Elsie and
Opal

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PREFACE

Every design, whether it be for a component or for a complete system, will utilize adhesive bonding in its reduction to the hardware stage.

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE has brought into being the first and only comprehensive guide to Government, National, Industrial and International specifications covering adhesives, binders, cements, glues, mortars, mucilages, pastes, gummed and pressure-sensitive adhesives.

However, specifications are living documents. They are continuously being created, changed and canceled. One of the more vexing problems facing most engineers and manufacturers in developing and maintaining products is the need to keep up with the advancing technology reflected in specifications.

The SUPPLEMENTS will meet this need by bringing up to date every 3 months the data contained in new, and revised adhesive material specifications, eliminating the need for extensive literature surveys, delays in specification procurement and expensive analyses.

The SUPPLEMENTS retain the same format and styling of the original book.

Irving Katz

Downey, California
May 15, 1965

PREFACE

Adhesive Materials, Their Properties and Usage

Currently, it takes nine glues for you to light up your cigarette. Detached retinas, worn arteries and broken bones are being repaired with adhesives. Highway departments use these materials in restoring roads, while builders are constructing houses and fences at lower costs by substituting these bonding agents for mortar. Automobiles contain between eight and twenty five pounds of plastic cements; moreover, in the not too distant future, the entire car may be free from screws, solder and rivets. The shoe manufacturers are discarding nails and threads for these adhesive materials, while the garment industry is attempting to assemble clothes by bonding, in order to eliminate costly sewn seams. The aircraft, shipbuilding, packaging, toy and dental industries all use bonding materials — in some cases even for prime structural purposes.

To support these assembly operations, approximately two billion pounds of chemical joining agents, commonly called adhesives, cements, glues, mucilages, pastes and pressure-sensitive tapes, are being produced in this country. The user has available such a wide variety of types, grades and forms that the problem of choosing which adhesive will join his components is not a simple one. Factors concerning loads, temperature range, weathering and environmental conditions affecting the joint, limit the selection. Further, since profitable operations not only depend on how fast and inexpensively parts can be made but also on how quickly the product can be assembled, additional factors are introduced. Typical ones which require consideration are process equipment availability, manufacturing sequences, purchasing commitments and storage (some adhesives spoil rapidly).

Other than a few limited reviews, there is no single source guide oriented toward the user which even begins to answer all these questions. The user is thus faced with a formidable problem. Not only does he have to sift out which types of adhesives can join his components, but also he must determine which is best for his application, consistent with process and equipment limitations. Considerable literature searching as well as supplier contact is therefore necessary. Such an ambitious project is time consuming; and in certain cases where decisions are urgent, the problem becomes difficult to resolve.

Nevertheless, there is actually a vast source of readily applicable data. These data are contained in specifications, which define what is expected in measurable terms, give the limits of uniformity and quality, and distinguish between a good and a bad product. Unfortunately, when the precise number and title of the desired specification are unknown, procurement is hindered.

In response to this shortcoming, this book provides a guide for choosing suitable adhesives covered by specifications. It gives basic and detailed information of value, on a comparable basis, to designers, manufacturers, engineers and technical personnel concerned with fabricated parts of almost every conceivable nature, where adhesive bonding assembly operations are an integral part of fabrication.

Towards this end, the book is divided into two parts. Part I guides the user to those adhesives which can fulfill specific jobs. Part II gives exact specification details covering the chemical, physical, process and performance properties, as well as availability of these bonding materials. In order to keep up with the changing technology of adhesive bonding which is reflected in the creation, revision and cancellation of specifications, this book will be revised periodically.

I wish to thank three publishers for their permission to use portions of my articles in this book. These are Reinhold Publishing Company ("Adhesives for Wood", Materials in Design Engineering, July 1962), Conover-Mast Publications ("Pressure-Sensitive Adhesive Electrical Tapes", Electro-Technology, August 1962 and "Adhesives for Optical and Electro-Optical Applications", Electro-Technology, April 1963, copyright C-M Technical Publications) and Palmerton Publishing Company ("A Guide to Federal and Military Specifications for Rubber Bonding Adhesives", Rubber Age, April 1964).

Irving Katz

Downey, California
July, 1964

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PART I

ADHESIVES SELECTION

1. PAPER AND FABRIC ADHESIVES

One of the more vexing problems encountered in the bonding of paper is the curling and wrinkling that is sustained with many paper adhesives. Rubber cement has been modified to permit bonding without any of these shortcomings. Additionally, it may be peeled readily without any discoloration to the substrate. The cement is suitable for mounting of prints, maps, drawings and charts as well as general purpose paper bonding work (Reference 1).

BIBLIOGRAPHY

Straight Paper Assembly Adhesives

(1) MMM-A-00185 Adhesive, rubber (for paper bonding), 10 November 1964. No QPL.

2. WOOD ADHESIVES

Wood adhesives fall into three general usage categories: the first, for straight wood assemblies, including plywood manufacture and veneering applications; the second, for specific mixed wood assemblies, such as wood/metal, wood/plastics, etc.; the third, for general purpose wood bonding applications. Innovations in mixed wood and general purpose adhesives have been introduced.

MIXED WOOD ASSEMBLY ADHESIVES

Mixed wood assembly adhesives are classified for the user according to the specific joint they can effect. Currently available are those for wood/metal, wood/paper, wood/plastic, wood/cotton fabric and wood/plaster or concrete joints. Adhesives have been modified for wood/metal and wood/plastics.

Wood/Metal

Adhesives for these assemblies are available as single adhesive and two adhesive systems (Reference 1). The single adhesive system is suitable for nonsandwich bonding of wood to aluminum and the two adhesive system for sandwich structures consisting of aluminum skins and wood cores.

Wood/Plastic

Solvent base neoprenes are available to permit room temperature bonding of wood to plastic laminates without resorting to anything more than contact pressure (Reference 2). Since the adherends will not slide for adjustment, considerable care must be exercised in closing the joint.

GENERAL PURPOSE WOOD ADHESIVES

There are two general purpose wood adhesives which have been modified. These are the epoxy and rubber base adhesives.

The epoxy can be cured at room temperature, although more rapid curing at 160 F is acceptable. This adhesive is suitable for structurally joining wood to itself and to metals, glass and plastics (Reference 3).

The rubber adhesive is available in three types (Reference 4). These are nonoil, oil and aromatic fuel resistant varieties. These

rubber base adhesives can also be cured at room temperature, although their structural properties are inferior to the aforementioned epoxy.

BIBLIOGRAPHY

Mixed Wood Assemblies

Wood/Metal

(1) MMM-A-00138 Adhesive, metal to wood, structural, 27 March 1964. Has QPL.

(2) MMM-A-130 Adhesive, contact, 15 June 1964. No QPL.

General Purpose Wood Adhesives

Epoxy

(3) MIL-A-14042 Adhesive, epoxy, 17 August 1964. No QPL.

Rubber

(4) MIL-A-5092 Adhesive, rubber base, general purpose, 14 July 1964. Has QPL.

3. RUBBER ADHESIVES

Adhesives for rubbers fall into three general categories. These are (1) straight rubber assembly adhesives, (2) mixed rubber assembly adhesives and (3) general purpose rubber bonding adhesives. The straight rubber and general purpose rubber adhesives have been modified.

STRAIGHT RUBBER ASSEMBLY ADHESIVES

Adhesives for bonding of strictly rubber assemblies are conveniently catalogued according to the type of rubber to be bonded. These include natural, butyl, nitrile, silicone and heterogeneous rubber combinations. Modifications have been made to the nitrile, silicone and heterogeneous rubber assembly adhesives.

Nitrile

Nitrile rubber has excellent resistance to aromatic fuel. An adhesive is available for bonding nitrile rubber intended for severe service conditions such as those encountered in fuel cell applications (Reference 1).

This liquid brushable adhesive is a one-part system which air cures at room temperature under contact pressure. This adhesive retains at least 60% of its initial strength after immersion in aromatics and can sustain loads up to 160 F.

Silicone

Silicone rubber possesses excellent resistance to both low and high temperatures. Adhesives are available for bonding silicones, as well as silicones to metals (Reference 2). These adhesives cure at room temperature under contact pressure.

Heterogeneous Rubber Adherends

Neoprene base adhesives have been available for bonding neoprene coated fabrics for use in the manufacture and repair of airships, rubber boats and lifesaving equipment. They have been modified to permit the bonding of nylon to neoprene. The modified adhesive can be cured either at room or elevated temperatures dependent on type (Reference 3).

GENERAL PURPOSE RUBBER ADHESIVES

General purpose rubber adhesives are capable of adhering practically any combination of materials providing joints ranging from weak temporary bonds to those suitable for moderate structural loads. For the general purpose bonding of rubber, a classification system defining flexibility of the bond is useful.

Flexible Bonds

General purpose rubber adhesives giving flexible bonds are available and dependent on type with nonoil, oil and aromatic fuel resistance (Reference 4). They will also bond duck, leather, felt, cork, wood, aluminum, steel and plastics.

Rigid Bonds

General purpose rubber adhesives giving rigid joints are available which can be cured at room temperature or more rapidly at 160 F (Reference 5). This adhesive can also bond metals, plastic laminates, glass and wood.

BIBLIOGRAPHY

Straight Rubber Assembly Adhesives

Nitrile

(1) MIL-A-9117 Adhesive; sealing, for aromatic fuel cells and general repair, 5 February 1965. No QPL.

Silicone

(2) MIL-A-25457 Adhesive, air-drying, silicone rubber, 27 May 1964. Has QPL.

Heterogeneous Rubber Adherends

(3) MIL-A-005540 Adhesive, polychloroprene, 6 July 1964. Has QPL.

General Purpose Rubber Adhesives

Flexible

(4) MIL-A-5092 Adhesive, rubber base, general purpose, 14 July 1964. Has QPL.

Rigid

(5) MIL-A-14042 Adhesive, epoxy, 17 August 1964. No QPL.

4. PLASTICS ADHESIVES

Adhesives for bonding of plastics can be also conveniently catalogued into three general categories. The first is for straight plastic assemblies; the second for specific mixed plastic assemblies such as plastic/wood, plastic/metal, etc.; and the third for general purpose bonding applications. New and modified adhesives have been introduced for specific mixed plastic assemblies and for general purpose plastics bonding.

SPECIFIC MIXED PLASTIC ASSEMBLY ADHESIVES

When bonding plastics to other materials, the coefficients of expansion as well as the reactivity of the individual components are important considerations. However, the user has available adhesives specifically formulated for the particular joint. Recently appearing are those for plastic/metal and plastic/rubber joints.

Plastic/Metal

Under certain conditions metallic structures are subject to vibration. These vibrations, if they are allowed to pass into resonance, can literally shake the structure to destruction. Epoxy adhesives can be used to bond plastic tiles to these metallic structures to dampen the vibrations (Reference 1).

Plastics are also adhered to metallic surfaces for decorative purposes. This is accomplished with solvent base neoprene adhesives. Bonding is achieved at room temperature without resorting to anything more than contact pressure. The adherends will not slide for adjustment during fitup; therefore, considerable care is necessary during fitup (Reference 2).

Plastic/Wood

The same adhesive used for bonding plastic to metal can be used for bonding to wood (Reference 2).

Plastic/Rubber

Neoprene base adhesives have been available for bonding neoprene coated fabrics. However, an innovation in the composition of the adhesive permits the bonding of nylon to neoprene coated fabrics. This adhesive is suitable for the manufacture and repair of airships, rubber boats and lifesaving equipment (Reference 3).

GENERAL PURPOSE PLASTICS ADHESIVES

There are two general purpose plastic adhesives which have been modified. These are the epoxy and the rubber base adhesives.

The epoxy can be cured at room temperature, although more rapid curing at 160 F is acceptable. This adhesive is suitable for structurally joining plastics to themselves and to metals, glass and wood (Reference 4).

The rubber adhesive is available in three types. These are nonoil, oil and aromatic fuel resistant varieties. They can also be cured at room temperature, although their structural properties are inferior to the aforementioned epoxy (Reference 5).

BIBLIOGRAPHY

Mixed Plastic Assembly Adhesives

Plastic/Metal

(1) MIL-A-24084 Adhesive, plastic sheet vibration damping, 14 August 1964. Has QPL.

(2) MMM-A-130 Adhesive, contact, 15 June 1964. No QPL.

Plastic/Rubber

(3) MIL-A-005540 Adhesive, polychloroprene, 6 July 1964. Has QPL.

General Purpose Plastics Adhesives

Epoxy

(4) MIL-A-14042 Adhesive, epoxy, 17 August 1964. No QPL.

Rubber

(5) MIL-A-5092 Adhesive, rubber base, general purpose, 14 July 1964. Has QPL.

5. METAL ADHESIVES

Metal adhesives also fall into three general usage categories. The first is for straight metal assemblies, the second for mixed metal assemblies and the third for general purpose metal bonding. New and modified adhesives for the three usage categories have been introduced.

STRAIGHT METAL ASSEMBLY ADHESIVES

Adhesives are available for structural and nonstructural applications. The structural metal adhesives, limited to the vinyls and epoxies, produce joints capable of carrying high loads. One of the room temperature curing epoxies has been modified. This adhesive possesses excellent resistance to weathering and aromatic fluids. However, it should not be used above 160 F (Reference 1).

MIXED METAL ASSEMBLY ADHESIVES

Modified and new adhesives for metal/wood, metal/plastics and metal/rubber joints have been introduced.

Metal/Wood

Wood may be adhered to metal for both structural and nonstructural purposes.

The structural variety is available in both single and two adhesive systems (Reference 2). The single adhesive system is intended for nonsandwich applications and the double adhesive system for predominantly sandwich applications consisting of aluminum skins and wood cores.

The nonstructural variety, a solvent dispersed neoprene adhesive, is suitable for the application of plywood to metal for decorative purposes (Reference 3).

Metal/Plastics

The above nonstructural adhesive (Reference 3) can also be used to adhere decorative laminates to metal.

An innovation in damping vibrations in metal structures has been introduced. This consists of adhering plastic tiles to metal structures with a new epoxy adhesive (Reference 4). This adhesive

will sustain shock loadings by high impact and is water and fuel resistant.

Metal/Rubber

Silicone rubber moldings can be adhered to aluminum with a room temperature curing adhesive (Reference 5). This adhesive has good water and oil resistance.

GENERAL PURPOSE METAL ADHESIVES

A general purpose adhesive is available for adhering metal to cotton duck, leather, felt, cork, wood, steel, rubber and plastics, (Reference 6). It has, dependent on type, resistance to oil and aromatic fuels. One type is also available possessing no oil or fuel resistance. None of these types should be used for structural purposes in life raft, airship or de-icer boot manufacture or repair.

BIBLIOGRAPHY

Straight Metal Assembly Adhesives

(1) MIL-A-14042 Adhesive, epoxy, 17 August 1964. No QPL.

Mixed Metal Assembly Adhesives

Metal/Wood

(2) MMM-A-00138 Adhesive, metal to wood, structural, 27 March 1964. Has QPL.

(3) MMM-A-130 Adhesive, contact, 15 June 1964. No QPL.

Metal/Plastics

(4) MIL-A-24084 Adhesive, plastic sheet vibration damping, 14 August 1964. Has QPL.

Metal/Rubber

(5) MIL-A-25457 Adhesive, air-drying, silicone rubber, 27 May 1964. Has QPL.

General Purpose Metal Adhesives

Rubber

(6) MIL-A-5092 Adhesive, rubber base, general purpose, 14 July 1964. Has QPL.

6. PACKAGING ADHESIVES

Packaging adhesives are intended for use in (1) carton manufacture, (2) carton closure, (3) packing and (4) labeling. New and modified packaging adhesives have been developed for the first three usage categories.

CARTON MANUFACTURE

Paper bags, spirally wound tubes and fiberboard cartons are the basic packaging forms. Modifications to adhesives for waterproof bags and spirally wound tubes have been made.

Waterproof Paper Bags

These bonding materials, compounded from solvent base, water emulsion and hot melt resins, can resist the passage of water for 8 hours, remain flexible as low as 0 F and have fast (less than 90 seconds) tackiness characteristics. These adhesives no longer contain fungus resistant ingredients unless specified by the purchaser (Reference 1).

Spiral Tubes

Spiral tubes are constructed by winding adhesive coated paper on a mandrel. Although silicate, animal glue and dextrin are used for this purpose, only dextrin (Reference 2) has been modified. This adhesive is suitable for packing ammunition.

CARTON CLOSURES

Paper bags require adhesive bonding for closure. The spirally wound tubes generally use closures which are removable. The same adhesive used for manufacturing the bag can be used for closing it (Reference 1).

PACKING

Packing consists of (1) reinforcing and sealing cartons, (2) sealing container closures and (3) preservative applications. Modified and new adhesives have been made for the first and third usage categories.

Reinforcing and Sealing of Cartons.

Waterproof sealing tapes have been modified extending their use in applications ranging from 32 to 160 F. They are available for both internal and external usage. The external variety offers good resistance to rain, sunlight and outdoor weathering. The internal variety is offered both as transparent and nontransparent tapes (Reference 3).

Another sealing tape has been introduced to give, in addition to good weather resistance, high reflectivity (Reference 4). It differs from the above plastic film in that the backing consists of aluminum. It can be used for packing of ammunition.

Preservation

In addition to the above two sealing tapes a third pressure-sensitive tape has been modified for usage up to 125 F (Reference 5). It is intended for protecting complex machinery, such as rockets, airplanes and ground support equipment, against the deleterious effects of outdoor weathering for protracted periods. This tape has resistance to oil and will not stain lacquers.

BIBLIOGRAPHY

Packaging Adhesives

Carton Manufacture

(1) MMM-A-260 Adhesive, water-resistant (for sealing waterproofed paper), 17 December 1964. No QPL.

(2) MIL-A-13374 Adhesive, dextrin, 22 May 1964. No QPL.

Packing

(3) PPP-T-60 Tape: pressure-sensitive adhesive, waterproof, for packaging, 2 September 1964. No QPL.

(4) L-T-0080 Tape, pressure-sensitive adhesive (aluminum backed), 9 June 1964. No QPL.

(5) MIL-A-22085 Tape, pressure-sensitive adhesive, preservation and sealing, 26 January 1965. Has QPL.

7. ELECTRICAL ADHESIVES

Splicing wires and electrical conductors at low temperatures has presented a formidable problem. The conventional rubber, polyethylene, polyvinyl chloride, etc., pressure-sensitive adhesive splicing tapes become stiff, difficult to work, when used in Arctic and cold winter climates. Increased processing costs and inferior reliability have been the price for using these tapes.

A new pressure-sensitive adhesive splicing tape is now available which overcomes this shortcoming without any sacrifice in electrical properties (Reference 1).

BIBLIOGRAPHY

Splicing Tapes

Primary Insulation

(1) HH-I-00595 Insulation tape, electrical, pressure-sensitive adhesive, plastic, for low temperature application, 20 February 1964. Has QPL.

8. OPTICAL ADHESIVES

No new or modified optical adhesives have been introduced.

9. BUILDING CONSTRUCTION ADHESIVES

New and modified Building Trade adhesive materials have been recently developed for use in (1) road repair, (2) exterior wall construction and (3) interior wall construction.

ROAD REPAIR

Roads are constructed using either asphalt or concrete. Asphalt roads are repaired by repaving with heated asphalt. However, repair of concrete roadways requires more extensive effort. Nevertheless, concrete roads, subject to cracking, spalling and other damage during use, now can be readily repaired with two adhesive materials without resorting to major removal of hardened concrete and subsequent repaving.

The first adhesive material consists of an epoxy resin binder to which concrete is added and applied by trowelling (Reference 1). The second, an identical adhesive, except it contains 50% mineral filler already incorporated, is more useful in grouting cracks, bonding portland cement concrete to hardened portland cement and pavement dowels in preformed holes (Reference 2).

EXTERIOR WALL CONSTRUCTION

Exterior walls are subjected to moderate, high and very high temperatures, dependent on their ultimate usage, such as in fences, furnaces, etc. Adhesives for these applications are commonly called mortars and are classified into three categories. These are (1) room temperature setting subject to moderate temperature service, (2) room temperature setting subject to high temperature service and (3) heat setting for very high temperature service. Modified moderate and high temperature mortars have been introduced.

Moderate Temperature Service

Slag base cement having better compressive properties than conventional masonry cement mortar is now available. It is mixed with hydrated lime for masonry applications and with portland cement for making concrete (Reference 3).

High Temperature Service

Silica base and fire clay-sodium silicate base cements have been used for the construction of fireplaces, chimneys, incinerators and boiler furnaces. However, air-setting heat resistant clay base cements, stable as high as 2910 F, can now be used for the construction of furnaces (Reference 4).

INTERIOR WALL CONSTRUCTION

The inside walls of rooms are generally plastered, followed by painting. In certain instances they may be covered instead with decorative plywood or laminates.

Plastered Walls

Two cements are used for plastering walls. These are Keene's cement and gypsum plaster. The Keene's cement has been modified and is available in both the quick setting and standard setting varieties (Reference 5). These varieties are intended for use in both the base and finish coats.

Decorative Plywood and Laminates

Neoprene cements can be used to adhere plywood and decorative plastic laminates to wood and metal walls without resorting to anything more than contact pressure (Reference 6). Considerable caution must be used in laying the decorative sheets, since they will not slide for adjustment.

BIBLIOGRAPHY

Road Repair

(1) MMM-B-350 Binder, adhesive, epoxy resin, flexible, 2 June 1964. No QPL.

(2) MMM-G-650 Grout, adhesive, epoxy resin, flexible, filled, 4 June 1964. No QPL.

Exterior Wall Construction

Moderate Temperature Service

(3) SS-C-218 Cement, slag, 10 July 1964. No QPL.

High Temperature Service

(4) MIL-M-15842 Mortar, refractory (high temperature, air setting) 24 August 1964. Has QPL.

Interior Wall Construction

Plastered Walls

(5) SS-P-00410 Plaster, gypsum (Keene's cement), 10 September 1964. No QPL.

Decorative Plywood and Laminates

(6) MMM-A-130 Adhesive, contact, 15 June 1964. No QPL.

10. OTHER ADHESIVES

New and modified adhesives have been developed for pyrotechnic, dental, photographic and automotive applications.

PYROTECHNIC ADHESIVES

Epoxy and silicone adhesives have been introduced for rocket engines.

The epoxy is suitable for the MARK 38 and MARK 39 engines. This adhesive possesses outstanding salt and humidity resistance and is a two part system, cured at room temperature and optionally up to 150 F (Reference 1).

The silicone adhesive is useful for igniter construction especially in the MARK 265 rocket engine (Reference 2). Since this adhesive may release acidic by-products during its room temperature cure, considerable caution must be exercised in choosing metal components. Those that corrode easily should be checked prior to usage.

Where high resistance to weathering and moisture is necessary in the packaging of ammunition components, a pressure-sensitive aluminum foil tape is available (Reference 3). This tape requires no moisture, heat or other preparation prior to or subsequent to application.

DENTAL ADHESIVES

Zinc phosphate cement is intended primarily (1) to join or seal dental appliances to oral structures or to other appliances, (2) as a heat insulating base for other more permanent fillings and (3) as a temporary filling (Reference 4).

PHOTOGRAPHIC ADHESIVES

Photographic prints can be mounted in albums without subsequent curling, wrinkling or shrinkage using rubber cement (Reference 5). This cement can be peeled from the paper substrate without leaving any discoloration.

MISCELLANEOUS ADHESIVES

Brake linings can be joined to steel and aluminum drums with a new adhesive resistant to brake fluid, water and for short periods of time to temperatures as high as 400 F (Reference 6).

BIBLIOGRAPHY

Pyrotechnic

Rocket Motors

(1) MIL-A-23941 Adhesive, epoxy type, two part, for rocket motors MARK 38 and MARK 39, 19 August 1964. No QPL.

(2) MIL-A-23940 Adhesive, silicone rubber for igniter MARK 265, 19 August 1964. No QPL.

Packaging

(3) L-T-0080 Tape, pressure-sensitive adhesive (aluminum backed), 9 June 1964. No QPL.

Dental

(4) U-C-00211 Cement, zinc phosphate, dental, 26 August 1964. No QPL.

Photographic

(5) MMM-A-00185 Adhesive, rubber (for paper bonding), 10 November 1964. No QPL.

Other

(6) MIL-A-46091 Adhesive, brake lining to metal, 1 September 1964. No QPL.

PART II

ADHESIVE PROPERTIES DATA

NOTICE TO THE READER

Specifications are living documents: they are continuously being created, changed and cancelled. The following new and revised abstracts (tabulated in numerical order — Federal first, Military second and others third) reflect the current status of these documents, giving the latest issue date, revision and amendment.

These abstracts additionally set forth the six basic constituents of any specification. These are Scope, Classification, Properties, Form, Qualified Products List and Notes.

The Scope defines the purpose of the joining agent — specifically, what the adhesive is intended to do and what it will bond.

The Classification section defines the various conditions, expressed as types, classes and grades, under which the adhesive is available.

The Properties section is subdivided into four parts. These are chemical, physical, process and performance. The chemical section designates the composition of the joining agents. However, for various reasons, some specifications do not define the ingredients; one purpose is to leave the choice to the manufacturer in order to promote competition among the suppliers. The physical properties give the characteristics of the joining agents which will be needed if the material is to meet the intended purpose. Such things as viscosity, solids and ash content, toxicity, flexibility, specific gravity, consistency, pH, etc. fall into this category. Process properties define the make-ready and curing conditions necessary to convert the bonding material. Storage requirements are given here since they are an integral part of the conversion process. Performance properties define what is expected from the joining agent when properly converted.

The Form defines the physical state of the joining material, such as liquid, solid, film, etc., and the quantities in which it is normally available. Some of the specifications do not specify quantities, and these are noted accordingly. Packaging specifications covering the containers are not given.

The Notes give additional information of value to the user such as which type, grade or class is preferable for a specific application, other types of adherends which can be joined, etc.

Each abstract contains all the data actually defined in the specification. Where specific items need modification or are not given, the reader should add these in any purchase orders.

A certain degree of caution is necessary concerning the use of adhesives conforming to any specification. The properties are guaranteed only when the specific adherends are tested in strict accordance with the procedures given in the specification. A change in adherends may change the expected performance properties. Further, the test methods employed may not reflect the actual environmental conditions of a particular part. And still further, performance properties called out by a specification are generally minimum; the actual values obtained with the adhesives should be higher than specified. Consequently, the specification values serve admirably as a screening technique to reduce development costs.

When a specification appears promising, the final step is to obtain adhesives covered by these documents. Certain of the specifications have concomitant Qualified Products Lists (QPL) which give the names of adhesives, including the suppliers, which meet the requirements. When no Qualified Products List exists, many adhesive suppliers will certify that their products conform to the requirements (if they do) when procured under the specification designation.

Appendix A lists all of the new and revised adhesive material abstracted. Many of these specifications refer to other documents to define some of the adherends and test procedures. These references are designated by the document number in the abstract.

The following abstracts are a compilation of essential data contained in adhesive material specifications. Extensive effort has been made to verify and check the information contained in each abstract. However, neither the author nor the publisher is responsible for errors which may have occurred in this book.

L-T-0080 (ARMY-MR) TAPE, PRESSURE-SENSITIVE ADHESIVE (ALUMINUM-BACKED)

Issue: 9 June 1964 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing and masking applications where good reflectivity, weather and moisture vapor resistance are required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of an aluminum backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape has a backing thickness of 0.0025–0.0035 inch, a tensile strength of at least 26 lb/in. and a water vapor transmission rate of 0.07 gr/100 sq in./24 hour (Fed Test Method Std 147, Methods 36, 30 and 70 respectively).

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. A force no greater than 3.0 and 4.0 lb/in. is required for unrolling the tape either as received or aged 12 days at 150 F and 80% RH (Fed Test Method Std 147, Method 60).

PERFORMANCE. The tape has a peel strength at 75 F of at least 40 oz/in. of width and at least 35 oz/in. of width after aging 12 days at 150 F and 80% RH prior to application using a AISI 302 or 304 stainless steel substrate (Fed Test Method Std 147, Method 10). No evidence of corrosion and no more than 5 (not aged) and 10% (aged) adhesive transfer occurs after peeling. The tape will not curl, buckle or deteriorate during 288 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151).

FORM

The tape, unless otherwise specified, is available in 60 yard rolls wound on 3 inch diameter cores in ½, ¾, 1 and 1½ inch widths. Each roll may contain up to 3 splices.

QPL

No.

NOTES

1. Do not order tape in quantities greater than that which can be used in 6 months.
2. Suitability with explosives must be demonstrated at a Government Laboratory.
3. This specification includes the requirements of MIL-T-11291 (see abstract).

U-C-00211(GSA-FSS) CEMENT, ZINC PHOSPHATE, DENTAL

Issue: 26 August 1964 Revision: b Amendment: None

SCOPE

This cement is intended for (1) bonding and sealing prefabricated restorations, (2) temporary fillings and (3) as a heat insulating base under more permanent inlays.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The zinc phosphate cement consists of two components: a powder and a liquid. The water soluble arsenic content of the mixed cement is not more than 0.0002%.

PHYSICAL. The cement when mixed in accordance with the manufacturers' directions has a consistency to compress (three minutes after mixing under a load of 33 pounds over 2 sq cm of mixed cement) to a film thickness not greater than 40 microns measured 10 minutes after mixing.

PROCESS. The cement is activated by mixing the liquid and powder components, applied with a condenser and cured at mouth temperature under contact pressure. For establishing proper testing consistency, the amount of powder necessary for each 0.5 ml of liquid is determined when a 0.5 ml quantity of mixed cement is compressed into a circle of 30 mm diameter under a 120 gram load after seven minutes when applied 3 minutes after starting the mix. No gas is evolved during mixing and the cement sets between four and ten minutes at 99 F.

PERFORMANCE. The cement does not discolor tooth structure and has a water-wet compressive strength of at least 12,000 psi, at 75 F, seven days after mixing. The set cement (one hour at 99 F) does not lose more than 0.30% weight after seven days immersion in 99 F water.

FORM

The cement powder is available in one ounce bottles and the proper quantity plus 20% excess of liquid is available in sealed glass bottles. The shade is specified by the purchaser.

QPL

No.

NOTE

(1) This specification is similar to American Dental Association Specification No. 8, and American Standards Association Specification No. ASA Z93.8-1962, "Dental Zinc Phosphate Cements".

HH-I-00595 (NAVY-WEPS) INSULATION TAPE, ELECTRICAL, PRESSURE-SENSITIVE ADHESIVE, PLASTIC FOR LOW TEMPERATURE APPLICATION

Issue: 20 February 1964 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating conductors and spliced wires where application must be performed at temperatures as low as 10F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a black pigmented plastic film backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape is between 0.006 and 0.011 inch thick, has a tensile strength of at least 17 lb/in., an elongation at 40F of 15% under a 10 pound load applied for 1 minute, and a dielectric strength of at least 7000 volts after 24 hours immersion in water and 6000 volts after 4 hours at 160F (Fed Test Method Std No. 406, Method 4031).

PROCESS. The tape does not require moisture, heat or other preparation prior to or subsequent to application. A force no greater than 4 lb/in. at 75F and 8 lb/in. at 10F is needed to unwind the tape. The tape can be stored one year.

PERFORMANCE. The tape when wound on a 5/8 inch diameter, 19 inch long flexible steel conduit does not crack when the conduit is bent 180° at 10F. Additionally it has, as received and after one year storage, a peel strength of 1 lb/in. of width at 73F and at 10F using both a stainless steel (QQ-S-766) and the tape backing as substrates.

FORM

The black tape, unless otherwise specified, is available in 35 yard rolls wound on 1 inch diameter cores in ½, ¾ and 1 inch widths. Each core is marked with the month and year of manufacture.

QPL

Yes.

SS-C-218 CEMENT, SLAG

Issue: 10 July 1964 Revision: d Amendment: None

SCOPE

This cement is intended for blending with (1) hydrated lime for making masonry mortar and (2) with portland cement for making concrete.

CLASSIFICATION

The cement is available in two types.

Type S Slag
Type SA Air-entraining slag

PROPERTIES

CHEMICAL. The cement consists of hydrated lime (SS-L-351, Type M) containing not more than 8% unhydrated oxide and at least 60% water quenched blast-furnace slag composed of calcium silicates and alumino-silicates. The maximum percentage of other ingredients is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF SS-C-218 CEMENT

INGREDIENT	PERCENT, MAX
Sulfur trioxide	4.0
Soluble alkali as Na_2O, %, max (1)	0.03
Sulfide sulfur	2.0
Insoluble residue	1.0
Loss on ignition	4.0

(1) Applies only when a nonstaining cement is requested.

PHYSICAL. The physical properties of the cement are given in Table II.

SS-C-218 (Continued)

TABLE II. PHYSICAL PROPERTIES OF SS-C-218 CEMENT

PROPERTY	TYPE S	TYPE SA
Fineness, air permeability, sq cm/gr (1)		
Average, min	4700	4700
Individual, min	4200	4200
Air content of mortar, %	12 (2)	16–22
Soundness, autoclave expansion or contraction, %, max (3)	0.50	0.50
False set, %, min (4)	50	50

(1) Fed Test Method Std No. 158, Method 2601.1.
(2) Maximum.
(3) Fed Test Method Std No. 158, Method 2211.1.
(4) Applies only when requested. Fed Test Method Std No. 158, Methods 2511.1 and 2501.1.

PROCESS. The cement is mixed with either hydrated lime (for mortar) or portland cement (for concrete), activated by mixing with water, applied by trowelling, the joint closed and cured at room temperature under contact pressure. The cement reaches an initial set (Gillmore) in not less than 60 minutes and a final set in not more than 24 hours.

PERFORMANCE. The performance properties of the cement are given in Table III.

TABLE III. PERFORMANCE PROPERTIES OF SS-C-218 CEMENT

PROPERTY	TYPE S	TYPE SA
Compression, psi, at 75 F, min (1)		
1 day in moist air, 6 days in water	600	500
1 day in moist air, 27 days in water	1500	1000

(1) Fed Test Method Std No. 158

FORM

The powdered cement is available in commercial packages.

QPL

No.

NOTES

(1) This specification is similar to ASTM C358 and ASA A1.21, "Slag Cement".

(2) The supplier may add during the grinding of the slag and lime, water and/or untreated calcium sulfate and up to 1% unspecified ingredients.

SS-P-00410 (GSA-FSS) PLASTER, GYPSUM (KEENE'S CEMENT)

Issue: 10 September 1964 Revision: None Amendment: None

SCOPE

This cement is intended for base and finish coat plastering.

CLASSIFICATION

The cement is available in two types.

Type I Quick setting
Type II Standard setting

PROPERTIES

CHEMICAL. The cement consists of anhydrous calcined gypsum, other unspecified ingredients to control set and no more than 2% combined water.

PHYSICAL. The cement is a powder of sufficient fineness that at least 80% passes through a U S Standard No. 100 mesh sieve, 98% through a No. 40 and 100% through a No. 14.

PROCESS. The cement is activated by mixing with water and retarders, if any, to give a consistency equivalent to a 28-32 mm penetration under a 150 gram weight plunger (Modified Vicat-ASTM C471), applied by troweling and cured 24 hours at room temperature under contact pressure. The cement sets between 20 minutes and 6 hours.

PERFORMANCE. The cement has a compressive strength of at least 2500 psi at room temperature (ASTM C472).

FORM

The powdered cement, unless otherwise specified, is available in 50 and 100 pound containers.

QPL

No.

NOTES

(1) This specification is identical to ASTM C61 and ASA A66.1, "Keene's Cement".

(2) This specification supersedes SS-C-0016 "Cement; Keene's" (see abstract).

MMM-A-130 ADHESIVE, CONTACT

Issue: 15 June 1964 Revision: a Amendment: None

SCOPE

This adhesive is intended for bonding plastic decorative laminates to wood or metal.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of 18-25% chloroprene (neoprene) rubber and synthetic resin in an unspecified solvent.

PHYSICAL. The adhesive has a density between 6.5 and 7.3 lb/gal, a viscosity at 25 C between 400 and 1500 centipoises and the dry film an ash content between 3 and 20% (ASTM D297).

PROCESS. The adhesive is applied by brushing, air dried 20 minutes, an additional coat applied, again air dried one hour, the joint closed and cured seven days at room temperature under contact pressure. The adhesive coated adherends have an open time of not less than three hours and will not slide for adjustment; they bond directly on contact. The adhesive in closed containers can be stored 15 days at 60 C and is stable after three freeze-thaw cycles between -10 F and 120 F, each cycle lasting 24 hours.

PERFORMANCE. The adhesive has a shear strength of at least 150 psi immediately after bonding and 200 psi after seven days cure using ¼ inch fir plywood and 0.062 inch thick plastic laminate (L-P-508) adherends (Fed Test Method Std No. 175, Method 1033.1). No more than 1/16 inch edge lift occurs for the bonded assembly after aging two hours at 160 F.

FORM

The liquid adhesive, unless other specified, is available in 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) The adhesive will also bond leather, wood, fabrics, unglazed ceramics, hardboard, carpet and core base to themselves or in combination.

MMM-A-00138 (NAVY-WEPS) ADHESIVE: METAL TO WOOD, STRUCTURAL

Issue: 27 March 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for structural bonding of clad aluminum alloy to wood including sandwich construction.

CLASSIFICATION

The adhesive is available in two types and two conditions.

Type I Single adhesive system

Type II Two adhesive system

Condition A Primary adhesive with room temperature (75-90F) setting secondary adhesive.

Condition B Primary adhesive with intermediate temperature (90-180F) setting secondary adhesive.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. Unspecified hardeners, carriers (for film form), solvents and modifiers may be used.

PHYSICAL. The adhesive may be liquid, powder, stick or film. The pH of the secondary adhesive cured film is between 3.5 and 11.0.

PROCESS. The Type I adhesive is activated by mixing with accelerator, hardener, modifier and solvent, if any, applied by brushing if liquid or laid in joint if solid, air dried and precured, if necessary, in accordance with the supplier's instructions, the joint closed and cured in accordance with the conditions given in Table I. Type II primary adhesive is applied by brushing if liquid or laid if solid to the metal adherend only, air dried and precured, if necessary, in accordance with the supplier's instructions, the secondary adhesive applied in quantities ranging usually between 40-50 lb/1000 sq ft to both wood and previously coated metal adherends, the joint closed and cured in accordance with the conditions given in Table I. The adhesive has a working life of at least 2.5 hours at room temperature.

PERFORMANCE. The performance properties of the adhesive are given in Table II.

FORM

The liquid adhesives and accelerators are available in metal cans or in 12 to 55 gallon drums. Powdered or jelly-type materials are available in cans, 5 gallon pails or in 12 to 55 gallon drums.

QPL

Yes.

MMM-A-00138 (Continued)

TABLE I. PROCESS PROPERTIES OF MMM-A-00138 ADHESIVE

PROPERTY	TYPE I	TYPE II			
		CONDITION A		CONDITION B	
		Primary	Secondary	Primary	Secondary
Cure					
Temperature, °F, max	335(1)	335(1)	75–90	335(1)	90–180
Time, hr, max	1/3(1)	1/3(1)	8	1/3(1)	5
Pressure, psi, max	50	50	50	50	50
Storage, months,					
At 25 C	3	3	12	3	6
At 5–10 C	6	6	NR	6	NR

(1) If a lower temperature is specified for curing, the curing period may be proportionately longer.

NR = No Requirement

TABLE II. PERFORMANCE PROPERTIES OF MMM-A-00138 ADHESIVE

PROPERTY	TYPE I	TYPE II
Shear, interlaminar, psi, min (1)		
At 75 F		
Initial (2)	900	900
After 7 days in 75 F water	700	500
After 7 days in 3% 75 F salt water	700	500
After 7 days in 75 F hydrocarbon (MIL-S-3136, Type II)	700	700
At 180 F, 1 hr	700	700

(1) Fed Test Method Std No. 175, Method 1032, using a birch core and Al-Clad 2024 aluminum facings (QQ-A-362).

(2) Left standing in distilled water 1 hour, allowed to dry overnight at 75–80 F and 50–70% RH and then tested dry.

NOTES

(1) These adhesives are not intended for fabrication of aircraft primary structures.

(2) Type I adhesive is for nonsandwich panel constructions. Type II adhesive is suitable for both sandwich and nonsandwich panel constructions.

(3) Use Type II, Condition A adhesives where small areas are involved or where heat cannot be used in the final assembly operation. Type II, Condition B adhesive should be used where the fabrication of large items necessitates a curing time in excess of the Condition A adhesive.

(4) This specification can be used in lieu of MIL-A-928 "Adhesive: Metal to Wood, Structural."

MMM-A-00185 (GSA-FSS) ADHESIVE, RUBBER (FOR PAPER BONDING)

Issue: 10 November 1964 Revision: a Amendment: None

SCOPE

This adhesive is intended for mounting photos, maps, drawings, charts and for general paper to paper bonding applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of at least 12% crepe natural rubber or unspecified synthetic rubber in a sulfur-free hydrocarbon solvent.

PHYSICAL. The adhesive has a vicosity between 2,800 and 4,000 centipoises, acetone extractables not greater than 1.4% (ASTM D297), is colorless and dries to a colorless film. The solvent fraction has a distillation end point no greater than 145 C.

PROCESS. The adhesive is applied by brushing or spatula up to thicknesses of 0.014 inch, air dried 20 minutes, the joint closed and cured at least two hours at room temperature under contact pressure. During brushing the adhesive does not tend to draw together, the surface remaining smooth and free from streaks or ridges. Each 4 oz closed bottle loses no more than 0.5 g during 5 hours exposure to 120 F.

PERFORMANCE. The adhesive does not wrinkle, curl or shrink unglazed manifold paper (25% rag content) upon drying, nor does it stain or discolor bond paper after being rubbed off. The cement has a peel strength of at least 165 grams at room temperature using 25% rag content bond paper adherends, 15 mm wide.

FORM

The adhesive is available in commercial packages including collapsible tubes.

QPL

No.

NOTES

(1) This specification supersedes in part Federal Specification ZZ-C-191 (see abstract).

MMM-A-260 ADHESIVE, WATER-RESISTANT (FOR SEALING WATERPROOF PAPER)

Issue: 17 December 1964 Revision: a Amendment: None

SCOPE

This adhesive is intended for the manufacture and closure of waterproof paper bags, wraps and case liners.

CLASSIFICATION

The adhesive is available in two types, two grades and three classes.

Type I For application by machine
Type II For application by hand
Grade A For subsistence items
Grade B For other than subsistence items
Class 1 Solvent-base adhesive
Class 2 Water-emulsion adhesive
Class 3 Hot melt adhesive

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, no toxic ingredients are present.

PHYSICAL. The nontoxic adhesive is water resistant such that it prevents passage of water for at least 8 hours and is resistant to fungus when specified by the purchaser.

PROCESS. The adhesive is applied by machine (Type I) or by brushing (Type II), the joint closed in 30 seconds (class 3 in 5 seconds) and cured 24 hours at room temperature under 0.5 psi bonding pressure. The adhesive, Type II, classes 1 and 2, can be stored in closed containers as long as two weeks at 140F and can withstand freezing when cycled three times between 0 F (16 hours) and 75 F (8 hours) without any deleterious effect.

PERFORMANCE. The adhesive is flexible at 0 F such that it can be bent 180°, including reverse bending, on a ¾ inch mandrel without separation of the bond using Barrier Material adherends (UU-P-271, Class H-4 and L-2). With the same adherends it has a shear strength at 75 F of at least 10 psi after a four hour water soak and 7.5 psi after 10 days at 140 F. No separation or flow of adhesive occurs after 10 days heat aging at 140 F. Further, Type II develops sufficient tack such that after 90 seconds bonding time, it can support for 60 seconds a 21 ounce tensile load over a bond area of 0.785 sq in.

FORM

The liquid adhesive is available in 1, 5 and 55 gallon containers.

QPL

No.

MMM-B-350 BINDER, ADHESIVE, EPOXY RESIN, FLEXIBLE

Issue: 2 June 1964 Revision: a Amendment: None

SCOPE

This adhesive is intended for repairing spalls and other defects in portland cement concrete pavements.

CLASSIFICATION

The adhesive is available in two types.

Type I For use when pavements, materials and atmospheric temperatures are between 20 and 40 C (68 and 104 F).

Type II For use when pavements, materials and atmospheric temperatures are between 4.5 and 20 C (40 and 68 F).

PROPERTIES

CHEMICAL. The adhesive is a two component system consisting of an epoxy resin and polysulfide rubber in the ratio of 2:1. No diluents, wetting agents or volative solvents are present. The hardener is 2,4,6-tridimethylaminomethyl phenol alone or in combination with dimethyl aminomethyl phenol.

PHYSICAL. The physical properties of the epoxy resin and polysulfide rubber ingredients are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MMM-B-350 ADHESIVE

PROPERTY	EPOXY RESIN MIN	EPOXY RESIN MAX	POLYSULFIDE RUBBER MIN	POLYSULFIDE RUBBER MAX
Color, Hellige	NR	5	9	12
Epoxide equivalent	175	210	NR	NR
Viscosity				
At 25 C, poises	100	180	NR	NR
At 80 F, centipoises	NR	NR	700	1200
Specific gravity				
20/20 C	NR	NR	1.24	1.30
25/25 C	1.15	1.18	NR	NR
pH of water extract	NR	NR	6.0	8.0
Flash point, °F (Cleveland Open Cup)	NR	NR	390	NR
Fire point °F (Cleveland Open Cup)	NR	NR	420	NR
Sulfur, %	NR	NR	36	40
Water Content, %	NR	NR	NR	0.1

NR = No Requirement

MMM-B-350 (Continued)

PROCESS. The adhesive is activated by mixing the epoxy and polysulfide rubber components in accordance with the supplier's instructions, the adhesive mixed with dry concrete, applied by trowelling and cured at least 96 hours at 75 F under contact pressure. The adhesive should be shipped and stored between 68 and 86 F.

PERFORMANCE. The adhesive has a (double) shear strength of at least 400 psi at room temperature using portland cement adherends (SS-C-192, Type I). Exposure to 200 F for 3 hours gives equal or better shear strength.

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

MMM-G-650 GROUT, ADHESIVE, EPOXY RESIN, FLEXIBLE, FILLED

Issue: 4 June 1964 Revision: a Amendment: None

SCOPE

This adhesive is intended for (1) cementing pavement dowels in preformed holes, (2) bonding plastic portland cement concrete to hardened portland cement concrete and (3) grouting cracks in pavements.

CLASSIFICATION

The grout is available in two types and three grades.

Type I For use when pavements, materials and atmospheric temperatures are between 20 and 40 C (68 and 104 F).

Type II For use when pavements, materials and atmospheric temperatures are between 4.5 and 20 C (40 and 68 F).

Grade A Spray Application
Grade B Brush or Broom Application
Grade C Trowel Application

PROPERTIES

CHEMICAL. The adhesive is a two component system consisting of an epoxy resin and polysulfide rubber in the ratio of 2:1 and containing no more than 50 percent unspecified nor settling mineral filler. No diluents, wetting agents or volatile solvents are present. The hardener is 2, 4, 6-tridimethylaminomethyl phenol alone or in combination with dimethylaminomethyl phenol. Finely divided (100% through a U S Standard No. 325 mesh sieve) quartz silica flour or feldspathic aluminum silicate flour is incorporated; not more than 5% in Grade A, 25% in Grade B and 50% Grade C.

PHYSICAL. The physical properties of the epoxy resin and polysulfide rubber are given in Table I.

MMM-G-650 (Continued)

TABLE I. PHYSICAL PROPERTIES OF MMM-G-650 GROUT

PROPERTY	EPOXY RESIN MIN	EPOXY RESIN MAX	POLYSULFIDE RUBBER MIN	POLYSULFIDE RUBBER MAX
Color, Hellige	NR	5	9	12
Epoxide equivalent	175	210	NR	NR
Viscosity				
At 25 C, poises	100	180	NR	NR
At 80 F, centipoises	NR	NR	700	1200
Specific gravity				
20/20 C	NR	NR	1.24	1.30
25/25 C	1.15	1.18	NR	NR
Water content	NR	NR	NR	0.1
pH of water extract	NR	NR	6.0	8.0
Flash point, °F (Cleveland Open Cup)	NR	NR	390	NR
Fire point, °F (Cleveland Open Cup)	NR	NR	420	NR
Sulfur, %	NR	NR	36	40

NR = No Requirement

PROCESS. The grout is activated by mixing the epoxy and polysulfide rubber components in accordance with the supplier's instructions, the adhesive applied by spraying, brushing, or trowelling according to grade, the joint closed and cured at least 96 hours at 75 F under contact pressure. The thixotropic grout after activation has a working life of at least ½ hour; working life is considered ended when the viscosity reaches 85,000 centipoises. The adhesive should be shipped and stored between 68 and 86 F.

PERFORMANCE. The adhesive has a (double) shear strength of at least 400 psi at room temperature using portland cement adherends (SS-C-192, Type I). Exposure to 200 F for 3 hours gives equal or better shear strength.

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

PPP-T-60 TAPE; PRESSURE-SENSITIVE ADHESIVE, WATERPROOF, FOR PACKAGING

Issue: 2 September 1964 Revision: b Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for packaging applications subjected to temperatures between 32 and 160 F where waterproofness is required.

CLASSIFICATION

The tape is available in three classes.

Class 1 Exterior, colored
Class 2 Interior, transparent
Class 3 Interior, colored

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The Class 2 tape is sufficiently transparent to read 10 point type. The other physical properties of the tape are given in Table I.

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. A force no greater than 4 lb/in. of width is required for unrolling the tape, either as received or aged 7 days at 155 F and 85% RH.

PERFORMANCE. The Class 1 tape does not fade to an extent that it is not similar to the original color after 24 hours accelerated weathering (CCC-T-191, Method 5804). The other performance properties are given in Table II.

FORM

The tape, unless otherwise specified, is available in 60 yard rolls for Class 1 and 72 yard rolls for Classes 2 and 3, each wound on 3 inch diameter cores. The color (see Table III) and width are specified by the purchaser. Each roll may contain up to three splices.

QPL

Yes.

NOTES

(1) Use Class 1 for applications requiring high strength characteristics and maximum resistance to rain, sunlight or other deteriorating elements.

(2) Use Class 2 for packaging of supplies which are overpacked in exterior containers where high strength characteristics are not required but transparency is desired.

(3) Use Class 3 for packaging of supplies which are overpacked in exterior containers where high strength and transparency are not required.

PPP-T-60 (Continued)

TABLE I. PHYSICAL PROPERTIES OF PPP-T-60 TAPE

PROPERTY	Class 1	Class 2 & 3
Tensile strength, lb/in., at 75 F, min (1)		
Dry	35	25
Wet	30	8
Bursting strength, psi, at 75 F, min (2)	65	35
Specular gloss (3)	11.0	11.0
Water penetration rate, gr/100 sq in./24 hr		
Under 1 inch water head, max	5.0	5.0
Curling		
Initial		
Curl, in., max (4)	3	3
Twist, degrees, max (5)	360	360
After 7 days at 155 F and 85% RH		
Curl, in., max (4) (6)	3	NR
Twist, degrees, max (5) (6)	360	NR

(1) CCC-T-191, Method 5102.
(2) CCC-T-191, Method 5122.
(3) Fed Test Method Std No. 141, Method 6101, on olive drab tapes only.
(4) The difference in unwound length of 36 inches and length when tape is released.
(5) The amount of twisting of an unsupported 36 inch length of tape.
(6) Conditioning refers to rolls of tape prior to performance of test.
NR = No Requirement

PPP-T-60 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF PPP-T-60 TAPE

PROPERTY	Class 1	Class 2 & 3
Peel, oz/in., at 75 F, min (1)		
Initial	25	25
After aging roll 7 days at 155 F and 85% RH prior to application	25	25
After accelerated weathering (2) 72 hours	25	NR
After application at 32 F	20	20
Creep in shear, (3) (4)		
At 75 F, 1000 gr/sq in. load, hr, min		
Initial		
Steel	3/4	16
Backing	1/3	3
After aging roll 7 days at 155 F and 85% RH prior to application		
Steel	3/4	8
Backing	1/4	3
At 155 F, 100 gr/sq in. load, hr, min		
Initial		
Steel	24	24
Backing	24	16
After aging roll 7 days at 155 F and 85% RH prior to application		
Steel	24	8
Backing	24	8

(1) Tape to SAE 1020 Steel substrate.
(2) Tape to copper (QQ-C-576) per CCC-T-191, Method 5804. No evidence of corrosion (deep brown or blackish discoloration) is present.
(3) Tape to corrosion resistant steel (QQ-S-766) substrate.
(4) The tape does not creep or slip more than 1/8 inch under the indicated load for the time specified.

NR = No Requirement

PPP-T-60 (Continued)

TABLE III. COLOR AVAILABILITY OF PPP-T-60 TAPE

COLOR (1)	GLOSS	SEMI GLOSS	FLAT
Black	17038	27038	37038
Blue, dark	15102	25102	–
Blue, light	15177	25177	35177
Brown	10049	–	–
Gray, dark	16251	26251	36251
Gray, light	–	26373	36373
Green, dark	14110	24108	34108
Green, light	14187	–	–
Natural (2)	–	–	–
Olive, drab	–	X24087	X34087
Orange	12197	–	–
Red	11136	21136	31136
White	17875	27875	37875
Yellow, dark	13538	23538	33538
Yellow, light	13655	23655	–

(1) Fed Std 595.

(2) No coloring is added to tape.

MIL-A-5092 ADHESIVE, RUBBER BASE, GENERAL PURPOSE

Issue: 14 July 1964 Revision: B Amendment: None

SCOPE

This adhesive is intended for nonstructural, general purpose bonding applications.

CLASSIFICATION

The adhesive is available in three types.

Type I	Not oil resistant
Type II	Oil resistant
Type III	Aromatic fuel resistant

PROPERTIES

CHEMICAL. The adhesive consists of a solvent dispersed rubber; Type I is natural rubber; Type II, neoprene; and Type III, Buna N.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is applied by brushing, air dried, the joint closed and cured at room temperature under contact pressure. No cure time is given; however, 24 hours is usually satisfactory. Open face drying periods and number coats are given by supplier; although, no more than 3 coats are used. The adhesive in sealed containers can be stored 15 days at 140 F without gelling or otherwise deteriorating.

PERFORMANCE. The Type II adhesive can support a 90° peel load of 2 lb/in. of width at 160 F for 24 hours without separation or creep. The other performance properties are given in Table I.

FORM

The liquid adhesive, unless otherwise specified, is available in pint, quart and gallon containers.

QPL

Yes.

NOTES

1. These adhesives are not intended for structural purposes or for life raft, airship or de-icer boat manufacture or repair.
2. These adhesives will bond duck, leather, felt, cork and, similar materials to themselves, combinations and to aluminum alloy, steel, laminates and wood.
3. Type II has the poorest storage properties. It will last about 6 to 9 months under normal storage conditions.
4. Types I and III can be thinned with solvent in accordance with the supplier's directions when brushable viscosity is exceeded.
5. When bonding rubber, use Type I for natural rubber, Type II for neoprene, and Type III for Buna N and vinyl plastics.

MIL-A-5092 (Continued)

6. Type III supercedes cancelled MIL-C-4003 adhesive (see abstract).

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-5092 ADHESIVE

PROPERTY	TYPE		
	I	II	III
Peel, lb/in., at 75 F, min (1)			
Initial			
Aluminum to Duck (2)	12	15	10
Aluminum to Neoprene	NR	15	NR
Aluminum to Vinyl	NR	NR	8
After 22hr immersion (2)			
75 F Water	6	12	5
160 F Oil (3)	NR	12	8
75 F Aromatic Fuel (4)	NR	NR	8
After Aging (2)			
160 F, 7 days (5)	12	15	10
140 F, 15 days (6)	10	12	8

(1) Fed Test Method Std No. 175, Method 1041.1.
(2) Substrates are 2024 Alclad aluminum (QQ-A-362) and cotton duck (CCC-C-419, Type I, Olive Drab QM Shade 7, Hard Texture No. 7).
(3) Fed Test Method Std No. 601, Method 6001, Medium No. 1.
(4) Fed Test Method Std No. 601, Method 6001, Medium No. 6.
(5) The joint is aged.
(6) The adhesive is aged prior to application.
NR = No Requirement.

MIL-A-005540 (WEPS) ADHESIVE, POLYCHLOROPRENE

Issue: 6 July 1964 Revision: A Amendment: 1

SCOPE

This adhesive is intended for bonding of neoprene coated fabrics.

CLASSIFICATION

The adhesive is available in four classes.

Class 1 Heat cure for manufacture (Heat stable to 140 F)
Class 2 Room temperature cure for manufacture (Heat stable to 140 F)
Class 3 Room temperature cure for repair (Heat stable to 140 F)
Class 4 Heat cure or room temperature cure

PROPERTIES

CHEMICAL. The adhesive consists of neoprene, solvent and accelerator, either incorporated or separate.

PHYSICAL. The adhesive has a viscosity at 75 F between 400 and 2000 centipoises and is nontoxic.

PROCESS. The two part adhesive is activated by mixing base resin with accelerator, the one part or mixed two part adhesive applied by brushing, the joint closed and cured no longer than 7 days at room temperature under contact pressure. The number of coats not exceeding three, drying time between coats and elevated temperature curing conditions, if any, are given by the supplier. The adhesive has a working life of at least 6 hours at room temperature. remains brushable without thinning during this period and Class 3 even after aging 15 days at 140 F.

PERFORMANCE. The adhesive (all classes) has a peel strength of at least 8 lb/in. of width at room temperature, 6.4 lb/in. of width at room temperature after 7 days at 160 F and 6 lb/in. of width at room temperature after 48 hours immersion in 75 F water using neoprene coated cloth adherends (MIL-C-19002). Class 4 has a peel strength of at least 5.0 lb/in. of width at room temperature using nylon to neoprene adherends. The adhesive (Cl 2 and 3 only) has sufficient strength to sustain a 50 psi load (75 lb on a 2 in. by ¾ in. joint) for 24 hours at 140 F without separation creep using the same adherends.

FORM

The liquid adhesive is available in commercial packages in the following Fed Std 595 colors: Black (27038), Blue (25177), Green (24227), Gray (26081), Neutral (No number), Olive Drab (24087), Orange (22246), Red (21158) and Yellow (23538). Two component adhesives are available in separate containers containing the proper stoichiometric equivalents of each component.

QPL

Yes.

MIL-A-9117 ADHESIVE, SEALING, FOR AROMATIC FUEL CELLS AND GENERAL REPAIR

Issue: 5 February 1965 Revision: C Amendment: None

SCOPE

This adhesive is intended for bonding nitrile rubbers and for general repair work where aromatic fuel resistance is necessary.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The adhesive is a liquid.

PROCESS. The adhesive is applied by brushing on two coats, air dried one hour, the surfaces reactivated by wetting with a cotton cloth saturated with methyl ethyl ketone, the joint closed within 1 minute and cured in accordance with the time specified in Table I under contact pressure. The adhesive can be stored 28 days at 120 F in unopened containers.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-9117 ADHESIVE

PROPERTY	CURE 4 HOURS	CURE 24 HOURS
Peel, lb/in., min (1)		
At 75 F		
Initial	5	10
After 7 days in TT-S-735 Type III, aromatic fuel	NR	6
After 28 days at 120 F (2)	NR	8
Creep, psi, at 75 F, max (3)	NR	2

(1) Using Hycar 1002 base adherends.

(2) Adhesive before bonding.

(3) Maintain shear load without failure while at 160 F for 24 hours.

NR = No Requirement

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

MIL-A-13374 ADHESIVE, DEXTRIN

Issue: 22 May 1963 Revision: B Amendment: None

SCOPE

This adhesive is intended for manufacturing spirally wound containers especially for packing ammunition and components.

CLASSIFICATION

The adhesive is available in four classes.

Class 1 Liquid adhesive
Class 2 Cold water soluble
Class 3 Hot water soluble
Class 4 Chemically modified water soluble

PROPERTIES

CHEMICAL. The adhesive consists of dextrin derived from starch containing no more than 75% water. Alkaline chemicals up to a pH of 9.5, fillers, no more than 0.5% preservatives and no more than 1% defoamers may be added by the supplier to Classes 1, 2 and 3. The user may add these chemicals to Class 4 or for further modifications to Classes 1, 2 and 3.

PHYSICAL. The pH of the adhesive (see Process Section) is between 7.5 and 9.5 and contains no more than 0.2% dirt and grit which is retained on a U S Standard No. 80 mesh sieve.

PROCESS. The adhesive as received, Class 1, or dissolved is not more than 75% water, Classes 2, 3 and 4, is applied by machine or by brushing, the joint closed within 10 seconds and cured 24 hours at room temperature under approximately 4 psi bonding pressure.

PERFORMANCE. The adhesive has sufficient bond strength such that peeling bonded fiberboard (MIL-B-20390) by hand shows at least 75% fiber failure in bonded area at room temperature and at room temperature after 24 hours exposure to 160 F.

FORM

The liquid adhesive, Class 1, is available in 55 gallon containers. The solid adhesive, Classes 2, 3 and 4, is available in multiwall bags.

QPL

No.

NOTES

(1) Class 1 liquid dextrin may be used in place of vegetable glue covered by specification MIL-G-3937 (see abstract).

MIL-A-14042 (MR) ADHESIVE, EPOXY

Issue: 17 August 1964 Revision: B Amendment: None

SCOPE

This adhesive is intended for structural bonding of metals, plastic laminates (phenolic, polyester and epoxy), glass and wood to each other and in combination.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and a separate liquid amine accelerator.

PHYSICAL. The physical properties of the adhesive are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-14042 ADHESIVE

PROPERTY	BASE RESIN	ACCELERATOR	ADHESIVE
Nonvolatiles, % after 3 hours at 105 C, min	NR	NR	99.5
Specific Gravity	1.20–1.22	0.94–0.96	NR
Ash Content, %, max	0.12	0.01	NR
pH	6.1–6.5	6.1–6.5	NR

NR = No Requirement

PROCESS. The adhesive is activated by mixing together 7 parts of accelerator with 100 parts epoxy resin, the adhesive applied by brushing, the joint closed and allowed to cure 7 days at 75 F or 1 hour at 160 F under contact pressure. The maximum storage and working life between 32 and 100 F of the adhesive with and without accelerator is given by the supplier. The workability of the adhesive in terms of maximum viscosity measured at 65 F is 30,000 centipoises immediately after mixing, 75,000 centipoises in 30 minutes and 160,000 centipoises in 60 minutes.

PERFORMANCE. The performance properties of the adhesive are given in Table II.

MIL-A-14042 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-A-14042 ADHESIVE

PROPERTY	VALUE			
	7 DAYS CURE AT 75 F		1 HOUR CURE AT 160 F	
	AVERAGE	INDIVIDUAL	AVERAGE	INDIVIDUAL
Shear, psi, min (1)				
At -65 F, 30 min.	1330	1150	1800	1500
At 75 F				
Initial	2450	1900	3160	3000
After 7 days in Aromatic hydrocarbon (TT-S-735, Type II)	2450	2000	2850	2500
After 168 hr accelerated weathering (2)	1800	1200	2300	1500
After 176 hr salt spray (3)	1550	1250	2000	1750
At 160 F, 1 hr	600	485	950	700

(1) Fed Test Method Std No. 175, Method 1033, using 2024 Aluminum, Condition O (QQ-A-250/4b) and 1022, No. 4 soft steel (QQ-S-698) adherends, 1/8 inch thick.
(2) Fed Test Method Std No. 141, Method 6152.
(3) Fed Test Method Std No. 141, Method 6061.

FORM

Unless otherwise specified, the liquid base resin is available in 1, 5 and 55 gallon containers and the liquid accelerator in 1 gallon containers.

QPL

Yes.

NOTES

(1) Store base resin between 35 and 60 F unless otherwise specified by supplier.

(2) The suitability of the adhesive with explosives must be substantiated at the Picatinny Arsenal, Dover, New Jersey.

MIL-M-15842 MORTAR, REFRACTORY (HIGH TEMPERATURES, AIR SETTING)

Issue: 24 August 1964 Revision: B Amendment: None

SCOPE

This mortar is intended for laying and bonding refractory bricks especially in ship and stationary boilers, bright annealing furnaces, controlled atmosphere furnaces and electrically heated furnaces.

CLASSIFICATION:

The mortar is available in two classes:

Class 1 Dry
Class 2 Wet

PROPERTIES

CHEMICAL. The mortar consists of finely ground clays, minerals or a mixture of the two.

PHYSICAL. The dry mortar, Class 1, has a pyrometric cone equivalent of at least 32 (ASTM C24) and is sufficiently fine to pass at least 95% through a U S Standard No. 40 mesh sieve and 99.5% through a No. 30 mesh sieve. The wet mortar, Class 2, is of trowelling consistency.

PROCESS. The Class 1 mortar is activated by mixing with water, both classes applied by trowelling, the brick laid, air dried 24 hours and cured 5 hours at 230 F under contact pressure. 1/16 inch thick joints can be made with the trowelling consistency mortar without any newly laid bricks floating out of position. The mortar, both classes, can be stored one year.

PERFORMANCE. The mortar has a modulus of rupture of at least 200 psi at 230 F and 100 psi at both 1000 and 2000 F using firebrick (MIL-B-15606, Grade B) adherends (ASTM C133). After heating 5 hours at 2910 F, it does not fuse or shrink to give anything greater than hairline cracks (ASTM C199).

FORM

The Class 1 mortar is available in 100 pound multiwall sacks and the Class 2 in commercial packages.

QPL

Yes.

MIL-T-22085 (Wep) TAPE, PRESSURE-SENSITIVE ADHESIVE, PRESERVATION AND SEALING

Issue: 26 January 1965 Revision: A Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for exterior preservation and sealing at temperatures varying between -65 F and 125 F.

CLASSIFICATION

The tape is available in two types.

Type I Oil and weather resistant (for application to irregular and flat surfaces)

Type II Weather resistant (for application to nonoil contaminated flat surfaces)

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-22085 TAPE

PROPERTY	VALUE
Tensile strength, lb/in., at 75 F, min	10
Curling	
Curl, in., max (1)	3.0
Twist, degrees, max (2)	360
Water penetration rate, gr/100 sq in./24 hr	
Under 1 inch water head, max (3)	5.0
Water vapor transmission rate, gr/100 sq in./24 hr	
After 72 hr at 100 F and 90–5% RH, max (2)	
Initial	3.0
After 400 hr accelerated weathering (4)	5.0

(1) The difference in unwound length of 36 inches and length when tape is released for both the as received condition and after 14 days at 155 F and 85% RH.

(2) The amount of twisting of an unsupported 36 inch length of tape.

(3) No adhesive transfer occurs.

(4) The tape is subjected to accelerated weathering per Fed Test Method Std No. 141, Method 6151, or ASTM D822 prior to application.

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. A force no greater than 4 lb/in. of width is required for unrolling the tape. The rolls do not telescope more than ½ inch after aging for 14 days at 155 F and 85% RH and can be stored 1 year in unopened packages.

PERFORMANCE. The tape does not deteriorate or stain acrylic-nitrocellulose lacquer (MIL-L-19537) after 400 hours accelerated

MIL-T-22085 (Continued)

weathering (see Table I, Note 3 above) or after 1 year exposure in Miami and Philadelphia. Further, no deterioration or lifting from 2024 aluminum occurs after 24 hours contact with acrylic and strippable coatings (MIL-C-6799, MIL-C-16555 and MIL-S-8141). It sustains a 500 gr/sq in. load to stainless steel (QQ-S-766) with no more than 1/8 inch slippage when cycled 16 hours at -65 F, followed by 8 hours at 125 F. The Type I tape only on 2024 aluminum alloy containing magnesium cleats causes no corrosion after 120 hours exposure to a G. E. RS sunlamp followed by 48 hours exposure to synthetic salt water spray (MIL-C-18687). Additionally, Type I tape does not deteriorate or lift from metal after 24 hours contact at 125 F with 2 ethylhexylsebacate or ASTM No. 3 petroleum base (MIL-S-3136) oils.

FORM

The black or natural colored tape is available in 36 and 60 yard rolls would on 3 inch diameter yellow cores (Fed Std 595, Color No. 33538) in 1, 2 and 3 inch widths. Each roll may contain up to 3 splices.

QPL

Yes.

NOTES

(1) The tape is suitable for the protection of aircraft, missiles and rockets during storage, handling and shipment. Type II is not intended for bonding to surfaces that may become oil contaminated.

MIL-A-23940 (WEP) ADHESIVE, SILICONE RUBBER FOR IGNITER MARK 265

Issue: 19 August 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding electrical components, especially the Mark 265 igniter.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a silicone rubber.

PHYSICAL. The adhesive has a viscosity at 75 F of between 650,000 and 750,000 centipoises.

PROCESS. The adhesive is applied with a spatula, the joint closed and cured 24 hours at room temperature under contact pressure. The adhesive cures by reaction with moisture in the air; consequently relative humidity must be at least 20%. It has a pot life of between 30 and 45 minutes in presence of air and a storage life of at least 6 months in unopened containers.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-23940 ADHESIVE

PROPERTY	VALUE	
	MINIMUM	MAXIMUM
Shrinkage, %	NR	1
Hardness (1)	24	30
Tensile Strength, psi (2)	150	NR
Elongation, % (2)	200	NR
Brittle point, °F (3)	NR	-100
Corrosion (4)	None	None

(1) ASTM D676.
(2) ASTM D412.
(3) ASTM D746.
(4) Some metal discoloration is permissible (See Note Section).
NR = No Requirement

FORM

The adhesive is available in commercial packages which are protected against moisture.

QPL

No.

NOTES

(1) Certain of these adhesives release acetic acid as a result of the hardening process. Metals having a high corrosion susceptibility to acid should be checked prior to usage.

MIL-A-23941 (WEP) ADHESIVE, EPOXY TYPE, TWO PART, FOR ROCKET MOTORS MARK 38 AND MARK 39

Issue: 19 August 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding components on rocket motors especially the Mark 38 and Mark 39.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and an unspecified hardener.

PHYSICAL. The adhesive may be either liquid or solid.

PROCESS. The adhesive is activated by mixing resin and hardener, applied with a spatula, the joint cured in accordance with Table I. No settling out of components occurs after mixing and the activated adhesive (100 gram batch) has a pot life of at least 60 minutes at 77 F and longer between 50 and 60 F.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-23941 ADHESIVE

	STRENGTH PROPERTIES AT (4)			
PROPERTY	–67 F	77 F	140 F	165 F
Shear, psi, min (1)				
Cure A (2)	2020	3193	1093	NR
Cure B (3)				
Initial	2173	2846	NR	1376
After 2 weeks exposure to				
100% RH	2287	3566	NR	2320
95 F salt spray	2360	3000	NR	1754

(1) Using 2024-T3 Alclad aluminum adherends (QQ-A-362).
(2) Cure A consists of 7 days at 77 F under 2 psi bonding pressure.
(3) Cure B consists of 1 hour at 130 F under 10 psi bonding pressure followed by 2 hours at 150 F under no pressure.
(4) After 10 minute exposure to indicated temperature except for 77 F which is after 4 days.
NR = No Requirement

FORM

The adhesive is available in commercial packages.

QPL

No.

MIL-A-24048 (SHIPS) ADHESIVE, PLASTIC SHEET VIBRATION DAMPING

Issue: 14 August 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding vibration damping tiles to steel hull plating.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and an unspecified hardener.

PHYSICAL. The adhesive components are different colored and will produce a homogeneous color upon mixing the components.

PROCESS. The adhesive is activated by mixing resin with hardener, applied with a spatula, the joint closed, hammered with a wooden mallet to assure contact and cured 96 hours at room temperature under contact pressure. Thirty minutes after mixing, the adhesive has a consistency equivalent to a Vicat cone penetration of between 19 and 26 mm and 1½ hours after mixing a pot life equivalent to at least 17 mm penetration (ASTM D 217). Further it has sufficient tack to adhere 6 plastic vibration damping tiles (MIL-P-22581) in a vertical position to unprimed mild steel and one tile in a horizontal overhead position to zinc chromate (TT-P-645, Formula 84) coated mild steel without any slippage, sagging, buckling or separation. The adhesive can be stored 1 year.

PERFORMANCE. The adhesive, after 30 minutes room temperature cure, has an initial peel strength of 4 oz/in. at 75F using glass tape (MIL-Y-1100, Form 5, Class C) and mild steel adherends. After 96 hour room temperature cure it produces mild steel/plastic vibration damping tiles (MIL-P-22581) composites which will not slip, sag, buckle or separate when subjected separately to (1) 24 hours at 150 F, (2) 24 hours immersion in 150 F distilled water, (3) 1 week immersion in 75 F JP-5 fuel (MIL-J-5624) and (4) consecutive shock loadings applied to the steel side of 100, 200, 400, 700, 1000, 2000 and 2000 (repeated) ft lb (MIL-S-901). After cure the adhesive has a Shore durometer, Type A, hardness of 85.

FORM

The adhesive is available in 1 and 5 gallon containers. The hardener is supplied in the required stoichiometric proportions for the resin package.

QPL

Yes.

MIL-A-25457 ADHESIVE, AIR-DRYING, SILICONE RUBBER

Issue: 27 May 1964 Revision: B Amendment: None

SCOPE

This adhesive is intended for bonding silicone rubber to aluminum or to itself.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The adhesive is either a one or two part paste.

PROCESS. The two part adhesive is activated by mixing the base resin and catalyst, the one or two part premixed adhesive applied by brushing, air dried between 20 and 60 minutes unless otherwise specified by the supplier, the joint closed and cured 3 days at room temperature under contact pressure. The adhesive can be stored 28 days at 120 F in unopened containers.

PERFORMANCE. The adhesive after 24 hour and 3 day cures has a peel strength of at least 8 and 10 lb/in. of width at 75 F using either silicone rubber adherends or silicone rubber to 2024 Alclad aluminum (QQ-A-362). The peel strength using the latter composite (3 day cure) is (1) 8.5 lb/in. after 24 hours immersion in water and (2) 8.0 lb/in. after 24 hours immersion in oil (Fed Test Method Std No. 601, Method 6001, Medium No. 1). After 24 hour room temperature cure the same composite will have sufficient peel strength to resist a 2 lb/in. peeling force applied for 24 hours at 400 F provided the composite is first aged 24 hours at 212 F.

FORM

The adhesive is available in ½ and 1 pint, quart and gallon containers. Catalyst, if any, is supplied in the proper stoichiometric proportions for the base compound.

QPL

Yes.

NOTES

(1) This adhesive should be used to bond silicone rubber moldings to metal where heat and pressure cannot be used to effect a cure.

MIL-A-46091 (MR) ADHESIVE, BRAKE LINING TO METALS

Issue: 1 September 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding brake linings to steel and aluminum.

CLASSIFICATION

The adhesive is available in two forms.

Form 1 Liquid
Form 2 Film

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. The film form is unsupported. Unspecified solvents and activators may be added.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is mixed with solvents and activators, if any, the liquid form applied by brushing and the tape form laid, the joint closed and cured at elevated temperature and pressure specified by the supplier.

PERFORMANCE. The adhesive has a disk shear strength at 75 F and at 400 F after 5 minutes of at least 1000 psi using steel to steel (QQ-S-698, Grade 1020) and aluminum to aluminum (QQ-A-250/11) joints (SAE Recommended Practice J840). It further passes the axial shear strength test (ASTM D1205) at 75 F, and after (separately) 24 hours immersion in nonpetroleum base brake fluid (VV-H-910), 24 hours in water and 5 minutes exposure to 400 F using brake lining (HH-L-361) to the aforementioned steel and aluminum adherends.

FORM

The liquid and film adhesives are available in commercial packages.

QPL

No.

APPENDIX A

INDEX OF ADHESIVE BONDING SPECIFICATIONS

This index lists all of the new and revised specifications abstracted. Suffix letters following specifications numbers are not reproduced here but are shown in the individual abstract. Thus, for example, L-T-0080 (ARMY MR) is shown as L-T-0080.

AMERICAN DENTAL ASSOCIATION

AMERICAN SOCIETY FOR TESTING AND MATERIALS

AMERICAN STANDARDS ASSOCIATION

APPENDIX B

INDEX OF CANCELED ADHESIVE BONDING SPECIFICATIONS

This index lists all of the adhesive material specifications canceled. The date shown is the cancelation date. Superseding specifications are given when applicable. The page number refers to the page in the original book where the specification is abstracted.

INDEX

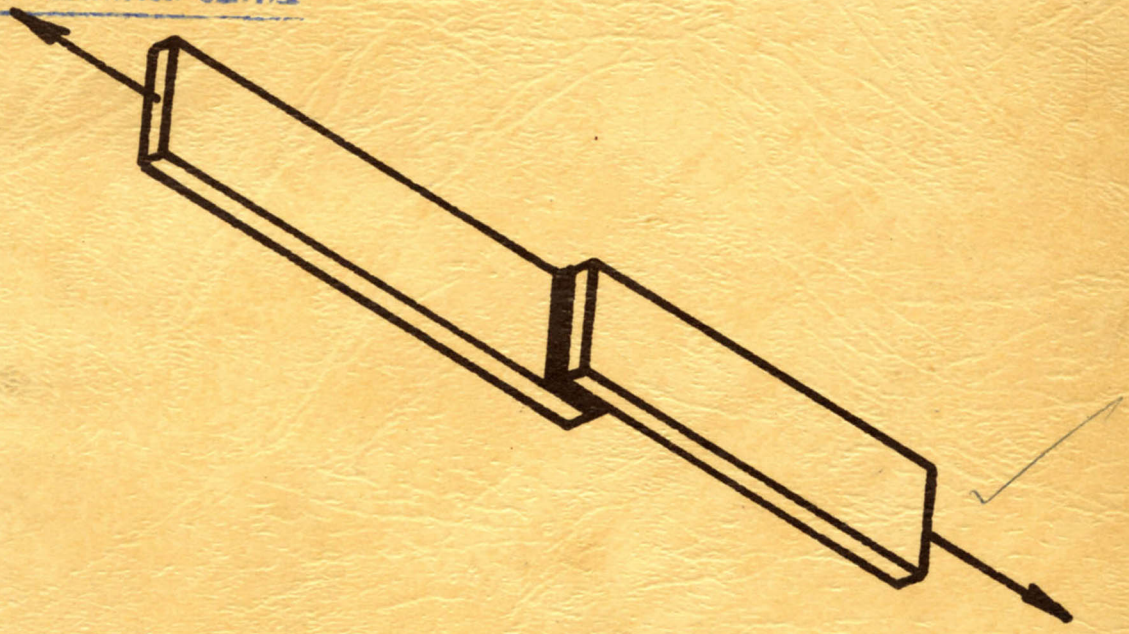
ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ

SEPTEMBER 1965



Foster Publishing Company

Table Of Equivalents

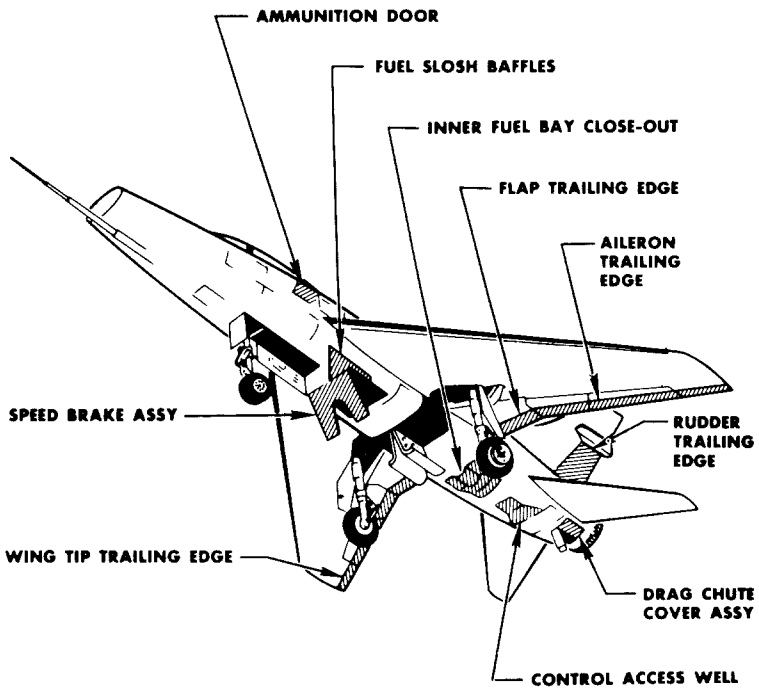
Adhesive Materials, Their Properties and Usage

UNIT	VALUE
Length	1 in equals 2.540 cm
	1 ft equals 30.480 cm
	1 yd equals 91.440 cm
Mass	1 oz equals 28.35 g
	1 lb equals 453.6 g
	1 lb equals 0.453 Kg
Pressure	psi equals 70.30 g/cm^2
Temperature	°F equals 1.8 (°C) + 32
Volume	1 oz equals 29.57 cm^3
	1 in^3 equals 16.39 cm^3
	1 ft^3 equals 28.32 l
Density	lb/ft^3 equals 0.016 g/cm
	lb/gal equals 0.119 g/cm
Energy	1 BTU equals 252 Cal
	Ft lb equals 0.3240 Cal
Power	BTU/min equals 0.1760 KW
	Horsepower equals 0.746 KW

ADHESIVE MATERIALS, THEIR PROPERTIES

AND USAGE

SUPPLEMENTS



Adhesive Bonded Components in Aircraft.

(Courtesy North American Aviation, Inc.)

Volume 1 Number 2

ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ
North American Aviation, Inc.
Downey, California

SEPTEMBER 1965

FOSTER PUBLISHING COMPANY
Long Beach, California

To Lucy, Philip, Laurie,
Barbara, Morris, Elsie,
Opal and Alice

ADHESIVE MATERIALS,
THEIR PROPERTIES AND USAGE
SUPPLEMENTS

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LONG BEACH, CALIFORNIA 90815

PREFACE

Every design, whether it be for a component or for a complete system, will utilize adhesive bonding in its reduction to the hardware stage.

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE has brought into being the first and only comprehensive guide to Government, National, Industrial and International specifications covering adhesives, binders, cements, glues, mortars, mucilages, pastes, gummed and pressure-sensitive adhesives.

However, specifications are living documents. They are continuously being created, changed and canceled. One of the more vexing problems facing most engineers and manufacturers in developing and maintaining products is the need to keep up with the advancing technology reflected in specifications.

The SUPPLEMENTS will meet this need by bringing up to date every 3 months the data contained in new and revised adhesive material specifications, eliminating the need for extensive literature surveys, delays in specification procurement and expensive analyses.

The SUPPLEMENTS retain the same format and styling of the original book.

Irving Katz

Downey, California
August 15, 1965

PREFACE

Adhesive Materials, Their Properties and Usage

Currently, it takes nine glues for you to light up your cigarette. Detached retinas, worn arteries and broken bones are being repaired with adhesives. Highway departments use these materials in restoring roads, while builders are constructing houses and fences at lower costs by substituting these bonding agents for mortar. Automobiles contain between eight and twenty five pounds of plastic cements; moreover, in the not too distant future, the entire car may be free from screws, solder and rivets. The shoe manufacturers are discarding nails and threads for these adhesive materials, while the garment industry is attempting to assemble clothes by bonding, in order to eliminate costly sewn seams. The aircraft, shipbuilding, packaging, toy and dental industries all use bonding materials — in some cases even for prime structural purposes.

To support these assembly operations, approximately two billion pounds of chemical joining agents, commonly called adhesives, cements, glues, mucilages, pastes and pressure-sensitive tapes, are being produced in this country. The user has available such a wide variety of types, grades and forms that the problem of choosing which adhesive will join his components is not a simple one. Factors concerning loads, temperature range, weathering and environmental conditions affecting the joint, limit the selection. Further, since profitable operations not only depend on how fast and inexpensively parts can be made but also on how quickly the product can be assembled, additional factors are introduced. Typical ones which require consideration are process equipment availability, manufacturing sequences, purchasing commitments and storage (some adhesives spoil rapidly).

Other than a few limited reviews, there is no single source guide oriented toward the user which even begins to answer all these questions. The user is thus faced with a formidable problem. Not only does he have to sift out which types of adhesives can join his components, but also he must determine which is best for his application, consistent with process and equipment limitations. Considerable literature searching as well as supplier contact is therefore necessary. Such an ambitious project is time consuming; and in certain cases where decisions are urgent, the problem becomes difficult to resolve.

Nevertheless, there is actually a vast source of readily applicable data. These data are contained in specifications, which define what is expected in measurable terms, give the limits of uniformity and quality, and distinguish between a good and a bad product. Unfortunately, when the precise number and title of the desired specification are unknown, procurement is hindered.

In response to this shortcoming, this book provides a guide for choosing suitable adhesives covered by specifications. It gives basic and detailed information of value, on a comparable basis, to designers, manufacturers, engineers and technical personnel concerned with fabricated parts of almost every conceivable nature, where adhesive bonding assembly operations are an integral part of fabrication.

Towards this end, the book is divided into two parts. Part I guides the user to those adhesives which can fulfill specific jobs. Part II gives exact specification details covering the chemical, physical, process and performance properties, as well as availability of these bonding materials. In order to keep up with the changing technology of adhesive bonding which is reflected in the creation, revision and cancellation of specifications, this book will be revised periodically.

I wish to thank three publishers for their permission to use portions of my articles in this book. These are Reinhold Publishing Company ("Adhesives for Wood", Materials in Design Engineering, July 1962), Conover-Mast Publications ("Pressure-Sensitive Adhesive Electrical Tapes", Electro-Technology, August 1962 and "Adhesives for Optical and Electro-Optical Applications", Electro-Technology, April 1963, copyright C-M Technical Publications) and Palmerton Publishing Company ("A Guide to Federal and Military Specifications for Rubber Bonding Adhesives", Rubber Age, April 1964).

Irving Katz

Downey, California
July, 1964

CONTENTS

PART I

ADHESIVES SELECTION

1. PAPER AND FABRIC ADHESIVES

Three new adhesives have been introduced for paper and fabric assemblies. One is for bonding only paper and the other two for bonding paper to itself or to fabrics.

STRAIGHT PAPER ASSEMBLY ADHESIVES

These adhesives are available in liquid, solid and tape (temporary and water remoistenable) varieties. Only the solid variety has been changed.

This solid adhesive in the form of a paste will not cockle, wrinkle or warp paper despite the fact that it contains water. Additionally, it can be thinned with ordinary tap water (Reference 1).

MIXED PAPER AND FABRIC ASSEMBLY ADHESIVES

These two adhesives are both formulated from polyvinyl acetate. The first, containing 40% by weight PVA solids, is a general purpose adhesive. It will adhere paper and fabrics including glass cloth. Glass cloth joints sustain peel loads of 5 lb/in. (Reference 2).

The second, containing 50% by weight PVA solids, will bond paper to itself and to fabrics, leather, wood and metals (Reference 3). It has a peel strength of 15 lb/in. using cotton duck adherends and can be removed with boiling deinking solution. This adhesive is particularly suitable for book binding operations.

BIBLIOGRAPHY

Straight Paper Assembly Adhesives

(1) MMM-A-177 Adhesive, paste, office and photomounting, 5 January 1965. No QPL.

Mixed Paper and Fabric Assembly Adhesives

(2) ASTM-D-2181 Vinylacetate resin emulsion adhesive, 1964. No QPL.

(3) MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 2 September 1964. No QPL.

2. WOOD ADHESIVES

Wood adhesives fall into three general usage categories: the first, for straight wood assemblies, including plywood manufacture and veneering applications; the second, for specific mixed wood assemblies, such as wood/metal, wood/plastics, etc.; and the third, for general purpose wood bonding applications. Innovations in all three categories have been introduced.

STRAIGHT WOOD ASSEMBLY ADHESIVES

Adhesives for straight wood assemblies are classified as interior, semidurable and weatherproof adhesives. Only one of the weatherproof adhesives has been changed.

These adhesives, compounded from phenolic, resorcinol or melamine resin, produce joints more durable than the wood itself (Reference 1). They are virtually indestructible by weather, mold and heat.

MIXED WOOD ASSEMBLY ADHESIVES

Mixed wood assembly adhesives are classified for the user according to the specific joint they can effect. Currently available are those for wood/metal, wood/paper, wood/leather, wood/plastic, wood/cotton fabric and wood/plaster or concrete. An adhesive has been modified for wood/leather joints.

Wood/Leather.

Polyvinyl acetate resin emulsion, removable with boiling deinking solutions is suitable for bonding wood to leather (Reference 2). This liquid adhesive is usually cured at room temperature.

GENERAL PURPOSE WOOD ADHESIVES

Wood has been bonded to a wide variety of materials using acrylic, cellulosic, epoxy, rubber and vinyl adhesives. However, heretofore the epoxy adhesives were intended for strictly structural purposes. A new epoxy nonstructural adhesive has been introduced (Reference 3). This adhesive will adhere practically anything to wood in the temperature range between −50 and 250F provided neither high stress nor excessive vibration are imposed. It has a

shear strength of 1500 psi as opposed to 2500-4500 psi for the structural epoxy adhesives.

BIBLIOGRAPHY

Straight Wood Assembly Adhesives

(1) MMM-A-181 Adhesive, room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine resin), 16 March 1965. No QPL.

Mixed Wood Assembly Adhesives

(2) MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 2 September 1964. No QPL.

General Purpose Wood Assembly Adhesives

(3) MMM-A-00187 Adhesive, synthetic, epoxy resin base, paste form, general purpose, 22 January 1965. No QPL.

3. RUBBER ADHESIVES

No new or modified rubber adherend adhesives have been introduced.

4. PLASTICS ADHESIVES

Plastics adhesives also fall into three general usage categories: the first, for straight plastic assemblies; the second, for mixed plastic assemblies; and the third, for general purpose plastics bonding applications. New and modified adhesives have been introduced for straight plastic assemblies and general purpose plastics bonding applications.

STRAIGHT PLASTIC ASSEMBLY ADHESIVES

Straight plastic assembly adhesives are conventionally designated by the type of adherend to be joined, such as thermoplastic or thermosetting. Adhesives based on phenolics, resorcinol or melamine have been compounded for joining thermosetting rigid plastic laminates (Reference 1). These adhesives, dependent on type, can be cured at room temperature or at intermediate temperatures (95-190 F, up to five hours). Exact design values must be determined for each laminate combination considered.

GENERAL PURPOSE PLASTICS ADHESIVES

A general purpose plastic adhesive based on an epoxy resin has been introduced. This adhesive will adhere practically anything to a plastic material as well as plastics to plastics. This adhesive, unlike the current structural epoxy adhesives, is intended for applications in the temperature range between −50 and 250 F, where neither high stress nor excessive vibration are imposed. It has a shear strength of 1500 psi as opposed to 2500-4500 psi for the structural epoxy adhesives (Reference 2).

BIBLIOGRAPHY

Straight Plastic Assembly Adhesives

(1) MMM-A-181 Adhesive, room-temperature and intermediate temperature setting resin (phenol, resorcinol and melamine resin), 16 March 1965. No QPL.

General Purpose Plastics Adhesives

(2) MMM-A-00187 Adhesive, synthetic, epoxy resin base, plastic form, general purpose, 22 January 1965. No QPL.

5. METAL ADHESIVES

Metal adhesives like plastic adherend adhesives also fall into three general usage categories. The first is for straight metal assemblies, the second for mixed metal assemblies and the third for general purpose metal bonding applications. New and modified adhesives for the mixed metal assembly and general purpose metal bonding applications have been introduced.

MIXED METAL ASSEMBLY ADHESIVES

Leather can be adhered to metals with a polyvinyl acetate resin emulsion adhesive (Reference 1). This adhesive will bond other materials to metal and gives a peel strength of 15 lb/in. using cotton duck adherends. It can be removed with a boiling deinking solution.

GENERAL PURPOSE METAL ADHESIVES

Heretofore, epoxy adhesives have been designed for structural metal bonding applications. However, an innovation has been created with the introduction of a new nonstructural epoxy adhesive. This adhesive is suitable for applications in the temperature range between −50 and 250 F where neither high stress nor excessive vibration are imposed (Reference 2).

BIBLIOGRAPHY

Mixed Metal Assembly Adhesives

(1) MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 2 September 1964. No QPL.

General Purpose Metal Adhesives

(2) MMM-A-00187 Adhesive, synthetic, epoxy resin base, paste form, general purpose, 22 January 1965. No QPL.

6. PACKAGING ADHESIVES

Packaging adhesives are used for (1) carton manufacture, (2) carton closure, (3) packing and (4) labeling. An innovation in carton closure adhesives has been introduced.

Fiberboard cartons can now be closed with a nontoxic, water resistant adhesive (Reference 1). These cartons remain functional in the temperature range between −40 F and 140 F and can sustain at least 24 hours immersion in water.

BIBLIOGRAPHY

Carton Closure

(1) MMM-A-250 Adhesive, water-resistant (for sealing fiberboard boxes) 27 January 1965. No QPL.

7. ELECTRICAL ADHESIVES

No new or modified electrical adhesives have been introduced.

8. OPTICAL ADHESIVES

No new or modified optical adhesives have been introduced.

9. BUILDING CONSTRUCTION ADHESIVES

New and modified Building Trade adhesive materials have been developed for use in (1) installation of thermal insulation, (2) painting and (3) installation of floor coverings.

INSTALLATION OF THERMAL INSULATION

Thermal insulation materials are used to control the flow of heat. Two distinct types are available: primary and secondary insulations. Primary insulations are applied directly to the component to be thermally protected without the need of a separate adhesive. Secondary insulations are materials that require a separate adhesive to bond them to the component. Only innovations in the primary insulation materials have occurred.

Five types of primary insulation materials have been introduced as modifications of existing insulants. These are (1) 85% magnesia cement suitable to 600 F, (2) asbestos cement to 1000 F, (3) mineral wool cement, the finish grade to 1200 F and the utility grade to 1800 F, (4) vermiculite cement to 1800 F, and (5) diatomaceous silica cement to 1900 F (Reference 1). These cements are activated with water, applied by trowelling and cured at room temperature.

PAINTING

Pressure-sensitive adhesive tapes are used during painting operations for masking and stripping purposes. Cellulose nitrate and acrylic-nitrocellulose base lacquers can be successfully masked with a special paper base tape. This tape is sufficiently resistant to prevent penetration of lacquer during application and does not lift or cause discoloration of underlying lacquer (Reference 2).

INSTALLATION OF FLOOR COVERINGS

Floor coverings are fabricated from many materials. Modifications to existing adhesives for the laying of asbestos and vinyl asbestos tiles and cork and linoleum materials have occurred.

Asbestos and vinyl asbestos tiles can be installed with cutback asphaltic base cements (Reference 3). The cement may be

used on (1) primed and unprimed cement subfloors, (2) steel or other metal subfloors and (3) primed plywood or hardwood subfloors.

Cork and linoleum materials can be installed with water base cements (Reference 4). However, this cement is not suitable against metal subfloors.

BIBLIOGRAPHY

Installation of Thermal Insulation

(1) SS-C-160 Cements, insulation, thermal, 21 September 1964. No QPL.

Painting

(2) MIL-T-21595 Tape, pressure-sensitive adhesive, paper, masking, nonstaining, 28 January 1965. Has QPL.

Installation of Floor Coverings

(3) MMM-A-00110 Adhesive, asphalt, cut-back type (for asphalt and vinyl asbestos tiles), 24 November 1964. No QPL.

(4) MMM-A-00137 Adhesive, linoleum, 18 May 1964. No QPL.

10. OTHER ADHESIVES

New and modified adhesives have been developed for pyrotechnic, photographic and automotive applications.

PYROTECHNIC ADHESIVES

During demolition operations it may be necessary to suspend explosive charges from an overhead or vertical position. A new adhesive paste is currently available which will permit adhering these explosive charges, even under water, to metal, wood and concrete surfaces (Reference 1). It is suitable in the temperature range from –40 to 100 F.

PHOTOGRAPHIC ADHESIVES

Once prints are made they are usually mounted in albums. A paste, which can now be thinned with ordinary tap water, has been specially formulated so that it will not curl, wrinkle or shrink the prints or album paper (Reference 2).

MISCELLANEOUS ADHESIVES

Brake linings can be joined to steel and aluminum drums with a new adhesive resistant to brake and hydraulic fluids, water and for short periods of time to temperatures as high as 400 F (Reference 3).

BIBLIOGRAPHY

Pyrotechnic

(1) MIL-A-60091 Adhesive for bonding charges to structural surfaces, 10 June 1964. No QPL.

Photographic

(2) MMM-A-177 Adhesive, paste, office and photomounting, 5 January 1965. No QPL.

Other

(3) MIL-A-46091 Adhesive, brake lining to metal, 4 March 1965. No QPL.

PART II

ADHESIVE PROPERTIES DATA

NOTICE TO THE READER

Specifications are living documents: they are continuously being created, changed and cancelled. The following new and revised abstracts (tabulated in numerical order — Federal first, Military second and others third) reflect the current status of these documents, giving the latest issue date, revision and amendment.

These abstracts additionally set forth the six basic constituents of any specification. These are Scope, Classification, Properties, Form, Qualified Products List and Notes.

The Scope defines the purpose of the joining agent — specifically, what the adhesive is intended to do and what it will bond.

The Classification section defines the various conditions, expressed as types, classes and grades, under which the adhesive is available.

The Properties section is subdivided into four parts. These are chemical, physical, process and performance. The chemical section designates the composition of the joining agents. However, for various reasons, some specifications do not define the ingredients; one purpose is to leave the choice to the manufacturer in order to promote competition among the suppliers. The physical properties give the characteristics of the joining agents which will be needed if the material is to meet the intended purpose. Such things as viscosity, solids and ash content, toxicity, flexibility, specific gravity, consistency, pH, etc. fall into this category. Process properties define the make-ready and curing conditions necessary to convert the bonding material. Storage requirements are given here since they are an integral part of the conversion process. Performance properties define what is expected from the joining agent when properly converted.

The Form defines the physical state of the joining material, such as liquid, solid, film, etc., and the quantities in which it is normally available. Some of the specifications do not specify quantities, and these are noted accordingly. Packaging specifications covering the containers are not given.

The Notes give additional information of value to the user such as which type, grade or class is preferable for a specific application, other types of adherends which can be joined, etc.

Each abstract contains all the data actually defined in the specification. Where specific items need modification or are not given, the reader should add these in any purchase orders.

A certain degree of caution is necessary concerning the use of adhesives conforming to any specification. The properties are guaranteed only when the specific adherends are tested in strict accordance with the procedures given in the specification. A change in adherends may change the expected performance properties. Further, the test methods employed may not reflect the actual environmental conditions of a particular part. And still further, performance properties called out by a specification are generally minimum; the actual values obtained with the adhesives should be higher than specified. Consequently, the specification values serve admirably as a screening technique to reduce development costs.

When a specification appears promising, the final step is to obtain adhesives covered by these documents. Certain of the specifications have concomitant Qualified Products Lists (QPL) which give the names of adhesives, including the suppliers, which meet the requirements. When no Qualified Products List exists, many adhesive suppliers will certify that their products conform to the requirements (if they do) when procured under the specification designation.

Appendix A lists all of the new and revised adhesive material abstracted. Many of these specifications refer to other documents to define some of the adherends and test procedures. These references are designated by the document number in the abstract.

The following abstracts are a compilation of essential data contained in adhesive material specifications. Extensive effort has been made to verify and check the information contained in each abstract. However, neither the author nor the publisher is responsible for errors which may have occurred in this book.

SS-C-160 CEMENTS, INSULATION, THERMAL

Issue: 21 September 1964 Revision: None Amendment: 1

SCOPE

This cement is intended to provide thermal insulation to piping systems and vessels from 100 to 1900 F.

CLASSIFICATION

The cement is available in five types and two grades.

Type I	Magnesia cement
Type II	Asbestos cement
Type III	Mineral wool cement
Grade F	Finishing
Grade U	Utility
Type IV	Vermiculite cement
Type V	Diatomaceous silica cement

PROPERTIES

CHEMICAL. The Type I cement consists of a mixture of basic hydrated magnesium carbonate and reinforcing mineral fibers; Type II asbestos fiber with or without an unspecified heat resistant binder; Type III, Grade F, mineral fibers, fillers and hydraulic setting binders, Grade U an unspecified heat resistant binder and a mineral filler from rock, slag or glass origin; Type IV a mixture of expanded or exfoliated vermiculite and an unspecified heat resistant binder; and Type V diatomaceous silica and an unspecified heat resistant binder.

PHYSICAL. No physical properties are given.

PROCESS. The cement is activated by mixing with water, applied by trowelling, and cured (dried) at room temperature under contact pressure. The supplier provides processing instructions. Other process properties are given in Table I.

SS-C-160 (Continued)

TABLE I. PROCESS PROPERTIES OF SS-C-160 CEMENT.

PROPERTY	Type I	Type II	Type III Grade F	Type III Grade U	Type IV	Type V
Consistency (1)						
Method A, %	35-45	35-45	NR	NR	35-45	38-45
Method B, in.	7-9	7-9	NR	NR	7-9	7-9
Dry Covering Capacity (2) sq ft/in. thickness/ 100 lb dry cement	50	75	100	10	15	25
Volumetric Shrinkage Upon drying, %, max (3)	30	45	10	25	20	30
Linear Shrinkage, % max (4), (5)	2.0	1.0	2.0	3.0	3.0	5.0

(1) ASTM C405.
(2) ASTM C166.
(3) ASTM C166.
(4) ASTM C356.
(5) After heat soaking 600 F (Type I), 1000 F (Type II and Type III, Class F), 1200 F (Type III, Class U), 1800 F (Type IV) and 1900 F (Type V).
NR = No Requirement

PERFORMANCE. The performance properties of the cement are given in Table II.

TABLE II. PERFORMANCE PROPERTIES OF SS-C-160 CEMENT.

PROPERTY	Type I	Type II	Type III Grade F	Type III Grade U	Type IV	Type V
Thermal Conductivity BTU/in./hr/sq in./°F, max (1)						
At mean temp.						
200 F	0.65	2.20	0.90	0.70	0.95	0.70
300 F	0.70	2.30	NR	NR	NR	NR
400 F	0.75	2.40	1.00	NR	NR	NR
500 F	NR	NR	NR	0.85	1.10	0.85
600 F	NR	NR	1.10	NR	NR	NR
700 F	NR	NR	NR	0.95	1.20	0.95
Compressive Strength, psi at 5% deformation min (2)	50	75	100	10	15	25

(1) ASTM C177.
(2) ASTM C354.
NR = No Requirement

SS-C-160 (Continued)

FORM

The cement is available in 5, 25, 50, 60 and 100 pound containers.

NOTES

(1) This specification supersedes HH-I-00500, HH-C-168 and in part HH-I-623 (see abstracts). This specification Type III Grade F also includes the requirements of MIL-C-2908 (see abstract).

(2) The temperature range and equivalent ASTM specification is given in Table III.

TABLE III. TEMPERATURE RANGE OF SS-C-160 CEMENT.

Type	Temp °F	Equivalent ASTM Specification
I	100 – 600	C193
II	100 – 1000	C194
III		
Grade F	To 1200	C449
Grade U	To 1800	C195
IV	100 – 1800	C196
V	100 – 1900	C197

MMM-A-00110 (GSA-FSS) ADHESIVE, ASPHALT, CUT-BACK TYPE (FOR ASPHALT AND VINYL ASBESTOS TILES)

Issue: 24 November 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for the installation of asphalt and vinyl asbestos tiles.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an asphaltic base material, a volatile solvent, and asbestos fiber or other mineral filler. No benzol, chlorinated solvents, or other toxic materials are used.

PHYSICAL. The alkali resistant adhesive has a viscosity at 75 F between 15,000 and 98,000 centipoises or between 50 and 200 seconds (Gardner mobilometer) and no more than 10% solvent is retained after 1 hour drying at 75 F.

PROCESS. The adhesive is applied by trowelling in thicknesses of 1/16 inch, air dried usually for 1½ hours, the asphalt tile laid and the joint cured at least one hour at room temperature under contact pressure. The bonding agent has an air drying time no longer than three hours, whereupon it assumes the properties of a pressure-sensitive adhesive. The adhesive can be stored for 3 months without excessive settling or caking. Stirring before use will restore it to its original consistency.

PERFORMANCE. Asphalt tile after bonding 1 hour to steel at 75 F under 0.18 psi pressure will not slip more than ½ inch when allowed to stand vertically (approximately 80°) for 1 hour at 75 F and at 75 F after aging the adhesive 72 hours at 160 F prior to laying tile.

FORM

The paste adhesive is available in 1, 2, 3, 3½, 5, 30 and 55 gallon containers.

QPL

No.

NOTES

(1) Cut-back primer should be applied to cement finished concrete slabs or floor fills prior to application of adhesive.

(2) This adhesive is suitable for laying tiles on (a) primed and unprimed concrete subfloors, either suspended, on grade, or below grade, (b) steel or other metal subfloors, and (c) suspended plywood or hardwood subfloors that have been properly primed.

(3) This specification is an interim revision of SS-A-128 (see abstract).

MMM-A-177 (Continued)

spreads smoothly and does not separate or granulate, and the moisture does not penetrate through nor soak into the surface of paper. When dry, it does not crackle, wrinkle or warp paper, nor does it discolor paper or photographic prints. Type II paste does not discolor paper. Both types do not corrode any metal components such as spreaders or caps. The paste has sufficient strength such that separation of white bond paper (UU-P-121, Type II) and kraft paper (UU-P-268, Grade B, No. 2) joints by peeling result in failure of the paper fibers.

FORM

The solid and semiliquid paste are available in the quantities given in Table I.

TABLE I. AVAILABILITY OF MMM-A-177 PASTE

CLASS	CONTAINER	Type I, oz, min (1)	Type II, oz, min
1	Desk jars (Type I) and tubes (Type II)	4–6	2–4 (2)
2	Desk jars	7–9	4–6 (2)
3	Pint jars	18	17
4	Quart jars	36	35
5	Gallon jars	145	142

(1) Desk jars are supplied with a brush or spreader and pint, quart, and gallon jars have mouths sufficiently large to accomodate 2, 3, or 4 inch paint brushes, respectively.

(3) Each tube and desk jar is supplied with a brush or spreader.

QPL

No.

MMM-A-180 ADHESIVE, POLYVINYL ACETATE RESIN EMULSION (ALKALI DISPERSIBLE)

Issue: 2 September 1964 Revision: None Amendment: 2

SCOPE

This adhesive is intended for bonding leather to metals, wood, cloth, paper, etc. and as a general book binding adhesive for hand operations.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of at least 50% alkali dispersible polyvinyl acetate emulsion.

PHYSICAL. The adhesive has a viscosity at 25 C between 600 and 1200 centipoises, a pH between 4.0 and 6.0, weighs at least 9.0 pounds per gallon and is compatible with 4 to 10 parts of a mixture containing 2 parts hexylene glycol and 1 part water, forming a smooth emulsion.

PROCESS. The adhesive is applied by brushing, the joint closed and cured usually at room temperature. The supplier provides details covering thinning, number of coats, film thicknesses, air drying time between coats and other process conditions. The dry film is soluble in a boiling, alkaline, deinking solution whose composition is given in Table I. The adhesive can be stored 3 months at room temperature in air tight containers.

TABLE I. COMPOSITION OF DEINKING SOLUTION FOR DISSOLVING MMM-A-180 POLYVINYL ACETATE ADHESIVE

INGREDIENT	WEIGHT IN GRAMS
Caustic soda	0.40
Sodium carbonate (soda ash)	0.20
Tetrasodium Pyrophosphate (TSPP)	0.50
Water, to make	100 (1)

(1) milliliters.

PERFORMANCE. The adhesive has a peel strength of 15 lb/in. of width, using cotton duck adherends.

FORM

The liquid adhesive is available in 1, 5 and 55 gallon containers.

QPL

No.

MMM-A-00137 (GSS-FSS) ADHESIVE, LINOLEUM

Issue: 18 May 1964 Revision: b Amendment: None

SCOPE

This adhesive is intended for installation of linoleum, cork carpet and other types of floor coverings to subfloors and floor under-layments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an unspecified water base binder, inorganic fillers and mold and odor retardant additives.

PHYSICAL. The adhesive is nonalkaline to litmus paper, mold resistant and does not have an objectionable odor.

PROCESS. The adhesive is applied by troweling in thicknesses of 1/32 inch, the linoleum laid and the joint cured at least 72 hours at room temperature under contact pressure. No settling of filler occurs during storage of the adhesive.

PERFORMANCE. The adhesive, 6 grams per 6 inch by 3 inch burlap-backed linoleum tile, cured 16 hours between 70 and 90 F, followed by 6 hours at 175 F, adheres without separation after (1) being bent around a 5 inch diameter mandrel (face side first and adhesive second side) and (2) being scraped with a knife while still in tension. A cleavage force of at least 4 pounds separates a 2-3/4 inch by 6 inch by 3/8 inch No. 1 common white pine board and a 2 inch by 8 inch piece of burlap-backed linoleum after the joint, using 5-1/2 grams of adhesive (on pine), is cured at 75 F for 72 to 120 hours under 10 pounds bonding pressure.

FORM

The paste adhesive is available in 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) This specification is an interim revision of Federal Specification O-P-106.

(2) Do not use this adhesive for bonding floor coverings to steel or other metal subfloors.

(3) Felt backed linoleum (LLL-F-471) can be laid with this adhesive.

MMM-A-177 ADHESIVE, PASTE, OFFICE AND PHOTO-MOUNTING

Issue: 5 January 1965 Revision: a Amendment: 2

SCOPE

This paste is intended for general purpose office and photomounting usage.

CLASSIFICATION

The paste is available in two types and seven classes.

Type I Solid, hard white paste – Office and photomounting use

- Class 1 4 to 6 oz in glass jar with water well and brush or spreader
- Class 2 7 to 9 oz in glass jar with water well and brush or spreader
- Class 3 1 pint glass jar
- Class 4 1 quart glass jar
- Class 5 1 gallon glass jar

Type II Semiliquid paste – Office use only

- Class 1 2 to 4 oz in collapsible tube with brush or spreader
- Class 2 4 to 6 oz in glass jar with brush or spreader
- Class 3 1 pint glass jar
- Class 4 1 quart glass jar
- Class 5 1 gallon glass jar

PROPERTIES

CHEMICAL. The composition of the paste is not given; however, phenol, thymol, sodium benzoate, benzoic or salicylic acid, but not formaldehyde, may be used as a preservative. When phenol is used, an essential oil such as cassia, wintergreen, clove, cinnamon, peppermint or sassafras is used. The essential oil is optional with other preservatives.

PHYSICAL. The Type I paste is a hard, white solid which does not darken with age, has a pH between 4.5 and 7.0 and an approximate specific gravity of 1.096. Type II is a semiliquid which does not lose more than 8% of its original weight after 24 hours at 25 C under a relative humidity of 31%, and has an approximate gravity of 1.072. Both types are free from grit and lumps and are mold resistant.

PROCESS. The paste is applied by brushing, the joint closed and cured at least ½ hour at room temperature under contact pressure. Water may be added to Type I as specified by the supplier; no water is necessary for Type II.

PERFORMANCE. The Type I paste when diluted with water

MMM-A-181 ADHESIVE, ROOM-TEMPERATURE AND INTERMEDIATE-TEMPERATURE SETTING RESIN (PHENOL, RESORCINOL, AND MELAMINE RESIN)

Issue: 16 March 1965 Revision: a Amendment: None

SCOPE

This adhesive is intended for (1) assembly wood gluing, (2) the manufacture of laminated members and other wooden articles (excluding hot-press plywoods) and (3) the bonding of rigid or nonflexible plastic laminates.

CLASSIFICATION

The adhesive is available in two types and four grades.

Type I Room temperature setting (75-95 F glue line temperature).
- Grade A Two years storage life
- Grade B Six months storage life

Type II Intermediate temperature setting (95-190 F glue line temperature).
- Grade C Six months storage life
- Grade D Thirty days storage life

Class 1 Liquid
Class 2 Powder

PROPERTIES

CHEMICAL. The adhesive consists of a phenolic, resorcinol or melamine resin containing no more than 20% insoluble material based on nonvolatile constituents. Any fillers, either separate or incorporated in the resin, are water insoluble and inert containing no amylaceous (starch or flour) or protein materials. A separate, unspecified hardener is used.

PHYSICAL. The pH of the set film is between 4.0 and 10.0.

PROCESS. The adhesive is activated by mixing base resin, hardener and filler, if any, applied by brushing, the joint closed and Type I usually cured for 7 hours at room temperature under 150-250 psi bonding pressure; Type II is cured not longer than 5 hours at 190 F. The activated adhesive has a working life of at least 2.5 hours at 75 F during which time it is removable with water, 0.5% sodium hydroxide, alcohol or any combination of these materials. The supplier recommends the minimum and maximum assembly time limits. Storage limits at room temperature are in accordance with the Classification section.

PERFORMANCE. The adhesive has an interlaminar shear strength of at least 400 psi at 75 F (Fed Test Method Std 175, Method 1032) and at 75 F after 3 hours immersion in boiling water or 48 hours immersion in RT water (Fed Test Method Std 175, Meth-

MMM-A-181 (Continued)

od 2031) using birch adherends. The block shear strength is 2800 psi at 75 F using maple adherends (Fed Test Method Std 175, Method 1031).

FORM

The liquid adhesive is available in pint and 1, 5 and 30 to 55 gallon containers. Solid adhesives are furnished in 100 and 300 pound quantities. The solid or liquid hardeners are furnished in containers containing the proper stoichiometric equivalent for an individual container of adhesive.

QPL

No.

NOTES

(1) When nonstaining properties are desired for bonding of wood, adhesives having a melamine resin base may be used.

(2) When volume is large and storage life beyond 6 months is not a factor, use liquid Grade B to effect a substantial savings in cost.

(3) Type I and II adhesives should be procured as a liquid with separate hardener to effect cost savings over powdered adhesives.

(4) The adhesive should be kept out of the sun, dry, tightly covered and, whenever practicable, below 80 F.

(5) This specification is essentially equivalent to MIL-A-46051, "Adhesive, Room-Temperature and Intermediate-Temperature Setting Resin (Phenol, Resorcinol and Melamine Base)".

MMM-A-00187 (GSA-FSS) ADHESIVE SYNTHETIC, EPOXY RESIN BASE, PASTE FORM, GENERAL PURPOSE

Issue: 22 January 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for general purpose repair and bonding of both porous and nonporous materials between −50 and 250 F where high stress or excessive vibration are not imposed.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and a separate unspecified activator. Pigments, inert fillers and other modifiers may be added.

PHYSICAL. The base resin and activator are both pastes and opaque. The activated adhesive contains 99.5% solids content (Fed Test Std 141, Method 4041) and possesses an off-white to light neutral gray color.

PROCESS. The adhesive is activated by mixing together equal portions of base resin and activator, applied by spatula or extrusion, the joint closed and cured either 24 hours at room temperature or 1 hour at 160 F under contact pressure. The adhesive (100 gram batch) has a pot life of 20 minutes at 75 F, will not run or flow without application of pressure and will not, in 1/16 inch beads, sag on a vertical surface.

PERFORMANCE. The adhesive has a shear strength of at least 1500 psi using 2024 T3 aluminum (QQ-A-355) adherends (Fed Test Method Std, Method 1033).

FORM

The paste resin and activator are available in 1/4, 3/4 and 1-3/4 ounce tubes and in half pint, pint, quart and gallon cans.

QPL

No.

MMM-A-250 ADHESIVE, WATER-RESISTANT (FOR SEALING FIBERBOARD BOXES)

Issue: 27 January 1965 Revision: a Amendment: None

SCOPE

This adhesive is intended for sealing fiberboard box flaps.

CLASSIFICATION

The adhesive is available in two types.

Type I For application by automatic case sealing equipment

Type II For hand application by brush

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, it does not contain benzene, chlorinated hydrocarbons, or other toxic solvents.

PHYSICAL. The adhesive is nontoxic.

PROCESS. The adhesive is applied by machine application (Type I) or by brushing (Type II), the joint closed within one minute and cured 24 hours at room temperature under 4 psi bonding pressure. The Type I adhesive does not string when machine transfer surfaces are separated, does not foam, and does not build up excessively on machine parts.

PERFORMANCE. The adhesive has a shear strength of at least 100 psi with not less than 75 percent fiber failure at 75F, after 24 hours exposure to 140F and to -40F, and after 24 hours immersion in 60 F tap water (72 hour RT cure) using fiberboard (PPP-B-636) adherends (Fed Test Method Std 101, Method 116).

FORM

The liquid adhesive is available in ½, 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) This specification includes the requirements of MIL-A-101 (see abstract).

MIL-T-21595 (ASG) TAPE, PRESSURE-SENSITIVE ADHESIVE, PAPER, MASKING, NONSTAINING

Issue: 28 January 1965 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive is intended as a maskant for use with cellulose nitrate and acrylic-nitrocellulose lacquers.

CLASSIFICATION

The tape is available in two types.

Type I Creped
Type II Flat

PROPERTIES

CHEMICAL. The tape consists of a paper backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape has a thickness no greater than 0.009 inch, a tensile strength at 75 F of at least 16 lb/in. of width (Type I) and 40 lb/in. (Type II) and an ultimate elongation not less than 8% (Type I only).

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The tape can be stored 1 year in unopened containers, and rolls stored 12 days at 155 F and 85% RH do not develop roll distortion more than ½ inch, telescoping more than ¼ inch or excessive adhesive flow.

PERFORMANCE. The tape applied over acrylic-nitrocellulose (MIL-L-19537) lacquered surfaces does not remove any lacquer or leave adhesive when stripped from the surface. The tape is sufficiently resistant to prevent penetration by lacquer during application. The tape has a peel strength at 75 F of 14 oz/in. of width on stainless steel even after storing the tape 12 days at 155 F and 85% RH prior to application. Areas of white cellulose nitrate lacquer (TT-L-32) and white acrylic-nitrocellulose lacquer (MIL-L-19537) after 6 hours contact with the tape (and then the tape removed) do not turn yellow or stain during 24 hour exposure at 120 F to a RS Sunlamp.

FORM

The tape is available in 60 yard rolls wound on 3 inch diameter cores in the widths specified by the purchaser. The tape is colored green approximating color No. 14491 of Fed Std No. 595. The roll may contain up to 3 splices.

QPL

Yes.

MIL-A-46091 ADHESIVE, BRAKE LINING TO METALS

Issue: 4 March 1965 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding brake linings to steel and aluminum where high frictional shearing forces are imposed.

CLASSIFICATION

The adhesive is available in two forms.

Form 1 Liquid
Form 2 Film

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. The film form is unsupported. Unspecified solvents and activators may be added.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is mixed with solvents and activators, if any, the liquid form applied by brushing and the tape form laid, the joint closed and cured at elevated temperature and pressure specified by the supplier.

PERFORMANCE. The adhesive has a disk shear strength at 75 F and at 400 F after 5 minutes of at least 1000 psi using steel to steel (QQ-S-633, Grade 1020) and aluminum to aluminum (QQ-A-225/8) joints (SAE Recommended Practice J840). It further passes the axial shear strength test (ASTM D1205) at 75 F, and after (separately) 24 hours immersion in nonpetroleum base brake fluid (VV-B-680, MIL-H-13910 and MIL-H-46046), 24 hours in water and 5 minutes exposure to 400 F using brake lining (HH-L-361) to steel (QQ-S-698, Grade 1020) and aluminum (QQ-A-250/11) adherends.

FORM

The liquid and film adhesives are available in commercial packages.

QPL

No.

NOTES

(1) This adhesive is suitable for bonding clutch facings to metals.

MIL-A-60091 (MU) ADHESIVE FOR BONDING DEMOLITION CHARGES TO STRUCTURAL SURFACES

Issue: 10 June 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding demolition charges to dry, wet and underwater surfaces of all types of structural materials, under all weather conditions.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a synthetic elastomer, pigment and a solvent.

PHYSICAL. The adhesive has a viscosity between 66,000 and 78,000 centipoises at 75 F and is olive drab in color (FED STD 595, No. 24087).

PROCESS. The adhesive is applied by extrusion from collapsible tubes or by spatula, the joint closed and hand pressure applied for 10 seconds. Bonding may be accomplished under water. The adhesive can be stored 12 months at temperatures not exceeding 80 F.

PERFORMANCE. The adhesive has sufficient strength to support a simulated charge when exposed 24 hours (separately) to (1) salt water immersion, (2) 100 F, (3) –40 F and (4) 70 F (wet surface), using SAE 1020 steel, plywood and cement building block surfaces. Further, after this exposure period, the adhesive can sustain, for 60 seconds, an additional five pound load over the 4 sq in. bond area again under the above environmental conditions. The simulated charge is SAE 1020 steel (4 x 1 x 3/8 in.). The faying surface is coated with double faced pressure-sensitive polyurethane foam tape prior to application of the simulated charge.

FORM

The adhesive, unless otherwise specified, is available in 5 ounce collapsible aluminum tubes.

QPL

No.

NOTES

(1) The purchaser may specify tests for compatibility with explosives.

ASTM D 2181T VINYL ACETATE RESIN EMULSION ADHESIVE

Issue: 1964 Revision: None Amendment: None

SCOPE

This adhesive is intended for general purpose, home or office work where high stress, temperature nor humi dity are imposed.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a vinyl acetate emulsion.

PHYSICAL. The adhesive has a solids content of at least 40% and a viscosity between 1000 and 4000 centipoises.

PROCESS. The adhesive is applied by brushing, the joint closed and cured usually at room temperature. The supplier provides processing details. The adhesive can be stored six months at room temperature in air tight containers and can be frozen three times down to −20F for periods as long as eighteen hours without adverse effects.

PERFORMANCE. The adhesive has sufficient strength to permit at least 90% failure in the adherends when tested in shear (ASTM D 1002) using 0.007 inch thick, 44 pound stock (500 sheets, 17 by 22 in.) rag bond ledger paper as adherends and a peel strength at room temperature of at least 5 lb/in. (ASTM D 1876) using glass cloth adherends.

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

APPENDIX A

INDEX OF ADHESIVE BONDING SPECIFICATIONS

This index lists all of the new and revised specifications abstracted. Suffix letters following specifications numbers are not reproduced here but are shown in the individual abstract. Thus, for example, L-T-0080 (ARMY MR) is shown as L-T-0080.

ASTM C197-61	Diatomaceous silica thermal insulating cement. No QPL.	18
ASTM C449-60T	Mineral fiber hydraulic-setting thermal insulating and finishing cement. No QPL.	18
ASTM D2181T-64	Vinyl acetate resin emulsion adhesive. No QPL.	32

APPENDIX B

INDEX OF CANCELED ADHESIVE BONDING SPECIFICATIONS

This index lists all of the adhesive material specifications canceled. The date shown is the cancelation date. Superseding specifications are given when applicable. The page number refers to the page in the original book where the specification is abstracted.

INDEX

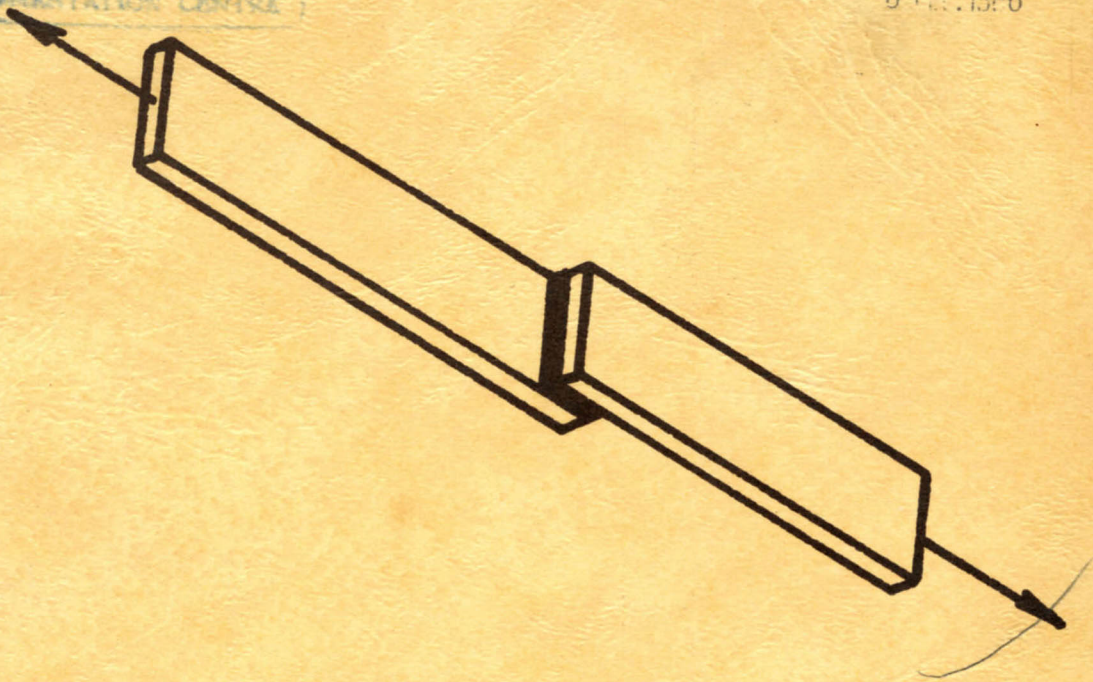
ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ

DECEMBER 1965



Foster Publishing Company

Table Of Equivalents

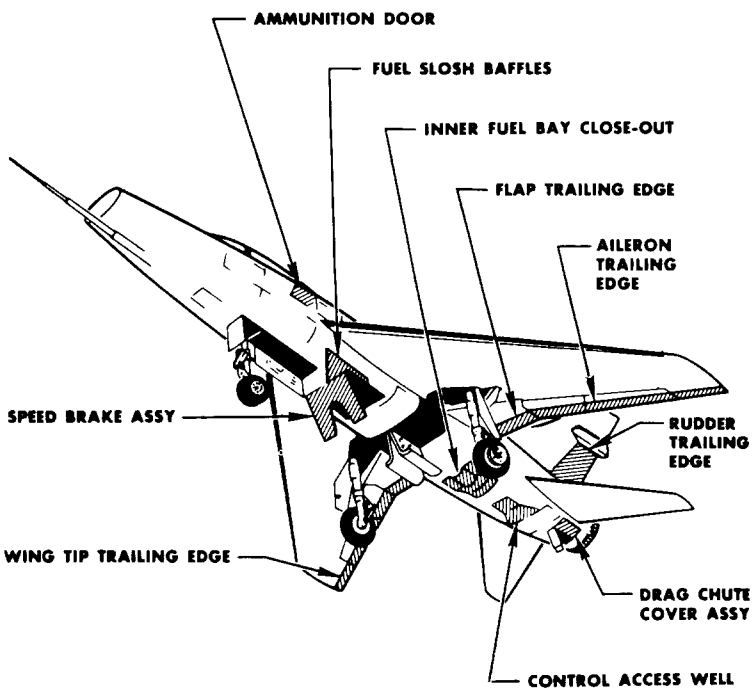
Adhesive Materials, Their Properties and Usage

UNIT	VALUE
Length	1 in equals 2.540 cm 1 ft equals 30.480 cm 1 yd equals 91.440 cm
Mass	1 oz equals 28.35 g 1 lb equals 453.6 g 1 lb equals 0.453 Kg
Pressure	psi equals 70.30 g/cm^2
Temperature	°F equals 1.8 (°C) + 32
Volume	1 oz equals 29.57 cm^3 1 in^3 equals 16.39 cm^3 1 ft^3 equals 28.32 l
Density	lb/ft^3 equals 0.016 g/cm lb/gal equals 0.119 g/cm
Energy	1 BTU equals 252 Cal Ft lb equals 0.3240 Cal
Power	BTU/min equals 0.1760 KW Horsepower equals 0.746 KW

ADHESIVE MATERIALS, THEIR PROPERTIES

AND USAGE

SUPPLEMENTS



Adhesive Bonded Components in Aircraft.

(Courtesy North American Aviation, Inc.)

Volume 1 Number 3

ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ
North American Aviation, Inc.
Downey, California

DECEMBER 1965

FOSTER PUBLISHING COMPANY
Long Beach, California

To Lucy, Philip, Laurie,
Barbara, Morris, Elsie,
Opal and Alice

ADHESIVE MATERIALS,
THEIR PROPERTIES AND USAGE
SUPPLEMENTS

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PREFACE

Every design, whether it be for a component or for a complete system, will utilize adhesive bonding in its reduction to the hardware stage.

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE has brought into being the first and only comprehensive guide to Government, National, Industrial and International specifications covering adhesives, binders, cements, glues, mortars, mucilages, pastes, gummed and pressure-sensitive adhesives.

However, specifications are living documents. They are continuously being created, changed and canceled. One of the more vexing problems facing most engineers and manufacturers in developing and maintaining products is the need to keep up with the advancing technology reflected in specifications.

The SUPPLEMENTS will meet this need by bringing up to date every 3 months the data contained in new and revised adhesive material specifications, eliminating the need for extensive literature surveys, delays in specification procurement and expensive analyses.

The SUPPLEMENTS retain the same format and styling of the original book.

Irving Katz

Downey, California
November 15, 1965

PREFACE

Adhesive Materials, Their Properties and Usage

Currently, it takes nine glues for you to light up your cigarette. Detached retinas, worn arteries and broken bones are being repaired with adhesives. Highway departments use these materials in restoring roads, while builders are constructing houses and fences at lower costs by substituting these bonding agents for mortar. Automobiles contain between eight and twenty five pounds of plastic cements; moreover, in the not too distant future, the entire car may be free from screws, solder and rivets. The shoe manufacturers are discarding nails and threads for these adhesive materials, while the garment industry is attempting to assemble clothes by bonding, in order to eliminate costly sewn seams. The aircraft, shipbuilding, packaging, toy and dental industries all use bonding materials — in some cases even for prime structural purposes.

To support these assembly operations, approximately two billion pounds of chemical joining agents, commonly called adhesives, cements, glues, mucilages, pastes and pressure-sensitive tapes, are being produced in this country. The user has available such a wide variety of types, grades and forms that the problem of choosing which adhesive will join his components is not a simple one. Factors concerning loads, temperature range, weathering and environmental conditions affecting the joint, limit the selection. Further, since profitable operations not only depend on how fast and inexpensively parts can be made but also on how quickly the product can be assembled, additional factors are introduced. Typical ones which require consideration are process equipment availability, manufacturing sequences, purchasing commitments and storage (some adhesives spoil rapidly).

Other than a few limited reviews, there is no single source guide oriented toward the user which even begins to answer all these questions. The user is thus faced with a formidable problem. Not only does he have to sift out which types of adhesives can join his components, but also he must determine which is best for his application, consistent with process and equipment limitations. Considerable literature searching as well as supplier contact is therefore necessary. Such an ambitious project is time consuming; and in certain cases where decisions are urgent, the problem becomes difficult to resolve.

Nevertheless, there is actually a vast source of readily applicable data. These data are contained in specifications, which define what is expected in measurable terms, give the limits of uniformity and quality, and distinguish between a good and a bad product. Unfortunately, when the precise number and title of the desired specification are unknown, procurement is hindered.

In response to this shortcoming, this book provides a guide for choosing suitable adhesives covered by specifications. It gives basic and detailed information of value, on a comparable basis, to designers, manufacturers, engineers and technical personnel concerned with fabricated parts of almost every conceivable nature, where adhesive bonding assembly operations are an integral part of fabrication.

Towards this end, the book is divided into two parts. Part I guides the user to those adhesives which can fulfill specific jobs. Part II gives exact specification details covering the chemical, physical, process and performance properties, as well as availability of these bonding materials. In order to keep up with the changing technology of adhesive bonding which is reflected in the creation, revision and cancellation of specifications, this book will be revised periodically.

I wish to thank three publishers for their permission to use portions of my articles in this book. These are Reinhold Publishing Company ("Adhesives for Wood", Materials in Design Engineering, July 1962), Conover-Mast Publications ("Pressure-Sensitive Adhesive Electrical Tapes", Electro-Technology, August 1962 and "Adhesives for Optical and Electro-Optical Applications", Electro-Technology, April 1963, copyright C-M Technical Publications) and Palmerton Publishing Company ("A Guide to Federal and Military Specifications for Rubber Bonding Adhesives", Rubber Age, April 1964).

Irving Katz

Downey, California
July, 1964

CONTENTS

PART I

ADHESIVES SELECTION

1. PAPER AND FABRIC ADHESIVES

A new adhesive has been introduced for fabric assemblies. This adhesive, consisting of a synthetic elastomer solution, is suitable for patching and repairing chloroprene coated, chlorosulphonated polyethylene top coated synthetic fabrics (Reference 1). This fabric is used for constructing inflatable dual-wall shelters.

BIBLIOGRAPHY

(1) MIL-A-43316 Adhesive, patching for chloroprene coated or chlorosulphonated polyethylene coated fabrics, 15 March 1965. No QPL.

2. WOOD ADHESIVES

Wood adhesives fall into three general usage categories: the first, for straight wood assemblies, including plywood manufacture and veneering applications; the second, for specific mixed wood assemblies, such as wood/metal, wood/plastics, etc.; and the third, for general purpose wood bonding applications. Innovations in the latter category have been introduced.

GENERAL PURPOSE WOOD ADHESIVES

Wood can be bonded to many materials using acrylic, cellulosic, epoxy, rubber and vinyl adhesives. Epoxy and rubber adhesives have been modified to offer a wide variety of joint strengths.

Epoxy

A structural epoxy adhesive has been modified to give an option on peel strength (Reference 1). This adhesive, dependent upon type, also offers outstanding resistance to elevated temperatures.

Rubber

A rubber adhesive has been specifically developed for applications where contact with aromatics is expected (Reference 2). However, design values must be established for use with wood.

BIBLIOGRAPHY

General Purpose Wood Adhesives

Epoxy

(1) MMM-A-132 Adhesives, heat resistant, airframe structural, metal to metal, 30 April 1965. Has QPL.

Rubber

(2) MMM-A-189 Adhesive, synthetic rubber (hot or cold bonding), 7 April 1965. No QPL.

3. RUBBER ADHESIVES

Adhesives for rubber fall into three general categories. There are (1) straight rubber assembly adhesives, (2) mixed rubber assembly adhesives and (3) general purpose rubber bonding adhesives. The straight rubber and general purpose rubber adhesives have been modified.

STRAIGHT RUBBER ASSEMBLY ADHESIVES

Adhesives for bonding of strictly rubber assemblies are conveniently catalogued according to the type of rubber to be bonded. A new adhesive has been developed for neoprene and chlorosulfonated polyethylene rubber assemblies.

Neoprene

Synthetic fabrics coated with neoprene rubber and top coated with chlorosulphonated polyethylene are used for constructing inflatable dual wall shelters. A synthetic rubber has been introduced for effecting patches and repairs on these assemblies (Reference 1). This adhesive is suitable for supporting shear loads of 15 psi as low as –40 F.

GENERAL PURPOSE RUBBER ADHESIVES

General purpose rubber adhesives are capable of adhering practically any combination of materials providing joints ranging from temporary bonds to those suitable for moderate structural loads.

A general purpose adhesive suitable for bonding steel, cotton duck, explosives, rubbers, etc., has been modified so that it is suitable for applications subject to contact with aromatics (Reference 2). It is available in both thermoplastic and thermosetting varieties.

BIBLIOGRAPHY

Straight Rubber Assembly Adhesives

Neoprene

(1) MIL-A-43316 Adhesive, patching for chloroprene coated or chlorosulphonated polyethylene coated fabrics, 15 March 1965. No QPL.

General Purpose Rubber Adhesives

(2) MMM-A-189 Adhesive, synthetic rubber (hot or cold bonding), 7 April 1965. No QPL.

4. PLASTICS ADHESIVES

Plastics adhesives also fall into three general usage categories: the first, for straight plastic assemblies; the second, for mixed plastic assemblies; and the third, for general purpose plastics bonding applications. Modified adhesives have been introduced for the latter category.

GENERAL PURPOSE PLASTICS ADHESIVES

There are two general purpose plastics adhesives which have been modified. These are the epoxy and the rubber base adhesives.

The epoxy adhesive is available in a variety of peel strengths and resistances to temperature (Reference 1). Although this adhesive is intended for metal bonding, it will bond plastic to metal and plastic to plastic. However, design values will have to be established for each nonmetallic joint combination.

The rubber adhesive will bond plastics, steel, explosives, fabrics, rubber, etc., for applications subjected to contact with aromatics (Reference 2). This adhesive is available in thermoplastic and thermosetting varieties.

BIBLIOGRAPHY

General Purpose Plastics Adhesives

Epoxy

(1) MMM-A-132 Adhesives, heat resistant, airframe structural, metal to metal, 30 April 1965. Has QPL.

Rubber

(2) MMM-A-189 Adhesive, synthetic rubber (hot or cold bonding), 7 April 1965. No QPL.

5. METAL ADHESIVES

Metal adhesives, like plastic adherend adhesives, also fall into three general usage categories. The first is for straight metal assemblies, the second for mixed metal assemblies, and the third for general purpose bonding. New and modified adhesives for the three usage categories have been introduced.

STRAIGHT METAL ASSEMBLY ADHESIVES

Adhesives for strictly metal assemblies are available for structural purposes involving high load carrying joints and for non-structural purposes where little or no load is imposed on the joint. A new adhesive has been introduced for structural applications.

This epoxy adhesive is available with a variety of peel strengths and temperature resistances (Reference 1). Unlike some adhesives which liberate volatile polymerization byproducts, yielding blisters, this adhesive can be used for large bond area joints. However, it is not specifically intended for sandwich structures.

MIXED METAL ASSEMBLY ADHESIVES

A modified adhesive has been developed for high strength metal/glass joints (Reference 2). This adhesive is intended for applications limited to –65 F and 140 F. The adhesive is a two component system available in both liquid and dry film types.

GENERAL PURPOSE METAL ADHESIVES

General purpose adhesives provide joints suitable for predominantly low load structural applications. Two new epoxy and two rubber base adhesives have been developed.

Epoxy Adhesives

The new epoxy adhesives are available with both low (Reference 3) and high (Reference 4) shear strengths. The former uses a polyamide curing agent and the latter a polyamine curing agent. The higher shear strength adhesive requires elevated temperature curing conditions.

Rubber Adhesives

The new rubber adhesives are available for applications requiring flexible joints. One of them (Reference 5) offers good resistance to aromatics; the other (Reference 6) does not. Both of these adhesives require elevated temperature curing conditions.

BIBLIOGRAPHY

Straight Metal Assembly Adhesives

Structural

(1) MMM-A-132 Adhesives, heat resistant, airframe structural, metal to metal, 30 April 1965. Has QPL.

Mixed Metal Assembly Adhesives

Metal/Glass

(2) MMM-A-00131 Adhesives; glass to metal (for bonding of optical elements), 22 March 1965. Has QPL.

General Purpose Metal Adhesives

Epoxy

(3) MIL-A-81236 Adhesive; epoxy resin with polyamide curing agent, 29 March 1965. No QPL.

(4) MIL-A-81253 Adhesive, modified epoxy resin with polyamine curing agent, 1 March 1965. No QPL.

Rubber

(5) MMM-A-189 Adhesive, synthetic rubber (hot or cold bonding), 7 April 1965. No QPL.

(6) MIL-A-81270 Adhesive, synthetic rubber, 10 May 1965. No QPL.

6. PACKAGING ADHESIVES

Packaging adhesives are used for (1) carton manufacture, (2) carton closure, (3) packing and (4) labeling. An innovation in labeling adhesives has been introduced.

Hazardous industrial chemical containers can now be identified with a pressure-sensitive label having a peel strength of at least 35 ounces per inch against stainless steel (Reference 1).

BIBLIOGRAPHY

(1) MIL-L-19868 Labels, paper, pressure-sensitive adhesive (for hazardous industrial chemicals and materials), 7 April 1964. No QPL.

7. ELECTRICAL ADHESIVES

No new or modified electrical adhesives have been introduced.

8. OPTICAL ADHESIVES

There are two functional types of adhesives available for the design and construction of optical and electro-optical systems. These are the transparent adhesives for bonding optical components in which the visual performance properties in the bonded area are not affected and the optically inactive adhesives for affixing optical components to nonoptically active fixtures. An innovation has been introduced in the latter category.

This innovation consists of a double adhesive system which will bond optical glass to metal in the temperature range between −45 F and 160 F (Reference 1). It is available as a liquid and has a dry film counterpart.

BIBLIOGRAPHY

(1) MMM-A-00131 Adhesives: glass to metal (for bonding of optical elements), 22 March 1965. Has QPL.

9. BUILDING CONSTRUCTION ADHESIVES

New and modified Building Trade adhesive materials have been developed for metal foundation repair, plumbing and floor covering installation.

METAL FOUNDATION REPAIR

Heretofore, metal foundation hardware could be repaired for only minor flaws with a heavily loaded, iron powder filled binder. An epoxy cement is now available for repairing structural defects (Reference 1). This cement will sustain high flexure, tension and compression loads.

PLUMBING

Plumbing lines used for transporting water, gas, steam, hot air and sewage are usually laid underground. These lines in underground locations are subject to corrosion. A pressure-sensitive tape has been introduced to prevent corrosion in these locations (Reference 2).

INSTALLATION OF FLOOR COVERINGS

Floor coverings are fabricated from many materials. Modifications have occurred to existing adhesives for laying cork and linoleum to subfloors and floor under-layments (Reference 3). These adhesives are not suitable against metal subfloors.

BIBLIOGRAPHY

Metal Foundation Repair

(1) MIL-C-23911 Compound, epoxy, structural filler, 22 December 1964. Has QPL.

Plumbing

(2) L-T-0075 Tape, pipe-coating: pressure-sensitive: polyethylene, 26 April 1965. No QPL.

Installation of Floor Coverings

(3) MMM-A-137 Adhesive, linoleum, 2 July 1965. No QPL.

10. OTHER ADHESIVES

New adhesives have been introduced for pyrotechnic applications.

PYROTECHNIC APPLICATIONS

Epoxy and resin modified rubber base adhesives have been made available for rocket engine applications.

The epoxy adhesives are available with low (Reference 1) and high (Reference 2) shear strength options. The low shear strength adhesive is converted at essentially room temperature and the high shear strength adhesive at elevated temperatures.

The resin modified rubber is available for applications requiring elastomeric properties (Reference 3). It requires cure temperatures substantially higher than the epoxy counterparts.

BIBLIOGRAPHY

Pyrotechnic Adhesives

Epoxy

(1) MIL-A-81236 Adhesive; epoxy resin with polyamide curing agent, 29 March 1965. No QPL.

(2) MIL-A-81253 Adhesive, modified epoxy resin with polyamine curing agent, 1 March 1965. No QPL.

Rubber

(3) MIL-A-81270 Adhesive, synthetic rubber, 10 May 1965. No QPL.

PART II

ADHESIVE PROPERTIES DATA

NOTICE TO THE READER

Specifications are living documents: they are continuously being created, changed and cancelled. The following new and revised abstracts (tabulated in numerical order — Federal first, Military second and others third) reflect the current status of these documents, giving the latest issue date, revision and amendment.

These abstracts additionally set forth the six basic constituents of any specification. These are Scope, Classification, Properties, Form, Qualified Products List and Notes.

The Scope defines the purpose of the joining agent — specifically, what the adhesive is intended to do and what it will bond.

The Classification section defines the various conditions, expressed as types, classes and grades, under which the adhesive is available.

The Properties section is subdivided into four parts. These are chemical, physical, process and performance. The chemical section designates the composition of the joining agents. However, for various reasons, some specifications do not define the ingredients; one purpose is to leave the choice to the manufacturer in order to promote competition among the suppliers. The physical properties give the characteristics of the joining agents which will be needed if the material is to meet the intended purpose. Such things as viscosity, solids and ash content, toxicity, flexibility, specific gravity, consistency, pH, etc. fall into this category. Process properties define the make-ready and curing conditions necessary to convert the bonding material. Storage requirements are given here since they are an integral part of the conversion process. Performance properties define what is expected from the joining agent when properly converted.

The Form defines the physical state of the joining material, such as liquid, solid, film, etc., and the quantities in which it is normally available. Some of the specifications do not specify quantities, and these are noted accordingly. Packaging specifications covering the containers are not given.

The Notes give additional information of value to the user such as which type, grade or class is preferable for a specific application, other types of adherends which can be joined, etc.

Each abstract contains all the data actually defined in the specification. Where specific items need modification or are not given, the reader should add these in any purchase orders.

A certain degree of caution is necessary concerning the use of adhesives conforming to any specification. The properties are guaranteed only when the specific adherends are tested in strict accordance with the procedures given in the specification. A change in adherends may change the expected performance properties. Further, the test methods employed may not reflect the actual environmental conditions of a particular part. And still further, performance properties called out by a specification are generally minimum; the actual values obtained with the adhesives should be higher than specified. Consequently, the specification values serve admirably as a screening technique to reduce development costs.

When a specification appears promising, the final step is to obtain adhesives covered by these documents. Certain of the specifications have concomitant Qualified Products Lists (QPL) which give the names of adhesives, including the suppliers, which meet the requirements. When no Qualified Products List exists, many adhesive suppliers will certify that their products conform to the requirements (if they do) when procured under the specification designation.

Appendix A lists all of the new and revised adhesive material abstracted. Many of these specifications refer to other documents to define some of the adherends and test procedures. These references are designated by the document number in the abstract.

The following abstracts are a compilation of essential data contained in adhesive material specifications. Extensive effort has been made to verify and check the information contained in each abstract. However, neither the author nor the publisher is responsible for errors which may have occurred in this book.

L-T-0075 (ARMY-MO) TAPE, PIPE-COATING: PRESSURE-SENSITIVE: POLYETHYLENE

Issue: 26 April 1965 Revision: None Amendment: None

SCOPE

This pressure-sensitive tape is intended for preventing corrosion of metal pipes and conduits which are exposed underground, underwater or in damp galleries.

CLASSIFICATION

The tape is available in two types.

Type I Polyethylene
Type II Plasticized polyvinyl chloride

PROPERTIES

CHEMICAL. The Type I tape consists of a polyethylene or plasticized polyvinyl chloride (or its copolymers) backing coated one side with an unspecified adhesive. The Type II tape consists of a laminate of plasticized polyvinyl chloride (or its copolymers) and uncured butyl rubber.

PHYSICAL. The physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF L-T-0075 TAPE (1)

PROPERTY	TYPE I	TYPE II
Thickness, mils, min	10	15
Tensile strength, lb/in., min	20	30
Elongation, %, min	100	50
Water vapor transmission rate gr/100 sq in./24 hr, max (2)	0.2	0.1
Dielectric breakdown, volts (3)		
Initial	900	900
After 24 hr water immersion	800	800

(1) All tests except water vapor transmission rate are in accordance with ASTM D1000.
(2) ASTM E96, Procedure B.
(3) Omit conditioning 96 hours at 75 F and 96% RH of ASTM D1000.

PROCESS. The Type I tape can be applied to both primed and unprimed steel, Type II to primed steel only. The primer, if any, is applied in accordance with the supplier's instructions, the tape wound spirally, and cured 7 hours (Type I) or 72 hours (Type II) at room temperature under contact pressure.

L-T-0075 (ARMY-MO) Continued

PERFORMANCE. The performance properties of the tape are given in Table II.

TABLE II. PERFORMANCE PROPERTIES OF L-T-0075 TAPE

PROPERTY	TYPE I	TYPE II
Peel strength, oz/in, min (1)		
To bare stainless steel	25	NR
To primed stainless steel	32	48
To backing	20	NR

(1) ASTM D1000.
NR = No Requirement

FORM

The tape is available in two core sizes. The first, in 100 and 300 foot lengths, is wound on 1½ inch diameter cores in 1, 2, 3, 4, 6 and 9 inch widths. The second, in 400, 600 and 800 foot lengths, is wound on 3 inch diameter cores in 2, 3, 4, 6, 9 and 12 inch widths. The primer is available in 1, 5, and 55 gallon containers.

QPL

No.

MMM-A-00131 (ARMY-MR) ADHESIVES: GLASS TO METAL (FOR BONDING OF OPTICAL ELEMENTS)

Issue: 22 March 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding of glass to metal, including glass prisms and other optical glasses.

CLASSIFICATION

The adhesive is available in two types and four classes.

Type I Liquid adhesive
- Class 1 Phenolic neoprene
- Class 2 Phenolic polyamide

Type II Dry film adhesive
- Class 1 Fiberglass carrier
- Class 2 Polyamide carrier (nylon)

PROPERTIES

CHEMICAL. The adhesive, consisting of two parts (see process section), is composed of phenolic neoprene and phenolic polyamide bases. Type II is Type I (Class 1) adhesive, except as a dry film and is supplied on a fiberglass or polyamide carrier.

PHYSICAL. The physical properties of the adhesive are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MMM-A-00131 ADHESIVE

PROPERTY	TYPE I	TYPE II
Viscosity, seconds, at 25 C, max (1)		
Class 1	8	NR
Class 2	105	NR
Solids content, % (2)		
Class 1	6–10	NR
Class 2	27–33	NR
Thickness, in. (3)	NR	0.005–0.015
Thread count, threads per inch (4)		
Class 1 (warp and fill)	NR	16–20
Class 2 (warp and fill)	NR	60–72

(1) Fed Test Method Std No. 141, Method 4282.
(2) Fed Test Method Std No. 175, Method 4021.
(3) CCC-T-191, Method 5030.
(4) CCC-T-191, Method 5050.
NR = No Requirement

MMM-A-00131 (ARMY-MR) (Continued)

PROCESS. The Type I, Class I adhesive is applied to metal surfaces by spraying to give a coating thickness of 3 mils, air dried 30 minutes, oven dried 1 hour at 210 F, the Type I, Class 2 adhesive is then applied by spraying to give a coating thickness of 1 mil, air dried 30 minutes and oven dried 3 minutes at 210 F. The glass adherend is coated and treated with Classes 1 and 2 adhesive similar to the metal adherend. The coated metal and glass adherends are closed and cured 1 hour at 275 F under 25 psi pressure. For Type II adhesive, the metal and glass surfaces are coated with Type I adhesive as above except to a coating thickness of 1 mil and oven dried at 180 F. The Type II adhesive is then applied, the glass-metal joint closed and cured as above. Type I adhesive can be stored 6 months and Type II for 1 year at temperatures no higher than 75 F.

PERFORMANCE. The performance properties of the adhesive are given in Table II.

TABLE II. PERFORMANCE PROPERTIES OF MMM-A-00131 ADHESIVE

PROPERTY	VALUE
Shear, psi, min (1)	
At –60 F, 1 hr	1800
At 75 F	
After 24 hr at 75 F	1200
After 10 days at 160 F, 100% RH	320
At 160 F, 1 hr	1000
Shock, gr, at –45 F, max (2)	500

(1) Using 0.040 inch thick glass bonded between 0.064 inch thick 2024 aluminum (QQ-A-355).

(2) Bonded right angle glass prism (MIL-G-174, Type 541-599), 2 x 2 x 2 inches, and 0.25 inch thick 2024 or 7075 aluminum joints do not separate or have the prism shatter (MIL-STD-202, Method 202A).

FORM

Type I liquid adhesive is available in pint and quart containers and Type II dry film adhesive in rolls with each layer separated by a nonblocking film liner.

QPL

Yes.

NOTES

(1) These adhesives can be used for bonding optical glass elements to metal supports in Ordnance optical fire control instruments.

MMM-A-132 ADHESIVES, HEAT RESISTANT, AIRFRAME STRUCTURAL, METAL TO METAL

Issue: 30 April 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for structural bonding of metal parts subjected to temperatures between -67 and 500 F.

CLASSIFICATION

The adhesive is available in four types.

Type I Long time exposure from -67 to 180 F – 192 hours
- Class 1 High T-peel and blister detection
- Class 2 Normal T-peel and blister detection
- Class 3 No T-peel or blister detection required

Type II Long time exposure from -67 to 300 F – 192 hours

Type III Long time exposure from -67 to 300 F – 192 hours and short time exposure from 300 to 500 F – 10 minutes

Type IV Long time exposure from -67 to 500 F – 192 hours

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. Unspecified curing agents, fillers and solvents may be used.

PHYSICAL. The adhesive is either a liquid or film. Film adhesives may contain a carrier. The curing agent is either a powder or liquid.

PROCESS. The liquid adhesive is activated by mixing together the curing agent and base resin, applied by brushing, the joint closed and cured in accordance with the conditions given in Table I. The film adhesive, usually refrigerated, is applied directly after warming to room temperature. Application is normally between 60 and 100 F and relative humidities up to 75%, whereupon a working or pot life is (preferably) 8 hours or longer. The storage life conditions, as well as other instructions, are given by the supplier.

TABLE I. PROCESS PROPERTIES OF MMM-A-132 ADHESIVE

	TYPES (1)			
CURING CONDITIONS	I	II	III (2)	IV (2)
Temperature, °F, max	350	350	700	700
Pressure, psi, max	200	200	200	200
Time, hours, max	2	2	2	2

(1) Generally Types III and IV use considerably lower cure temperatures.

(2) Post curing is not desirable, but is acceptable for Types III and IV.

MMM-A-132 (Continued)

PERFORMANCE. The performance properties of the adhesive are given in Table II.

FORM

The adhesive is available in commercial packages.

QPL

Yes.

NOTES

(1) Types I and II adhesive are intended primarily for bonding aluminum alloys and Types III and IV for corrosion resistant steel alloys.

(2) This adhesive can bond plastic to metal and plastic to plastic components. However, allowable design values have to be established for each adhesive-adherend combination.

(3) This specification includes the requirements of MIL-A-005090E (see abstract) and MIL-A-5090.

EXTRA FOOTNOTES TABLE II –

(4) Maintain shear load without failure and no more than 0.015 inch deformation.

(5) Fed Test Method Std No. 175, Method 1061, at a rate up to 3600 cycles per minute ranging from maximum stress to 10% of maximum stress.

NR = No Requirement

MMM-A-132 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MMM-A-132 ADHESIVE

PROPERTY	TYPE I Class 1	TYPE I Class 2	TYPE I Class 3	TYPE II	TYPE III	TYPE IV
Shear, psi, min (1)						
At –67 F, 10 min.	5000	2500	2500	2250	2250	2250
At 75 F						
Initial	5000	2500	2500	2250	2250	2250
After 30 days salt spray (2)	3600	2250	2250	2100	2100	2100
After 30 days at 120 F and 95-100% RH	3600	2250	2250	2100	2100	2100
After 30 days in water	3600	2250	2250	2100	2100	2100
After 7 days immersion in Anti-icing Fluid (MIL-F-5566)	3600	2250	2250	2100	2100	2100
Hydraulic Oil (MIL-H-5606)	3600	2250	2250	2100	2100	2100
JP-4 (MIL-J-5624)	3600	2250	2250	2100	2100	2100
Standard Test Fluids (TT-S-735)	3600	2250	2250	2100	2100	2100
Blister detection (3)	3600	2250	NR	NR	NR	NR
At 180 F, 10 min.	2500	1250	1250	NR	NR	NR
At 300 F						
After 10 min.	NR	NR	NR	2000	2000	2000
After 192 hr	NR	NR	NR	2000	2000	2000
At 500 F						
After 10 min.	NR	NR	NR	NR	1850	1850
After 192 hr	NR	NR	NR	NR	NR	1000
Creep Rupture, psi, max (1) (4)						
At 75 F, 192 hr	1600	1600	1600	1600	1600	1600
At 180 F, 192 hr	800	800	800	NR	NR	NR
At 300 F, 192 hr	NR	NR	NR	800	800	NR
At 500 F, 192 hr	NR	NR	NR	NR	NR	800
Fatigue, psi, at 75 F, max (1) (5)						
10^6 cycles	750	750	750	750	750	750
10^7 cycles	600	600	600	600	600	600
Peel, lb/in., at 75 F, min	50	15	NR	NR	NR	NR

(1) Types I and II use 0.063 inch thick Alclad 2024-T3 aluminum (QQ-A-250/5) adherends and Types III and IV use 0.050 inch thick 17-7 PH condition TH-1050 corrosion resistant steel (MIL-S-25043).

(2) Fed Test Method Std No. 151.

(3) Lap shear specimens for blister detection are made with a 12 inch by 12 inch bond area as opposed to a 9 inch by ½ inch bond area for other shear specimens.

MMM-A-137

ADHESIVE, LINOLEUM

Issue: 2 July 1965 Revision: c Amendment: None

SCOPE

This adhesive is intended for installation of linoleum, cork carpet and other types of floor coverings to subfloors and floor under-layments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an unspecified water base binder, inorganic fillers and mold and odor retardant additives.

PHYSICAL. The adhesive is nonalkaline to litmus paper, mold resistant and does not have an objectionable odor.

PROCESS. The adhesive is applied by troweling in thicknesses of 1/32 inch, the linoleum laid and the joint cured at least 72 hours at room temperature under contact pressure. No settling of filler occurs during storage of the adhesive.

PERFORMANCE. The adhesive, 6 grams per 6 inch by 3 inch burlap-backed linoleum tile, cured 16 hours between 70 and 90 F, followed by 6 hours at 175 F, adheres without separation after (1) being bent around a 5 inch diameter mandrel (face side first and adhesive second side) and (2) being scraped with a knife while still in tension. A cleavage force of at least 4 pounds separates a 2-3/4 inch by 6 inch by 3/8 inch No. 1 common white pine board and a 2 inch by 12 inch piece of burlap-backed linoleum after the joint, using 5-1/2 grams of adhesive (on pine), is cured at 75 F for 72 to 120 hours under 10 pounds bonding pressure.

FORM

The paste adhesive is available in 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) This specification supersedes Federal Specification O-P-106.

(2) Do not use this adhesive for bonding floor coverings to steel or other metal subfloors.

(3) The same performance properties are achieved with felt-backed linoleum (LLL-F-471, Grades A or B).

MMM-A-189 ADHESIVE, SYNTHETIC-RUBBER (HOT OR COLD BONDING)

Issue: 7 April 1965 Revi sion: None Amendment: None

SCOPE

This adhesive is intended for general purpose bonding applications.

CLASSIFICATION

The adhesive is available in two types.

Type I Thermoplastic
Type II Thermosetting

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The nontoxic adhesive has a specific gravity between 0.80 and 0.98, a viscosity between 5 and 70 seconds at 25 C (ASTM D333), a pH between 5.5 and 9.0, an ash content no greater than 18%, a nonvolatile content between 28 and 32%, and the solvent portion a boiling point between 50 and 135 C.

PROCESS. The adhesive is applied by brushing, dried 1 hour at 77 C, the joint closed and cured between 145 and 150 C for 30 minutes under 500 psi bonding pressure.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

MMM-A-189 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MMM-A-189 ADHESIVE

PROPERTY	TYPE I		TYPE II	
	AVERAGE	INDIVIDUAL	AVERAGE	INDIVIDUAL
Shear, psi, min (1)				
At 25 C				
After 24 hr at 25 C	1200	1000	2700	2500
After 24 hr at 77 C then 2 hr at 25 C	1200	1000	2700	2500
After 24 hr in 25 C toluene	1200	1000	2700	2500
At 50 C				
After 2 hr at 50 C	700	500	1700	1500
Peel, lb/in., at 25 C, min (2)	12	10	12	10
Corrosion (3)	None	None	None	None

(1) Fed Test Method Std No. 175, Method 1033, using 1018 or 1020 steel (QQ-S-633) adherends.

(2) Fed Test Method Std No. 175, Method 1041, using cold rolled steel and cotton cloth (CCC-C-430) adherends cured 18 hours at 25 C followed by 24 hours at 50 C.

(3) Corrosion is determined against 1018 or 1020 steel (QQ-S-633), 2024 aluminum (QQ-A-200/3 or QQ-A-225/6) and brass (QQ-B-626, composition 22).

FORM

The liquid adhesive is available in 3/4 oz, pint, quart and 1 and 5 gallon containers.

QPL

No.

NOTES

(1) Type I adhesive should not be used for applications subjected to continuous high stress or to stress at elevated temperature. For these applications, use fully cured Type II.

(2) Compatibility with explosives must be checked prior to use.

(3) This specification includes the requirements of MIL-A-13883 (see abstract).

MIL-L-19868 LABELS, PAPER, PRESSURE-SENSITIVE ADHESIVE (FOR HAZARDOUS INDUSTRIAL CHEMICALS AND MATERIALS)

Issue: 7 April 1964 Revision: B Amendment: None

SCOPE

This pressure-sensitive adhesive label is intended for identifying containers containing hazardous industrial chemicals.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The label consists of an unspecified pressure-sensitive adhesive and a backing of bleached chemical wood pulp containing not more than 5% unbleached or ground wood pulp (UU-P-31, Method 300). An unspecified liner is used.

PHYSICAL. The backing weighs (25 by 38 – 500 sheets) between 57 and 66 pounds (UU-P-31, Method 110) and has a tearing resistance of at least 35 grams (UU-P-31, Method 170).

PROCESS. The label requires no solvent, heat or other preparation, other than removal of the liner, prior to or subsequent to application.

PERFORMANCE. The label has a peel strength of at least 35 ounces per inch to a number 4 finish stainless steel (QQ-S-766) adherend.

FORM

The labels are available in 100, 250 and 500 quantity cartons in the sizes, designs and colors given in MIL-STD-755.

QPL

No.

NOTES

(1) The labels should be ordered in quantities not greater than that which can be used in one year because of the deteriorating nature of this material.

MIL-C-23911 (WEP) COMPOUND, EPOXY, STRUCTURAL FILLER

Issue: 22 December 1964 Revision: A Amendment: None

SCOPE

This compound is intended for repairing structural defects.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The compound consists of an aluminum powder filled epoxy resin and a separate unspecified catalyst.

PHYSICAL. The base resin and catalyst are of contrasting colors, have a density in gr/cc at 25C of 1.80 - 1.90 and 0.95 - 1.15 and a viscosity in poises of no more than 3000 (at 30 C) and 20 (at 25 C), respectively.

PROCESS. The compound is activated by mixing base resin with catalyst in accordance with the manufacturer's instructions, applied by brushing, the joint closed, and cured one hour at 60 C followed by 2 hours at 107 C under contact pressure. The compound has a working life of at least 17 minutes and can be stored 1 year between 65 and 90 F in unopened containers.

PERFORMANCE. The performance properties of the compound are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-C-23911 COMPOUND.

PROPERTY	VALUE
Flexure, psi, at 75 F, min (1)	10,000
Tension, psi, at 75 F, min (2)	5,000
Compression	
Ultimate, psi, min	
at 75 F	33,000
at 160 F	20,000
5% offset, min	
at 75 F	16,000
at 160 F	10,000
Linear Thermal Expansion, in./in./°F (4)	$(15\text{-}23) \times 10^{-6}$
Thermal Cycling, cracks (5)	None

(1) Fed Test Method Std 406, Method 1031.
(2) Fed Test Method Std 406, Method 1011.
(3) Fed Test Method Std 406, Method 1021.
(4) Fed Test Method Std 406, Method 2031.
(5) MIL-STD 354 for 7 days.

MIL-C-23911 (WEP) (Continued)

FORM

The base compound is available in 5 gallon containers and the catalyst is packaged in quantities stoichiometrically equivalent to the quantity of base compound supplied.

QPL

Yes.

NOTES

(1) Suitability for use with explosives must be demonstrated at a Government laboratory.

MIL-A-43316 (GL) ADHESIVE, PATCHING FOR CHLOROPRENE COATED OR CHLOROSULPHONATED POLYETHYLENE COATED FABRICS

Issue: 15 March 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for repairing and patching chloroprene coated, chlorosulphonated polyethylene top coated synthetic fabrics.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of from 25 to 30% oil-resistant elastomer in a solvent blend of petroleum naphtha, toluol, xylol or ketones (Fed Test Method Std No. 175, Method 4021, Procedure A).

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is applied by brushing on two coats, dried 5 minutes between coats, the joint closed and cured 24 hours at room temperature under contact pressure. The adhesive can be stored (1) 1 year between 60 and 90 F, (2) 2 weeks at 120 F and (3) –65 F for 4 hours, all in unopened containers.

PERFORMANCE. The adhesive has a shear strength of at least 50 psi using chloroprene base coated, chlorosulphonated polyethylene top coated (MIL-C-43285) adherends (CCC-T-191, Method 5102). With the same adherends, the adhesive has sufficient shear strength to support (1) a 1 psi load after a 10-20 minute RT cure, (2) a 15 psi load at RT after 24 hour RT cure and (3) a 15 psi load at –40 F after 24 hour RT cure, all without more than 1/8 inch slippage. No more than 1/8 inch peel occurs under a 2 lb/in. load applied for 4 hours with the same adherends.

FORM

The adhesive is available in 1 pint containers.

QPL

No.

NOTES

(1) The adhesive is especially suitable for repairing and patching inflated dual-wall shelters.

MIL-A-81236 (WP) ADHESIVE; EPOXY RESIN WITH POLYAMIDE CURING AGENT

Issue: 29 March 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for general purpose bonding applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin base and a separate polyamide curing agent.

PHYSICAL. The physical properties of the epoxy resin base and polyamide curing agent are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-81236 ADHESIVE.

PROPERTY	EPOXY		POLYAMIDE	
	Min	Max	Min	Max
Viscosity, poises (1)				
at 25 C	110	160	NR	NR
at 75 C	NR	NR	2	6
Density, 25 C, g/ml (2)	1.15	1.21	0.94	1.00
Epoxy equivalent, g/eg (3)	187	191	NR	NR
Amine Value	NR	NR	350	400

(1) ASTM D1084.
(2) ASTM D891.
(3) ASTM D1652.
NR = No Requirement

PROCESS. The adhesive is activated by mixing 3 parts of epoxy resin with 2 parts by weight of polyamide curing agent, applied by brushing, the joint closed and cured for not more than 16 hours at 110 F under contact pressure. The cured adhesive in thicknesses between ¼ and ½ inch has a Shore D hardness between 65 and 85.

PERFORMANCE. The adhesive has a shear strength of at least 1500 psi at 75 F using 2024 Alclad aluminum (QQ-A-362) adherends (Fed Test Method Std 175, Method 1033).

FORM

The adhesive is available in commercial packages.

QPL

No.

MIL-A-81236 (WP) (Continued)

NOTES

(1) This adhesive is suitable for bonding components in rocket motor systems.

MIL-A-81253 (WP) ADHESIVE, MODIFIED EPOXY RESIN WITH POLYAMINE CURING AGENT

Issue: 1 March 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for general purpose bonding applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and a separate aliphatic polyamine hardener such as triethylenetetramine.

PHYSICAL. The epoxy resin has a viscosity between 2100 and 3600 centipoises at 25 C (ASTM D445), an epoxy value of between 0.40 and 0.43 equivalent (ASTM D1652), a color no greater than Gardner No. 3 (ASTM D1544), and a weight between 9.3 and 9.6 lb/gal (ASTM D891). The triethylenetetramine has a boiling range between 260 and 290 C (ASTM D1078) and a specific gravity between 0.976 and 0.982 at 25/25 C.

PROCESS. The adhesive is activated by mixing 100 parts epoxy resin with 10 parts by weight triethylenetetramine, applied by brushing, the joint closed and cured between 2 and 8 hours at 100 C under contact pressure.

PERFORMANCE. The adhesive has a shear strength of at least 3250 psi at room temperature using steel adherends (ASTM D1002).

FORM

The adhesive is available in commercial packages.

QPL

No.

NOTES

(1) This adhesive is suitable for bonding components in rocket motor systems.

MIL-A-81270 (WP) ADHESIVE, SYNTHETIC RUBBER

Issue: 10 May 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for general purpose bonding applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a solvent dispersed nitrile phenolic rubber adhesive containing between 19 and 21% solids.

PHYSICAL. The adhesive has a viscosity between 15 and 35 seconds (ASTM D1084 - 0.15 in. diameter cup).

PROCESS. The adhesive is applied by brushing, air dried, 2-3 minutes at 350 F, the joint closed and cured 30 minutes at 350 F under 500 psi bonding pressure.

PERFORMANCE. The adhesive has a shear strength of at least 1200 psi at room temperature using cold roll steel adherends (ASTM D1002).

FORM

The adhesive is available in commercial packages.

QPL

No.

NOTES

(1) This adhesive is suitable for bonding components in rocket motor systems.

APPENDIX A

INDEX OF ADHESIVE BONDING SPECIFICATIONS

This index lists all of the new and revised specifications abstracted. Suffix letters following specifications numbers are not reproduced here but are shown in the individual abstract. Thus, for example, L-T-0075 (ARMY MO) is shown as L-T-0075.

APPENDIX B

INDEX OF CANCELED ADHESIVE BONDING SPECIFICATIONS

This index lists all of the adhesive material specifications canceled. The date shown is the cancelation date. Superseding specifications are given when applicable. The page number refers to the page in the original book where the specification is abstracted.

INDEX

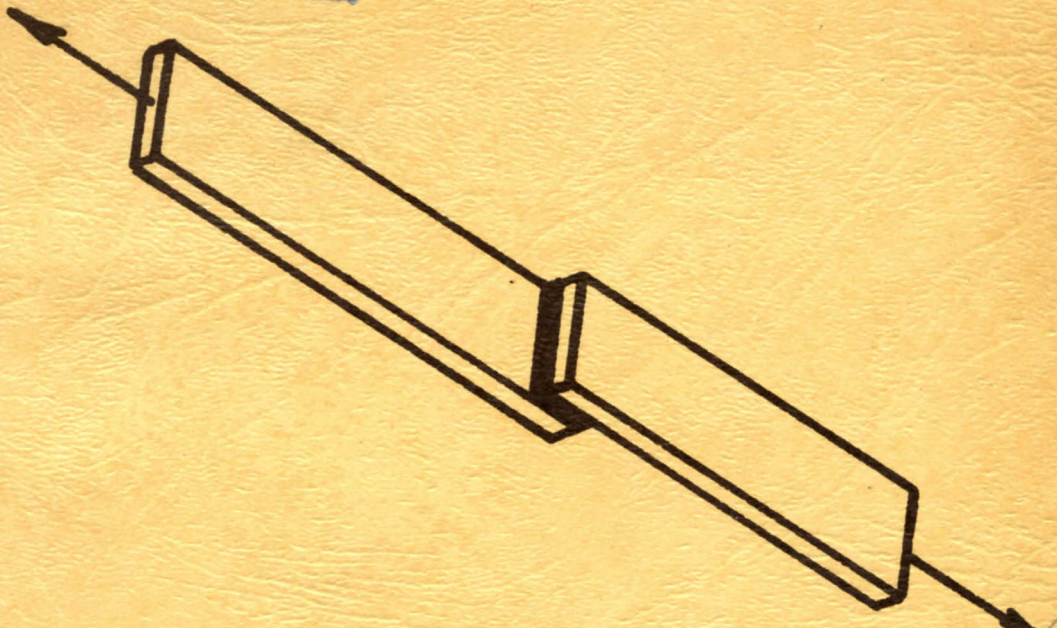
ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ

MARCH 1966



Foster Publishing Company

Table Of Equivalents

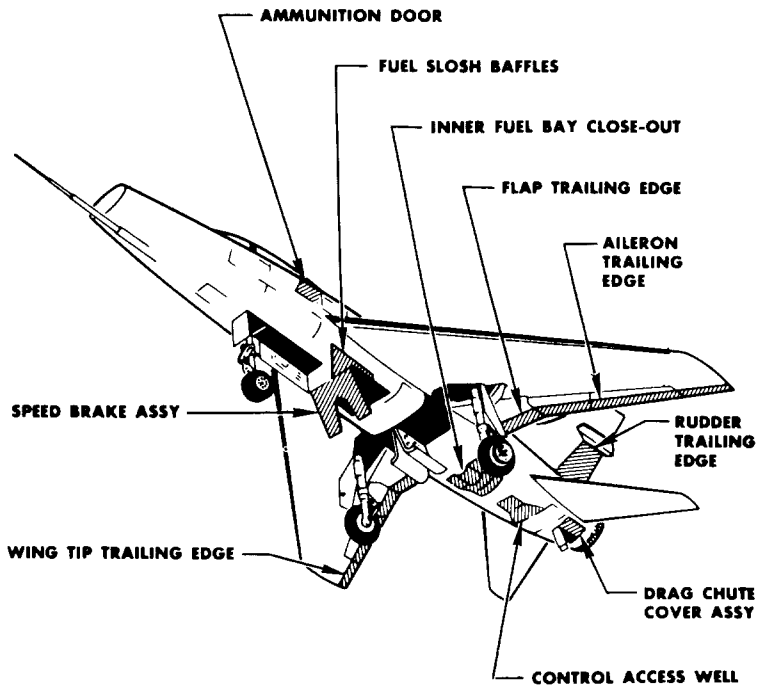
Adhesive Materials, Their Properties and Usage

UNIT	VALUE
Length	1 in equals 2.540 cm 1 ft equals 30.480 cm 1 yd equals 91.440 cm
Mass	1 oz equals 28.35 g 1 lb equals 453.6 g 1 lb equals 0.453 Kg
Pressure	psi equals 70.30 g/cm^2
Temperature	°F equals 1.8 (°C) + 32
Volume	1 oz equals 29.57 cm^3 1 in^3 equals 16.39 cm^3 1 ft^3 equals 28.32 1
Density	lb/ft^3 equals 0.016 g/cm lb/gal equals 0.119 g/cm
Energy	1 BTU equals 252 Cal Ft lb equals 0.3240 Cal
Power	BTU/min equals 0.1760 KW Horsepower equals 0.746 K

ADHESIVE MATERIALS, THEIR PROPERTIES

AND USAGE

SUPPLEMENTS



Adhesive Bonded Components in Aircraft.

(Courtesy North American Aviation, Inc.)

Volume 1 Number 4

ADHESIVE MATERIALS

Their Properties and Usage

SUPPLEMENTS

IRVING KATZ
North American Aviation, Inc.
Downey, California

MARCH 1966

FOSTER PUBLISHING COMPANY
Long Beach, California

To Lucy, Philip, Laurie,
Barbara, Morris, Elsie,
Opal and Alice

ADHESIVE MATERIALS,
THEIR PROPERTIES AND USAGE
SUPPLEMENTS

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LONG BEACH, CALIFORNIA 90815

PREFACE

Every design, whether it be for a component or for a complete system, will utilize adhesive bonding in its reduction to the hardware stage.

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE has brought into being the first and only comprehensive guide to Government, National, Industrial and International specifications covering adhesives, binders, cements, glues, mortars, mucilages, pastes, gummed and pressure-sensitive adhesives.

However, specifications are living documents. They are continuously being created, changed and canceled. One of the more vexing problems facing most engineers and manufacturers in developing and maintaining products is the need to keep up with the advancing technology reflected in specifications.

The SUPPLEMENTS will meet this need by bringing up to date every 3 months the data contained in new and revised adhesive material specifications, eliminating the need for extensive literature surveys, delays in specification procurement and expensive analyses.

The SUPPLEMENTS retain the same format and styling of the original book.

Irving Katz

Downey, California
February 15, 1966

PREFACE

Adhesive Materials, Their Properties and Usage

Currently, it takes nine glues for you to light up your cigarette. Detached retinas, worn arteries and broken bones are being repaired with adhesives. Highway departments use these materials in restoring roads, while builders are constructing houses and fences at lower costs by substituting these bonding agents for mortar. Automobiles contain between eight and twenty five pounds of plastic cements; moreover, in the not too distant future, the entire car may be free from screws, solder and rivets. The shoe manufacturers are discarding nails and threads for these adhesive materials, while the garment industry is attempting to assemble clothes by bonding, in order to eliminate costly sewn seams. The aircraft, shipbuilding, packaging, toy and dental industries all use bonding materials — in some cases even for prime structural purposes.

To support these assembly operations, approximately two billion pounds of chemical joining agents, commonly called adhesives, cements, glues, mucilages, pastes and pressure-sensitive tapes, are being produced in this country. The user has available such a wide variety of types, grades and forms that the problem of choosing which adhesive will join his components is not a simple one. Factors concerning loads, temperature range, weathering and environmental conditions affecting the joint, limit the selection. Further, since profitable operations not only depend on how fast and inexpensively parts can be made but also on how quickly the product can be assembled, additional factors are introduced. Typical ones which require consideration are process equipment availability, manufacturing sequences, purchasing commitments and storage (some adhesives spoil rapidly).

Other than a few limited reviews, there is no single source guide oriented toward the user which even begins to answer all these questions. The user is thus faced with a formidable problem. Not only does he have to sift out which types of adhesives can join his components, but also he must determine which is best for his application, consistent with process and equipment limitations. Considerable literature searching as well as supplier contact is therefore necessary. Such an ambitious project is time consuming; and in certain cases where decisions are urgent, the problem becomes difficult to resolve.

Nevertheless, there is actually a vast source of readily applicable data. These data are contained in specifications, which define what is expected in measurable terms, give the limits of uniformity and quality, and distinguish between a good and a bad product. Unfortunately, when the precise number and title of the desired specification are unknown, procurement is hindered.

In response to this shortcoming, this book provides a guide for choosing suitable adhesives covered by specifications. It gives basic and detailed information of value, on a comparable basis, to designers, manufacturers, engineers and technical personnel concerned with fabricated parts of almost every conceivable nature, where adhesive bonding assembly operations are an integral part of fabrication.

Towards this end, the book is divided into two parts. Part I guides the user to those adhesives which can fulfill specific jobs. Part II gives exact specification details covering the chemical, physical, process and performance properties, as well as availability of these bonding materials. In order to keep up with the changing technology of adhesive bonding which is reflected in the creation, revision and cancellation of specifications, this book will be revised periodically.

I wish to thank three publishers for their permission to use portions of my articles in this book. These are Reinhold Publishing Company ("Adhesives for Wood", Materials in Design Engineering, July 1962), Conover-Mast Publications ("Pressure-Sensitive Adhesive Electrical Tapes", Electro-Technology, August 1962 and "Adhesives for Optical and Electro-Optical Applications", Electro-Technology, April 1963, copyright C-M Technical Publications) and Palmerton Publishing Company ("A Guide to Federal and Military Specifications for Rubber Bonding Adhesives", Rubber Age, April 1964).

Irving Katz

Downey, California
July, 1964

CONTENTS

PART I

ADHESIVES SELECTION

1. PAPER AND FABRIC ADHESIVES

New and modified adhesives have been introduced for bonding coated fabrics.

The first is a new nitrile base adhesive used for hot patching vinyl coated nylon fabrics employed in the fabrication of air supported tents (Reference 1). It is readily cured by pressing with a hot iron set for cotton-wool.

The second is a modified natural rubber base adhesive for bonding natural rubber coated cotton fabrics (Reference 2). These fabrics are employed in the manufacture of airships, balloons, pneumatic life rafts and life jackets. The adhesive is available both in room temperature and elevated temperature curing varieties and can be obtained as a single or two component system.

BIBLIOGRAPHY

Fabric Assembly Adhesives

(1) MIL-A-43365 Adhesive (for repair of radome, air supported), 16 September 1965. No QPL.

(2) MIL-A-5539 Adhesive, natural or synthetic natural rubber, 5 February 1965. Has QPL.

2. WOOD ADHESIVES

No new or modified wood adhesives have been introduced.

3. RUBBER ADHESIVES

Adhesives for rubber fall into three general categories. There are (1) straight rubber assembly adhesives, (2) mixed rubber assembly adhesives and (3) general purpose rubber bonding adhesives. One straight rubber assembly adhesive has been modified.

This adhesive is intended for bonding natural rubber coated fabrics, such as those used in the manufacture of balloons, pneumatic life rafts, etc. (Reference 1). This adhesive is available in room temperature and elevated temperature curing varieties and can be obtained as single component and two component systems.

BIBLIOGRAPHY

Straight Rubber Assembly Adhesives

(1) MIL-A-5539 Adhesive, natural or synthetic natural rubber, 5 February 1965. Has QPL.

4. PLASTICS ADHESIVES

Plastics adhesives also fall into three general usage categories: the first, for straight plastic assemblies; the second, for mixed plastic assemblies; and the third, for general purpose plastics bonding applications. New and modified adhesives have been introduced for straight plastic assemblies and mixed plastic assemblies.

STRAIGHT PLASTIC ASSEMBLY ADHESIVES

Straight plastic assembly adhesives are conventionally designated by the type of adherend to be joined, such as thermoplastic or thermosetting. Adhesives for thermoplastics only have been introduced. These thermoplastics are acrylic, polyethylene and polyvinyl chloride.

Acrylics

Acrylics are joined with two adhesive materials (Reference 1), and both are based on methyl methacrylate. However, one contains methylene chloride as a solvent to help soften the heat resistant acrylic varieties. The second is for the straight acrylics and contains no solvent. It can be used for the heat resistant acrylics, but has less desirable processing characteristics than the former adhesive.

Polyethylene

Polyethylene can be bonded with pressure-sensitive adhesive tapes commonly used for insulating polyethylene coated wires (Reference 2). The tape is activated by stretching it 100% and applying it to the polyethylene assembly. Fusion occurs in a few minutes.

Polyvinyl Chloride

Polyvinyl chloride is joined with a new nitrile base adhesive (Reference 3). It is cured by pressing with an iron set for cotton-wool until the adhesive fuses.

SPECIFIC MIXED PLASTIC ASSEMBLY ADHESIVES

Whenever dissimilar materials are to be joined, the coefficients of expansion as well as the reactivity of the individual components

are important considerations. However, the user has available adhesives specially formulated for a particular type of joint. Those joints are plastic/wood, plastic/metal and plastic/plaster. A new adhesive has been developed for plastic foams/metal joints.

Plastic/Metal.

Plastic foam material is bonded to metal and to itself with a new adhesive (Reference 4). This adhesive is available dispersed in water or organic solvents and is cured at room temperature. The adhesive will not corrode steel which has been primed with zinc chromate.

BIBLIOGRAPHY

Straight Plastic Assembly Adhesives

Acrylic

(1) MIL-A-8576 Adhesive, acrylic base, for acrylic plastic, 22 September 1965. No QPL.

Polyethylene

(2) MIL-I-3825 Insulation tape, electrical, self-fusing; for use in electronic, communications and allied equipment, 21 May 1965. No QPL.

Polyvinyl Chloride

(3) MIL-A-43365 Adhesive (for repair of radome, air supported), 16 September 1965. No QPL.

Specific Mixed Plastic Assembly Adhesives

Plastic/Metal

(4) MIL-A-24179 Adhesive, flexible, unicellular-plastic thermal insulation, 18 October 1965. Has QPL.

5. METAL ADHESIVES

Metal adhesives, like plastic adherend adhesives, also fall into three general usage categories. The first is for straight metal assemblies, the second for mixed metal assemblies, and the third for general purpose bonding. A new adhesive for mixed metal assemblies has been introduced.

MIXED METAL ASSEMBLY ADHESIVES

This adhesive has been developed for adhering flexible plastic insulation to metal surfaces (Reference 1). The adhesive, which is cured at room temperature, is available dispersed in either water or organic solvents, thus providing an option where toxicity, flammability and explosion hazards exist.

BIBLIOGRAPHY

Mixed Metal Assembly Adhesives

(1) MIL-A-24179 Adhesive, flexible unicellular-plastic thermal insulation, 18 October 1965. Has QPL.

6. PACKAGING ADHESIVES

Packaging adhesives are intended for use in (1) carton manufacture, (2) carton closure, (3) packing and (4) labeling. New and modified packaging adhesives have been developed for use in carton closures and packing applications.

CARTON CLOSURES

A paper and a filament reinforced polyester tape have been introduced for carton closures.

The paper base tape is intended for temporary closing of chipboard and fiberboard boxes (Reference 1). It also can be used for bundling small parts prior to overpacking and for holding small parts to larger assemblies.

The filament reinforced polyester tape is intended for sealing fiber and slip cover metal containers (Reference 2). This tape, among those available, has medium tensile breaking strength properties and, in addition, possesses good removal features at low temperature.

PACKING

Packing consists of (1) reinforcing and sealing cartons, (2) sealing container closures and (3) preservative applications. Modified and new adhesives have been developed for the first and third usage categories.

Reinforcing And Sealing Of Cartons

Cartons requiring tapes having good weathering resistance and high reflectivity can be sealed with an aluminum backed pressure-sensitive tape (Reference 3). This tape can be used with explosives.

Preservation

Polished or finished metal and plastic surfaces are subject to scratching or marring during fabrication, storage, shipment and handling. A protective tape has been developed to protect these surfaces (Reference 4). This tape, dependent upon type, is available for both internal and external storage service. The protection

offered is suitable only for limited periods of time, whereupon the tape becomes difficult to remove.

BIBLIOGRAPHY

Carton Closure

(1) PPP-T-0042 Tape, pressure-sensitive adhesive; (general packaging application), 21 July 1965. No QPL.

(2) MIL-T-43036 Tape, pressure-sensitive adhesive, plastic film, filament reinforced (for sealing fiber containers and cans), 25 May 1965. No QPL.

Packing

Reinforcing And Sealing Of Cartons

(3) L-T-80 Tape, pressure-sensitive adhesive, (aluminum backed), 15 September 1965. No QPL.

Preservation

(4) MIL-T-38727 Tape, pressure-sensitive adhesive, protective, 19 April 1965. Has QPL.

7. ELECTRICAL ADHESIVES

Adhesive tapes for electrical applications can be divided into three general usage categories. The first is for wire splicing, including repair of insulation; the second for construction and repair of electrical equipment; and the third for identification marking of electrical circuits. Modified adhesive tapes have recently been introduced for wire splicing.

ELECTRIC WIRE SPLICING TAPES

Electrical splicing consists of uniting two or more wires into a single conductor. The splicing is performed by interweaving the conductor strands, whereupon the open splice area is insulated with the adhesive tape. Polyethylene and polytetrafluoroethylene (teflon) are the two recently modified adhesive tapes.

Polyethylene

This tape is intended primarily for splicing wires and cables insulated with polyethylene, although experience indicates that it also performs efficiently on most insulations (Reference 1). This tape has better electrical properties than the conventional rubber base splicing tapes.

Polytetrafluoroethylene

This tape is intended for insulating splices which are subjected to temperatures as high as 500 F (Reference 2). It is satisfactory for underwater applications and can effect insulated splices without the use of elevated temperatures and pressures for processing. Whenever subsequent impregnation is necessary, the tape is available with a treated backing to which varnish will adhere.

BIBLIOGRAPHY

(1) MIL-I-3825 Insulation tape, electrical, self-fusing; for use in electronic, communications, and allied equipment, 21 May 1965. No QPL.
(2) MIL-T-23594 Tapes, pressure-sensitive adhesive, electrical; high temperature insulation, polytetrafluoroethylene, 17 August 1965. Has QPL.

8. OPTICAL ADHESIVES

There are two functional types of adhesives available for the design and construction of optical and electro-optical systems. These are the transparent adhesives for bonding optical components in which the visual performance properties in the bonded area are not affected and the optically inactive adhesives for affixing optical components to nonoptically active fixtures. An innovation has been introduced in the former category.

This innovation consists of an adhesive specifically for bonding plastic lenses prepared from acrylic resins (Reference 1). This adhesive, according to type, is suitable for both the high temperature resistant acrylics (Type I) and the conventional acrylic materials (Type II).

BIBLIOGRAPHY

(1) MIL-A-8576 Adhesive, acrylic base, for acrylic plastic, 22 September 1965. No QPL.

9. BUILDING CONSTRUCTION ADHESIVES

New Building Trade adhesive materials have been recently developed for use in installing thermal insulation.

INSTALLATION OF THERMAL INSULATION

Thermal insulation materials are used to control the flow of heat. Two distinct types are available: primary and secondary insulations. Primary insulations are applied directly to the component to be thermally protected without the need of a separate adhesive. Secondary insulations are materials which require a separate adhesive to bond them to the component. Two new adhesives have been developed for secondary insulations.

Flexible unicellular plastic insulation is bonded to metal and to itself with a room temperature curing adhesive (Reference 1). This adhesive is available dispersed either in water or organic solvents, the former being of particular value where explosion, toxicity or fire hazards exist. The adhesive will not corrode steel which has a protective coating of zinc chromate primer.

Heretofore, damaged insulations would require removal and reinstallation of the base material prior to subsequent usage. However, a silicone base aluminum pressure-sensitive tape is now available to permit repairs without the necessity for replacing the damaged insulation, provided it is not too extensive (Reference 2). This tape requires no solvent, heat or other preparation prior to or subsequent to application.

BIBLIOGRAPHY

Installation of Thermal Insulation

(1) MIL-A-24179 Adhesive, flexible unicellular-plastic thermal insulation, 18 October 1965. Has QPL.

(2) MIL-T-81287 Tape, pressure-sensitive adhesive, aluminum foil backed, for high temperature application, 2 July 1965. Has QPL.

10. OTHER ADHESIVES

New and modified adhesives have been developed for pyrotechnic and automotive applications.

PYROTECHNIC ADHESIVES

Jet engine exhaust cones and tail pipe insulation blankets can be repaired with an aluminum backed, silicone pressure-sensitive adhesive tape without the necessity for removing damaged parts from the assemblies (Reference 1). This tape, suitable to 700 F, can be applied readily at room temperature and used immediately without any further preparation.

AUTOMOTIVE ADHESIVES

Brake linings can be joined to steel and aluminum drums with an adhesive resistant to brake and hydraulic fluids, water and for short periods of time to temperatures as high as 400 F (Reference 2). This adhesive has a disc shear strength of 350 psi.

BIBLIOGRAPHY

Pyrotechnic

(1) MIL-T-81287 Tape, pressure-sensitive adhesive, aluminum foil backed, for high temperature application, 2 July 1965. Has QPL.

Automotive

(2) MIL-A-46091 Adhesive, brake lining to metal, 16 July 1965. No QPL.

PART II

ADHESIVE PROPERTIES DATA

NOTICE TO THE READER

Specifications are living documents: they are continuously being created, changed and cancelled. The following new and revised abstracts (tabulated in numerical order — Federal first, Military second and others third) reflect the current status of these documents, giving the latest issue date, revision and amendment.

These abstracts additionally set forth the six basic constituents of any specification. These are Scope, Classification, Properties, Form, Qualified Products List and Notes.

The Scope defines the purpose of the joining agent — specifically, what the adhesive is intended to do and what it will bond.

The Classification section defines the various conditions, expressed as types, classes and grades, under which the adhesive is available.

The Properties section is subdivided into four parts. These are chemical, physical, process and performance. The chemical section designates the composition of the joining agents. However, for various reasons, some specifications do not define the ingredients; one purpose is to leave the choice to the manufacturer in order to promote competition among the suppliers. The physical properties give the characteristics of the joining agents which will be needed if the material is to meet the intended purpose. Such things as viscosity, solids and ash content, toxicity, flexibility, specific gravity, consistency, pH, etc. fall into this category. Process properties define the make-ready and curing conditions necessary to convert the bonding material. Storage requirements are given here since they are an integral part of the conversion process. Performance properties define what is expected from the joining agent when properly converted.

The Form defines the physical state of the joining material, such as liquid, solid, film, etc., and the quantities in which it is normally available. Some of the specifications do not specify quantities, and these are noted accordingly. Packaging specifications covering the containers are not given.

The Notes give additional information of value to the user such as which type, grade or class is preferable for a specific application, other types of adherends which can be joined, etc.

Each abstract contains all the data actually defined in the specification. Where specific items need modification or are not given, the reader should add these in any purchase orders.

A certain degree of caution is necessary concerning the use of adhesives conforming to any specification. The properties are guaranteed only when the specific adherends are tested in strict accordance with the procedures given in the specification. A change in adherends may change the expected performance properties. Further, the test methods employed may not reflect the actual environmental conditions of a particular part. And still further, performance properties called out by a specification are generally minimum; the actual values obtained with the adhesives should be higher than specified. Consequently, the specification values serve admirably as a screening technique to reduce development costs.

When a specification appears promising, the final step is to obtain adhesives covered by these documents. Certain of the specifications have concomitant Qualified Products Lists (QPL) which give the names of adhesives, including the suppliers, which meet the requirements. When no Qualified Products List exists, many adhesive suppliers will certify that their products conform to the requirements (if they do) when procured under the specification designation.

Appendix A lists all of the new and revised adhesive material abstracted. Many of these specifications refer to other documents to define some of the adherends and test procedures. These references are designated by the document number in the abstract.

The following abstracts are a compilation of essential data contained in adhesive material specifications. Extensive effort has been made to verify and check the information contained in each abstract. However, neither the author nor the publisher is responsible for errors which may have occurred in this book.

L-T-80 TAPE, PRESSURE-SENSITIVE ADHESIVE (ALUMINUM-BACKED)

Issue: 15 September 1965 Revision: a Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing and masking applications where good reflectivity, weather and moisture vapor resistance are required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of an aluminum backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape has a backing thickness of 0.0025–0.0035 inch, a tensile strength of at least 26 lb/in. and a water vapor transmission rate of 0.07 gr/100 sq in./24 hour (Fed Test Method Std 147, Methods 36, 30 and 70 respectively).

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. A force no greater than 3.0 and 4.0 lb/in. is required for unrolling the tape either as received or aged 12 days at 150 F and 80% RH (Fed Test Method Std 147, Method 80).

PERFORMANCE. The tape has a peel strength at 75 F of at least 40 oz/in. of width and at least 35 oz/in. of width after aging 12 days at 150 F and 80% RH prior to application using a AISI 302 or 304 stainless steel substrate (Fed Test Method Std 147, Method 10). No evidence of corrosion and no more than 5 (not aged) and 10% (aged) adhesive transfer occurs after peeling. The tape will not curl, buckle or deteriorate during 288 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151).

FORM

The tape, unless otherwise specified, is available in 60 yard rolls wound on 3 inch diameter cores in ½, ¾, 1 and 1½ inch widths. Each roll may contain up to 3 splices.

QPL

No.

NOTES

1. Do not order tape in quantities greater than that which can be used in 6 months.
2. Suitability with explosives must be demonstrated at a Government Laboratory.
3. This specification supersedes MIL-T-11291 "Tape, adhesive, aluminum-backed".

PPP-T-0042 (GSA-FSS) TAPE, PRESSURE-SENSITIVE ADHESIVE; (GENERAL PACKAGING APPLICATION)

Issue: 21 July 1965 Revision: None Amendment: None

SCOPE

This tape is intended for light duty bundling, holding and packaging applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a crepe paper backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape has a tensile strength of at least 16 lb/in. and an elongation of at least 6% (Fed Test Method Std 147, Method 30).

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The performance properties of the tape are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF PPP-T-0042 TAPE

PROPERTY	VALUE
Peel, oz/in., at 75 F, min (1)	
Against stainless steel	
Initial	25
Aged (2)	20
Against backing	
Initial	12
Tack, in., max (3)	6

(1) Fed Test Method Std 147, Method 10.
(2) The tape is aged 7 days at 150 F and 80% RH prior to bonding.
(3) The tape will stop a 1.0625 inch diameter steel ball weighing 80 grams after rolling down a right angle inclined plane (2-9/16 inch altitude and 6-3/4 inch base) within the distance specified.

FORM

The tape is available in 60 yard rolls wound on 3 inch diameter cores in 1, 2 and 3 inch widths. Each roll may contain up to three splices. Unless otherwise specified the color is natural.

PPP-T-0042 (GSA-FSS) (Continued)

QPL

No.

NOTES

(1) The tape is suitable for bundling small parts to be overpacked, holding small parts to larger assemblies and for temporary closing of chipboard and fiberboard boxes.

(2) This tape is not suitable as a substitute for PPP-T-76 carton sealing tape.

MIL-I-3825 INSULATION TAPE, ELECTRICAL, SELF-FUSING; FOR USE IN ELECTRONIC, COMMUNICATIONS, AND ALLIED EQUIPMENT

Issue: 21 May 1965 Revision: B Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced wire and cable including those jacketed with polyethylene.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the tape is not given. It is supplied with an unspecified liner.

PHYSICAL. The physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-I-3825 TAPE

PROPERTY	VALUE
Thickness, in.	0.020, 0.030
Thickness tolerance, ± %	15
Elongation, ultimate, %, at 75 F min	300
Dielectric strength, volts/mil, min (1)	
After 96 hours at 23 C – 0% RH	800
After 96 hours at 23 C – 96% RH	800
Volume resistivity, ohm-centimeter, min (2)	
After 96 hours at 23 C – 0% RH	10^{14}
After 96 hours at 23 C – 96% RH	10^{13}
Dielectric constant, at 23 C (3)	2.90
Dissipation factor, at 23 C (3)	0.006
Specific gravity, 23/23 C, max (4)	1.18

(1) ASTM D 1000.
(2) Fed Test Method Std No. 406, Method 4041.
(3) Fed Test Method Std No. 406, Method 4021, 1 megacycle.
(4) Fed Test Method Std No. 406, Method 5011.

PROCESS. The tape is activated by elongating 100 percent prior to application. No moisture, heat or other preparation except removal of separator and stretching is required prior to or subsequent to application. Fusing occurs within a few minutes after application. The tape can be stored for 2 years under normal ambient temperature conditions.

MIL-I-3825 (Continued)

PERFORMANCE. The tape, spirally wound, after being stretched 300 ± 10% on AWG size 8 wire and conditioned 24 hours between 20 and 30 C, does not delaminate, crack or split (1) under (hand) prying action, (2) heating 400 hours at 100 C, (3) heating 200 hours at 100 C and then bending 180° at room temperature on a mandrel whose diameter corresponds to that of the wire, (4) bending 180° on a mandrel (See 3) at -55C, and (5) subjected 72 hours to 0.015% ozone. The tape does not corrode wires during 168 hours exposure at 40 C and 96 percent RH.

FORM

The tape is available in 30 foot rolls wound on 1 inch minimum diameter cores in ½, ¾, 1, 1¼, 1½, 2, 2½ and 3 inch widths and in black, white or unpigmented colors.

QPL

No.

NOTES

(1) Methods of applying tape to wire (MIL-C-13294, "Wire, WD-1/TT and WD-14/TT") and Cable (MIL-C-10581, "Cable, CX-1065/G, CX-1512/U and CX-1066/6") are given in the specification.

(2) It is recommended that the resulting splices using this tape be protected by wrapping a more abrasion resistant tape over the self-fusing tape.

MIL-A-5539 ADHESIVE, NATURAL OR SYNTHETIC NATURAL RUBBER

Issue: 5 February 1965 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding natural rubber coated fabrics.

CLASSIFICATION

The adhesive is available in three classes.

Class 1 Heat cure for manufacture
Class 2 Room temperature cure for manufacture
Class 3 Room temperature cure for repair

PROPERTIES

CHEMICAL. The adhesive consists of natural or synthetic natural rubber. Catalyst is supplied either incorporated or as a separate entity.

PHYSICAL. The solids content and viscosity are specified by the supplier and will not vary more than ± 10%. The viscosity of Class 3 adhesive will not change by more than ± 20%, even after 15 days storage at 140 F.

PROCESS. The adhesive is activated by mixing the base resin with catalyst, if supplied separately, applied by brushing on no more than 3 coats, the joint closed and cured in accordance with the supplier's directions under contact pressure. The working life of the adhesive is at least 6 hours at 25 C.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

MIL-A-5539 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-5539 ADHESIVE

PROPERTY	CLASS		
	1	2	3
Shear, lbs, at 75 F, min (1) (2)			
Initial	425	425	425
After 7 days at 160 F	340	340	340
Peel, lb/in., at 75 F, min			
Initial	5	5	5
After 7 days at 160 F (3)	4	4	4
After 7 days at 160 F (4)	NR	NR	5
After 48 hr immersion in water	5	5	5
Creep in shear, hr, min (1) (5)			
At 140 F, 50 psi load	24	24	24

(1) Adherends are natural rubber coated cotton fabric (MIL-C-6819, Type O) using a 3/4 inch overlap, 2 inches wide.
(2) Also known as seam strength.
(3) The joint is aged prior to test.
(4) The adhesive is aged prior to bonding.
(5) The joint does not separate or creep under the indicated load for the time specified.
NR = No Requirement

FORM

The adhesive is available in pint, quart and gallon containers. The catalyst, if any, is available in dark glass bottles or metal cans.

QPL

Yes.

NOTES

(1) Do not use this adhesive for bonding nylon.

(2) The Classes covered by this specification corresponding to the Types of the previous issue are:

Current	Previous
Class 1 (One or two parts)	– – – –
Class 2 (One or two parts)	Type A (One or two parts)
– – –	Type B (One part)
Class 3 (One or two parts)	Type C (Two parts)

MIL-A-8576 ADHESIVE, ACRYLIC BASE, FOR ACRYLIC PLASTIC

Issue: 22 September 1965 Revision: B Amendment: None

SCOPE

This adhesive is intended for bonding acrylic plastics.

CLASSIFICATION

The adhesive is available in two types.

Type I Solvent type
Type II Nonsolvent, high viscosity type

PROPERTIES

CHEMICAL. The adhesive consists of methyl methacrylate monomer containing an unspecified inhibitor. Additionally, Type I contains methylene chloride (MIL-D-6998) and Type II an unspecified promoter. A separate catalyst is supplied with both types.

PHYSICAL. The base resin is a colorless, transparent liquid. The other physical properties are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-8576 ADHESIVE (1)

PROPERTY	TYPE I	TYPE II
Index of refraction at 25 C (2)	1.413-1.419	1.442-1.445
Specific gravity at 25 C		
Initial	1.165-1.185	1.03-1.04
After 1 week at 50 C	1.16-1.18	NR
Viscosity at 25 C, poises (3)		
Initial	1.0 (4)	17.6-36.2
After 1 week at 50 C	4.0 (4)	17.6-36.2

(1) All values are for base resin prior to addition of catalyst.
(2) Sodium D yellow light.
(3) Fed Test Method Std 141, Method 4271.
(4) Maximum.
NR = No Requirement

PROCESS. The adhesive is activated by mixing base resin and catalyst, applied by brushing, the joint closed and cured all in accordance with the instructions of the supplier. The adhesive (base resin and catalyst separate) can be stored 6 months.

PERFORMANCE. The performance properties of the adhesive are given in Table II.

MIL-A-8576 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-A-8576 ADHESIVE

PROPERTY	TYPE I		TYPE II	
	Avg.	Ind.	Avg.	Ind.
Tension, psi, min (1)				
At 23 C				
Initial	1800	1500	2700	2300
After 24 hr at 70 C	NR	NR	3100	2300
After 48 hr at 70 C	5000	4000	NR	NR
At 70 C				
After 24 hr at 70 C	NR	NR	2700	2000
After 48 hr at 70 C	2400	2000	NR	NR

(1) Type I adhesive uses butt joint bonded heat resistant acrylic plastic adherends (MIL-P-5425) and Type II straight acrylic plastic adherends (MIL-P-8184).

NR = No Requirement

FORM

The base resin is available in pint, quart and gallon containers. The promoter is unit packaged with the base resin. The catalyst package, in the required stoichiometric proportions, is securely joined to the base resin package.

QPL

No.

NOTES

(1) Use Type I adhesive for heat resistant acrylic plastics (MIL-P-5425). Type I may be used with other acrylics (except MIL-P-8184 acrylics) where the cushion joining technique is useful.

(2) Use Type II adhesive for any type of acrylic plastic especially where the cushion technique is not necessary.

(3) Do not store adhesive components above 140 F.

(4) This adhesive is flammable and toxic. Adequate ventilation and avoiding skin contact are necessary.

(5) Type II adhesive supersedes MIL-A-25055 (see abstract).

MIL-T-23594(Wep) TAPES, PRESSURE-SENSITIVE ADHESIVE, ELECTRICAL; HIGH TEMPERATURE INSULATION, POLYTETRAFLUORO-ETHYLENE

Issue: 17 August 1965 Revision: None Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced wires jacketed with polytetrafluoroethylene and for construction of electrical and electronic underwater ordnance equipment, aircraft, missile and other weapon systems.

CLASSIFICATION

The tape is available in two types.

Type I Smooth backing
Type II Treated backing (for insulation varnish)

PROPERTIES

CHEMICAL. The tape consists of a 100% pure polytetrafluoroethylene backing coated on one side with a silicone base adhesive. When required, liners are used with the Type II tape. Type II backing is chemically treated to accept varnish.

PHYSICAL. The thickness of the backing is such that the tensile strength and dielectric breakdown values are in accordance with Table I. The other physical properties of the tape are given in Table II.

TABLE I. TENSILE STRENGTH AND DIELECTRIC BREAKDOWN PROPERTIES OF MIL-T-23594 TAPE

Backing Thickness (1) (mils)	Tensile Strength (2) (lb/in. width-min)	Dielectric Breakdown (3) (volts-min)	
	Types I and II	Type I	Type II
1.5 - 2.5	7.0	4,200	3,800
2.6 - 3.5	12.0	7,200	6,500
3.6 - 4.5	17.0	10,300	9,000
4.6 - 5.5	22.0	12,700	11,500
5.6 - 6.5	27.0	15,400	14,000
6.6 - 7.5	32.0	18,000	16,500

(1) Exclusive of adhesive thickness.
(2) CCC-T-191, Method 5102.
(3) L-P-406, Method 4031.

MIL-T-23594 (Continued)

TABLE II. PHYSICAL PROPERTIES OF MIL-T-23594 TAPE

PROPERTY	VALUE
Melting point, °C (1)	317–337
Specific gravity (2)	2.15–2.21
Elongation, %, min (3)	100
Moisture absorption, %, max (4)	0.1
Volume resistivity, ohm-cm, min	10^{14}

(1) Backing only per ASTM D1457.
(2) Backing only per ASTM D792.
(3) CCC-T-191, Method 5102.
(4) L-P-406, Method 7031.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored 1 year.

PERFORMANCE. The tape, both types, has a peel strength of 16 oz/in. of width on stainless steel (QQ-S-766) at 75 F and at 75 F after aging the roll 14 days at 155 F and 85% RH prior to application. Both types adhered to 1 sq in. of its own backing support for 1 hour a 100 gram weight at 500 F with no more than 1/8 inch slippage. Type II tape only can be covered with an insulation varnish (MIL-V-13811) and after air drying 72 hours, leaves a uniform film which can be bent 180° over a 1/8 inch diameter mandrel without loss of adhesion of the insulation varnish to the backing.

FORM

The tape, unless otherwise specified, is available in 36 yard rolls wound on 1 or 3 inch diameter cores in ½, 1, 1½ and 2 inch widths.

QPL

Yes.

NOTES

(1) Use Type I for splicing polytetrafluoroethylene coated electrical wires intended for continuous operation at 500 F. Specify a minimum tensile strength of 15 lb/in. of width when used for (a) water tight seals around blasting cap and detonating cord, (b) splicing of firing cable to prevent shorting out of firing circuit, (c) water tight seals around junctions of nonelectric cap and (d) safety fuse and general use in underwater demolition.

(2) Use Type II where it is necessary to impregnate electrical equipment with insulation varnish after application of tape.

(3) This specification supersedes cancelled MIL-T-22742 and MIL-T-22260.

MIL-A-24179 (SHIPS) ADHESIVE, FLEXIBLE UNICELLULAR-PLASTIC THERMAL INSULATION

Issue: 18 October 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding flexible unicellular plastic thermal insulation to itself and to metal surfaces.

CLASSIFICATION

The adhesive is available in three types.

Type I Dispersed in water
Type II Dispersed in nonchlorinated organic solvent
Type III Dispersed in nonflammable organic solvent

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. However, benzene is not used. Only Type I and II contain no chlorinated or other halogenated solvents.

PHYSICAL. The physical properties of the adhesive are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-24179 ADHESIVE

PROPERTY	TYPE		
	I	II	III
Flash point, °F, min (1)	1-10	60	NR
Fire point, °F, min (2)	200	NR	200
Viscosity, centipoises (2)	200-3000	200-3000	200-3000

(1) Fed Test Method Std No. 141, Method 4294.
(2) ASTM D1084, Method B.
NR = No Requirement

PROCESS. The adhesive is applied by brushing on one coat over zinc chromate (TT-P-645, Formula 84/47) primed steel and the plastic insulation (MIL-P-15280), air dried one hour, the joint closed within two hours and cured at room temperature under contact pressure. No curing time is given. The adhesive can be stored one year between 50 and 90 F in unopened containers.

PERFORMANCE. The adhesive, immediately after bonding sandwich specimens of zinc chromate primed steel (facings) and plastic foam (core), can sustain a tensile load of 10 psf during the the following environmental conditions applied sequentially (1) 168 hours at 100 F, (2) 24 hours at 160 F, (3) 24 hours at 20 F and (4) 168 hours in 100 F water. There is no displacement of the plastic

MIL-A-24179 (SHIPS) (Continued)

foam from the primed steel substrate during 16 hours at 50 F. Additionally, the adhesive will not corrode zinc chromate primed steel even after 168 hours exposure in 100 F water. Type II and III adhesives can also sustain at least a 30 psi tensile load immediately after bonding and 20 psi after aging the bonded specimens 7 days at 160 F (Fed Test Method Std No. 601, Method 4111).

FORM

The adhesive is available in commercial packages.

QPL

Yes.

NOTES

(1) Use Type I above 50 F where flammability or explosion hazards exist.

(2) Use Type II below 50 F and for prefabrication of parts in areas where fire protection is provided and the quantity of adhesive present is enforced.

(3) Use Type III where (toxic) halogenated solvents can be tolerated. This type presents little flammability and explosion risk.

(4) Types II and III have much shorter drying times than Type I before assembly.

MIL-T-38727 (USAF) TAPE, PRESSURE-SENSITIVE ADHESIVE, PROTECTIVE

Issue: 19 April 1965 Revision: None Amendment: None

SCOPE

This tape is intended for protecting polished or finished surfaces against scratching or marring during fabrication, storage, shipment and handling.

CLASSIFICATION

The tape is available in two types and two classes.

Type I Heavy duty, exterior, weather resistant
Type II Regular duty
Class 1 Exterior, weather resistant
Class 2 Interior

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-38727 TAPE

PROPERTY	TYPE I	TYPE II (1)
Thickness, in., min	0.013	0.0045
Tensile strength, lb/in., min (2)	20	10
Elongation, %, min	10	5

(1) Values are applicable to both Class 1 and 2. Type I tape does not have classes.
(2) Fed Test Method Std No. 147, Method 30.

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. The tape can be stored 6 months preferably in a cool location.

PERFORMANCE. The performance properties of the tape are given in Table II.

MIL-T-38727 (USAF) (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-T-38727 TAPE

PROPERTY	TYPE I	TYPE II	
		CLASS 1	CLASS 2
Tack, in., max (1)	6	6	12
Weathering resistance, hr (2) (4)			
Against metal (3)	300	200	NR
Against plastic (3)	200	150	NR
Temperature resistance (4) (5)			
Time, days	14	14	14
Temperature, °F	135	135	135

(1) The tape will stop a 1.0625 inch diameter steel ball weighing 80 grams after rolling down a right angle inclined plane (2-9/16 inch altitude and 6-3/4 inch base) within the distance specified.
(2) Fed Test Method Std No. 141, Method 6151.
(3) AISI 302 stainless steel and 2024 aluminum (QQ-A-250) are the metal substrates. Methyl methacrylate (MIL-P-8184, Finish A) is the plastics substrate.
(4) After exposure the tape does not separate, become tacky and can be removed without tearing or delaminating. Any adhesive residue can be removed with naphtha (P-D-680).
(5) During temperature aging, the adhered tape carries a flatwise compressive load of 1 psi.

FORM

The tape, unless otherwise specified, is available in 30 yard (Type I) and 100 yard (Type II) rolls wound on 3 inch diameter cores in 6, 12, 18, 24, 36 or 48 inch widths. Each roll may contain up to three splices.

QPL

Yes.

NOTES

(1) This tape is not intended for protecting surfaces against corrosion.

(2) Use tape within the protection periods given in Table III.

TABLE III. TIME LIMITS IN MONTHS FOR PROTECTING SURFACES (1).

	STORAGE	AGAINST METAL	AGAINST PLASTIC
Type I	External	9	6
	Internal	12	12
Type II			
Class 1	External	3	2
	Internal	12	12
Class 2	External	(2)	(2)
	Internal	12	12

(1) Tape may cure if left on the surface for periods longer than indicated. It may be removed from metals with methyl ethyl ketone or trichloroethylene; however, it cannot be removed from methyl methacrylate without sustaining surface damage.

(2) Do not use for external service.

MIL-T-43036 TAPE, PRESSURE-SENSITIVE ADHESIVE, PLASTIC FILM, FILAMENT REINFORCED (FOR SEALING FIBER CONTAINERS AND CANS)

Issue: 25 May 1965 Revision: A Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended to provide a moisture vapor tight seal for fiber containers, cans and slip cover metal containers over the temperature range -66 and 155F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a polyester film backing coated on one side with an unspecified adhesive containing longitudinal reinforcing filaments.

PHYSICAL. The physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-43036 TAPE

PROPERTY	VALUE
Thickness, in., max	0.0075
Tensile strength, lb/in., at 75 F, min	
Dry	50
Wet, 6 hr in 75 F water	50
Elongation, ultimate, %, at 75 F	20–35
Water penetration rate, gr/100 sq in./24 hr	
Under 1 inch water head, max	1.0
Water vapor transmission rate, gr/100 sq in./24 hr	
After 24 hr at 100 F and 90–95% RH, max	2.0

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. A force no greater than 3.0 lb/in. of width is needed to unwind the tape in the as received condition and no more than 4.0 lb/in. after the rolls are aged at 50 C and 80% RH. No adhesive is transferred to the backing, nor does the tape break during unwinding. The tape after aging does not distort more than ½ inch.

PERFORMANCE. The performance properties of the tape are given in Table II.

MIL-T-43036 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-T-43036 TAPE

PROPERTY	VALUE
Peel, oz/in., min (1)	
At 50 F	20
At 75 F	
Initial	30
After 10 days at 122 F and 80% RH	24
Creep in shear, hr, min (1) (2)	
At 75 F using 1000 gr/sq in. load	
Initial	24
Wet, 24 hr in 75 F water	24
At 155 F, using 100 gr/sq in. load	24
Stability, 10 days at °C (3)	71.7
Low temperature removal, °F (4)	–66
Waterproof (5)	Yes

(1) Type 302 or 304 stainless steel substrate (QQ-S-766).
(2) The tape and stainless steel joint holds the indicated shear load for the time given without more than 1/8 inch creep or slippage.
(3) No buckling, curling or lifting more than ¼ inch when adhered to fiberboard (MIL-C-2439 and MIL-C-3055).
(4) The tape does not break when stripped from fiber containers (MIL-C-2439 and MIL-C-3955).
(5) A taped, sealed metal can is sufficiently waterproof to prevent passage of water while submerged 15 minutes under a 1 inch head of 40 F water.

FORM

The tape, unless otherwise specified, is available in 60 and 240 yard rolls wound on 3 inch diameter cores in ½, ¾, 1, 1½ and 2 inch widths and in gray (Fed Std No. 595, Color No. 16251), black (17038) and light green (14491) colors.

QPL

No.

NOTES

(1) Store the tape in a cool place.

(2) The specification gives recommended procedures for application of the tape.

(3) The tape is suitable for sealing fiber containers (MIL-C-2439) and cans (MIL-C-3955).

MIL-A-43365 (GL) ADHESIVE (FOR REPAIR OF RADOME, AIR SUPPORTED)

Issue: 16 September 1965 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding vinyl coated nylon fabrics.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of 25 to 30% nitrile elastomer in an unspecified solvent.

PHYSICAL. The adhesive is a volatile, flammable, toxic liquid.

PROCESS. The adhesive is applied by brushing on four coats to one of the adherends, allowed to air dry 10 minutes between coats, the joint closed and cured by pressing with a household iron (set for cotton-wool) until the adhesive fuses. A Kraft paper liner is used between the iron and the adherends. Application of adhesive should be made in well ventilated areas.

PERFORMANCE. The performance properties of the adhesive are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-43365 ADHESIVE (1)

PROPERTY	VALUE
Shear, psi, at 70-90 F, min (2)	
Initial	40
After 2 weeks at 120 F (3)	40
Creep in shear, hr, at 70-90 F, min (4)	
5 min after bonding, 1 psi load	4
48 hr after bonding, 5 psi load	4
Peel, lb/in. at 70-90 F, min (5)	5

(1) All property values are based on vinyl coated nylon fabric (MIL-C-43086) adherends bonded face side to back side.

(2) CCC-T-191, Method 5102.

(3) The adhesive is aged in closed containers prior to bonding.

(4) The adherends do not slip more than 1/8 inch under the indicated load for the time specified.

(5) No more than 1/8 inch peelback occurs, 24 hours after bonding time, using Fed Test Method Std No. 175, Method 1041.1.

FORM

The adhesive is available in 1 pint containers.

MIL-A-43365 (GL) (Continued)

QPL

No.

NOTES

(1) This adhesive is suitable for hot patching air supported tents including those used for radomes.

MIL-A-46091 ADHESIVE, BRAKE LINING TO METALS

Issue: 16 July 1965 Revision: A Amendment: 1

SCOPE

This adhesive is intended for bonding brake linings to steel and aluminum where high frictional shearing forces are imposed.

CLASSIFICATION

The adhesive is available in two forms.

Form 1 Liquid
Form 2 Film

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. The film form is unsupported. Unspecified solvents and activators may be added.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is mixed with solvents and activators, if any, the liquid form applied by brushing and the tape form laid, the joint closed and cured at elevated temperature and pressure specified by the supplier.

PERFORMANCE. The adhesive has a disk shear strength at 75 F and at 400 F after 5 minutes of at least 350 psi using steel to steel (QQ-S-633, Grade 1020) and aluminum to aluminum (QQ-A-225/8) joints (SAE Recommended Practice J840). It further passes the axial shear strength test (ASTM D1205) at 75 F, and after (separately) 24 hours immersion in nonpetroleum base brake fluid (VV-B-680, MIL-H-13910 and MIL-H-46046), 24 hours in water and 5 minutes exposure to 400 F using brake lining (HH-L-361) to steel (QQ-S-698, Grade 1020) and aluminum (QQ-A-250/11) adherends.

FORM

The liquid and film adhesives are available in commercial packages.

QPL

No.

NOTES

(1) This adhesive is suitable for bonding clutch facings to metals.

MIL-T-81287(WP) TAPE, PRESSURE-SENSITIVE ADHESIVE, ALUMINUM FOIL BACKED, FOR HIGH TEMPERATURE APPLICATION

Issue: 2 July 1965 Revision: None Amendment: None

SCOPE

This tape is intended for use in repairing components subjected to temperatures ranging from 0 F to 700 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of an annealed temper aluminum foil coated on one side with a silicone adhesive.

PHYSICAL. The natural colored tape has a tensile strength of at least 15 lb/in. and a water vapor transmission rate of no more than 0.5 g/100 sq in./24 hr after 72 hr exposure to 100 F and 90-95% RH.

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. The tape is capable of being stored 1 year at 75 F and 50% RH in unopened containers.

PERFORMANCE. The performance properties of the tape are given in Table I.

MIL-T-81287 (WP) (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MIL-T-81287 TAPE

PROPERTY	VALUE
Peel, oz/in., min	
At 0 F, 2 hr	
To steel (1)	16
To backing	16
At 75 F	
Initial	
To steel (1)	16
To backing	16
After 4 hr at 700 F	
To steel (1)	12
Creep in shear, hr (1), (2)	
At 500 F, 100 gr/sq in. load	1
Corrosion (3)	
Steel (QQ-S-698)	None
Copper (QQ-C-576)	None
Aluminum (QQ-A-362)	None

(1) Corrosion resistant steel (QQ-S-766).
(2) The tape does not creep or slip more than 1/2 inch under the indicated load for the time specified.
(3) Test consists of 20 hours (tape-steel), 48 hours (tape-copper) and 68 hours (tape-aluminum) exposure to 120 F at 65% RH.

FORM

The tape is available in 36 and 60 yard rolls wound on 3 inch diameter cores in 1, 2 and 3 inch widths.

QPL

Yes.

NOTES

(1) The tape is suitable for repairing jet engine exhaust cones and tail pipe insulation blankets without the necessity for removal of damaged parts from the assemblies.

APPENDIX A

INDEX OF ADHESIVE BONDING SPECIFICATIONS

This index lists all of the new and revised specifications abstracted. Suffix letters following specifications numbers are not reproduced here but are shown in the individual abstract. Thus, for example, L-T-0075 (ARMY MO) is shown as L-T-0075.

APPENDIX B

INDEX OF CANCELED ADHESIVE BONDING SPECIFICATIONS

This index lists all of the adhesive material specifications canceled. The date shown is the cancelation date. Superseding specifications are given when applicable. The page number refers to the page in the original book where the specification is abstracted.

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CUMULATIVE INDICES

1. 1965-6 NEW and REVISED SPECIFICATIONS

The references are designated by a letter and a number. The letters J (June 1965), S (September 1965), D (December 1965) and M (March 1966) indicate the Supplement. The number indicates the page on which the reference is listed. Thus, D 10 is page 10 of the December supplement.

FEDERAL

MILITARY

AMERICAN DENTAL ASSOCIATION

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM C197-61	Diatomaceous silica thermal insulating cement. No QPL.	S 18
ASTM C358-58	Slag cement. No QPL.	J 25
ASTM C449-60T	Mineral fiber hydraulic-setting thermal insulating and finishing cement. No QPL.	S 18
ASTM D2181T-64	Vinyl acetate resin emulsion adhesive. No QPL.	S 32

AMERICAN STANDARDS ASSOCIATION

ASA A1.21-1963	Slag cement. No QPL.	J 25
ASA A66.1-1951	Keene's cement.	J 26
ASA Z93.8-1962	Dental zinc phosphate cement. No QPL.	J 22

2. 1965-6 CANCELED SPECIFICATIONS

This index lists all of the adhesive material specifications canceled. The date shown is the cancelation date. Superseding specifications are given when applicable. The page number refers to the page in the original book where the specification is abstracted.

3. 1965-6 SUBJECT INDEX

The references are designated by a letter and a number. The letters J (June 1965), S (September 1965), D (December 1965) and M (March 1966) indicate the Supplement. The number indicates the page on which the reference is listed. Thus, D 10 is page 10 of the December supplement.

KATZ

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE (SUPPLEMENTS).