ADHESIVE MATERIALS

Their Properties and Usage

IRVING KATZ
North American Aviation, Inc.
Downey, California

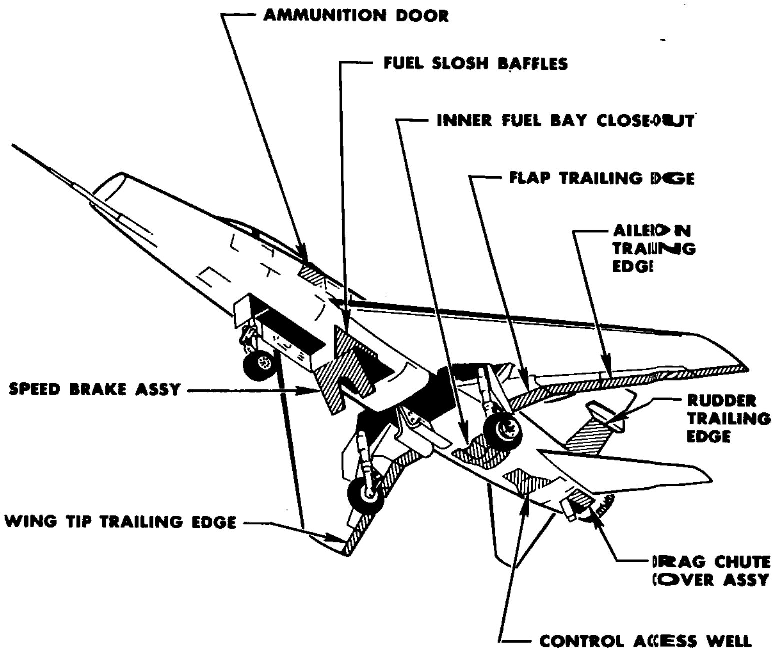
FOSTER PUBLISHING COMPANY
Long Beach, California

To Lucy, Philip, Laurie
Barbara, Morris and Elsie

ADHESIVE MATERIALS,
THEIR PROPERTIES AND USAGE

FOSTER PUBLISHING COMPANY
1602 PATTIZ AVENUE
LONG BEACH, CALIFORNIA 90815

ADHESIVE MATERIALS, THEIR PROPERTIES AND USAGE



Adhesive Bonded Components in Aircraft.

(Courtesy North American Aviation, Inc.)

PREFACE

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

ADHESIVE SELECTION

1. ANATOMY OF ADHESIVE BONDING

Adhesive bonding is a process for joining materials. It differs from most other joining techniques in that no contrivances are used to hold the components together such as in riveted or bolted joints.

Mechanics of Adhesion

Adhesives hold components, commonly called adherends or substrates, by both mechanical and chemical adhesion.

Mechanical adhesion is that component of the adhesive strength attributable to mechanical interlocking of the adhesive in the pores of the adherend. Porous substances such as paper and wood provide more porosity than metals or glass for the adhesive to gain entrance and lock the components together.

Chemical adhesion is that component of the adhesive strength attributable to either (1) primary bridging resulting from the chemical reaction between the adhesive and the adherend or (2) secondary bridging resulting from the residual electrical forces (polarity) surrounding the molecules. These residual forces, if properly oriented, cause mutual attraction between the adhesive and the adherend. When the molecules are small, these forces are usually insufficient for adhesive bonding. However, these forces become spectacular in their effect when the molecules are large, such as those of resins, the basic component of most adhesives. In fact, they may rival the strength achieved with the chemical reaction type joints. Little or no adhesion will occur when adhesives and adherend surfaces of dissimilar polarity are brought together. Table I lists the polarity of various adhesives and adherends.

Adhesive Bond Requirements

The ability of the adhesive to link up with the substrate fulfills only one of the two requirements for successful adhesive bonding. The other requirement is that the adhesive and substrate must have sufficient cohesive strength to transmit loads from one to the other. An assembled joint can fail in one of five places. These are by adhesive failure in the two adhesive-adherend interfaces or by cohesive failure within either the adhesive or two adherends. Destructive testing will cause failure in the weakest of the five links comprising the assembled joint.

TABLE I. POLARITY OF MATERIALS

Low Polarity	Medium Polarity	High Polarity
Metals	Metal oxides	Paper
Plastics	Plastics	Fabric
Polyethylene	Acrylics	Wood
Polypropylene	Epoxy	Plastics
Polyvinyl chloride	Polyvinylbutyral	Polyvinyl alcohol
Polytetrafluoroethylene (Teflon)	Polyvinyl acetate	Polyesters
	Rubber	Cellulose esters
Rubber	Nitriles	Urea
Natural	Polysulfides (Thiokol)	Melamine
SBR	Silicones	Nylon
		Natural adhesives
		Starch
		Casein
		Animal
		Dextrin
		Sodium silicate

Process Requirements

Special processing is required if both the adhesive and cohesive requirements are to be met. The adhesive requirement is fulfilled in part by the substrate treatment and in part by the conversion of the adhesive into a hardened mass. The cohesive rerequirement is met entirely by the proper conversion of the adhesive.

Adhesive Requirements

If an adhesive is to bond, it must touch the surface of the adherend. From the macroscopic viewpoint, contact is accomplished using pressure. The pressure forces the adherend surfaces into contact with the adhesive and eliminates voids caused by mismatched parts. There is, however, an upper limit to the amount of pressure which can be applied. Too much may squeeze the adhesive into pockets or even out of the joint. Pressures ranging between contact and 40 psi are commonly used. Certain wood adhesives use pressures up to 200 psi and certain vinyls up to 2000 psi.

From the microscopic viewpoint, pressure is not enough to insure contact between the adhesive and adherend. All surfaces are coated with dirt, oil and other contaminants. Solvent cleaning or degreasing removes these contaminants. However, for some materials such as metals, this is still not sufficient for intimate contact. The adhesives in contact with those materials tend to pull away from the substrate in much the same way that mercury balls up when placed on glass, although not to the same degree. An etching process which consists of treatment with strong oxidizing acids changes the character of the surface making it more compatible with the adhesive.

Unfortunately, the character of this altered (etched) surface is such that it is not stable for periods longer than 24 hours. Consequently, bonding must be made within this time period and preferably within eight hours. However, when manufacturing operations are such that bonding cannot be made within this period, a primer is placed over the activated surface and usually baked at temperatures above room temperature, but hardly ever at temperatures used to cure the adhesive. The primer is a dilute solution of the adhesive. Baking above room temperature hardens the primer but is not sufficient to reduce the chemical reactivity of the primer for the adhesive during the curing operation. Typical modified epoxy adhesives use primer baking temperatures of 150 F and primer-adhesive curing temperatures of 350 F. A baked primer requires only cleaning with solvent to remove oil, dirt and greases collected during storage prior to bonding.

Certain plastics such as Teflon, polyethylene, etc., are so nonpolar and chemically inert that an etching process is required to disrupt the chemical nature of the surface so that it will bond with nonpolar adhesives. Appendix A at the end of this book gives surface preparation procedures, including etching techniques commonly used in adhesive bonding.

Cohesive Requirements

The cohesive requirement and in part the adhesive requirement is achieved by converting the raw adhesive into a solid, hardened mass.

Adhesives are compounded from one of two basic types of material: thermoplastic and thermosetting. The thermoplastic variety softens under heat and, if sufficiently heated, will melt. Further, it is soluble in selected solvents. The thermosetting types harden (cure) under the action of heat and/or catalysts. Once hardened, they do not melt and are insoluble. Chapter 6 lists the currently available thermoplastic and thermosetting resins.

These thermoplastic and thermosetting adhesives are supplied basically in four types. These are (1) air drying, (2) pressure-sensitive tapes, (3) fusible, and (4) chemically reactive materials.

The air drying adhesives, predominantly thermoplastics, are converted to the solid state by evaporation of the solvent. They bond by mechanical and secondary bridging chemical adhesion. The adhesive is applied to the substrate, and, if necessary, baked or air dried for a short period of time to remove the solvent prior to closing the cleaned joint and then applying pressure for a suitable length of time.

The pressure-sensitive adhesives, predominantly thermoplastics, are supplied on a paper, plastic, etc., backing in tape form. They either require no moisture, heat or other preparation prior to or subsequent to application or are activated with water or solvent prior to application. These tapes also bond by mechanical and secondary bridging chemical adhesion. However, there are a few pressure-sensitive tapes containing thermosetting ingredients employed in electrical insulation applications which need heat curing to convert the resin portion into a more heat resistant material.

The fusible adhesives, predominantly thermoplastics, such as animal glues, are converted by melting, applying to the cleaned adherends, closing the joint and allowing to solidify (cool) under pressure. These fusible adhesives bond by mechanical and secondary bridging chemical adhesion.

The chemically reactive adhesives, predominantly thermosetting materials, are converted to the solid state by activating with catalyst and/or heat. They bond substantially by primary bridging and secondarily by mechanical and secondary bridging chemical adhesion. The adhesive is activated when necessary with a catalyst and applied to the cleaned substrate, the joint closed and cured at room or elevated temperature under pressure for a suitable length of time.

Process Restrictions

In the manufacture of a bonded part certain process restrictions are imposed. The major ones are the shelf life and working life of the adhesive.

Every adhesive has a certain shelf life. This is the period after manufacture that it remains usable. Air drying adhesives are usually stable indefinitely provided the solvent does not evaporate. The pressure-sensitive adhesives are essentially semiliquids available in different viscosities. However, with the passage of time the viscosity changes, altering the properties of the tape. These adhesives are usually stable from six months to two years dependent on type. The fusible adhesives are also stable for very long periods of time provided they are protected from moisture, loss of any residual solvent and against mold. The chemical reactive adhesives, if precatalyzed by the supplier, have very short shelf lives. Even with refrigeration they must be used within three months and some as soon as one month. Uncatalyzed, they are stable up to one year.

Working life starts from the period the adhesive is made ready for application to the point where the joint is closed. The air drying adhesives, once applied, vary in working life from minutes to a few hours, determined by the rate of evaporation of the solvent. The fusible adhesives, if animal base such as animal glue, have working lives ranging between 24 and 48 hours, which are reduced to less than one hour when applied to the open face joints. The other fusible adhesives vary considerably in working life, dependent on the type of adhesive. The pressure-sensitive adhesives which require no moisture, heat or other preparation have working lives essentially equivalent to their shelf life. Those that are activated with water or solvent have working lives in the order of minutes. The chemically reactive adhesives, once activated, range from minutes up to twelve hours. Those that are precatalyzed and returned to room temperature usually have slightly longer working lives.

In any bonding operation if the shelf life or working life of the adhesive is exceeded, inferior joints—or none at all—will be made.

Process controls are extensively covered by specifications for phenolic, resorcinol, melamine, urea and epoxy adhesives (References 1, 2, 3, 4). Further, there are specifications defining packaging of pressure-sensitive and gummed tapes.

Adhesive Selection

The choice of an adhesive is essentially an analytical process. It consists of (1) establishing what properties are necessary for the part, (2) determining the degree to which these properties are met by existing adhesives, and (3) choosing the optimum bonding material consistent with process and cost limitations.

The adhesives which deserve consideration for a particular application are described in Part I of this book; the properties of these adhesives in measurable specification terms are given in Part II. Thus, the reader defines his bonding problem, reviews Part I for applicable adhesives and then Part II for their properties. The ultimate choice is made using a trade-off between properties, process requirements and cost; the latter is provided by the supplier.

BIBLIOGRAPHY

Adhesive Bonding Process Controls

(1) MIL-A-5433 Adhesive, application of room-temperature and intermediate-temperature-setting resin (phenol, resorcinol and melamine base), 30 November 1954.
(2) MIL-A-5535 Adhesive, application of high-temperature-setting resin (phenol, melamine and resorcinol base), 12 March 1951.
(3) MIL-G-6803 Gluing, application of cold-setting resin (urea type), 25 July 1961.
(4) MIL-A-9067 Adhesive bonding, process and inspection requirements for, 16 March 1961.

Tape Packaging

(5) PPP-T-680 Tape, pressure-sensitive adhesive, packaging and packing of, 17 March 1960.
(6) PPP-T-681 Tape, gummed, packaging and packing of, 20 September 1962.

Typical Books On Adhesives

A. Primarily for Chemists and Formulators
B. Primarily for Adhesives Engineers

(7) "Adhesives and Sealants in Building". Building Research Institute, 1958. B.
(8) Berenbaum, M. G. "The Chemistry and Application of Polysulfide Polymers". Interscience Publishers, (In Press). A, B.
(9) Bergler, W. H., et al. "Structural Adhesives". Structural Adhesives Association, 1959. B.
(10) Bickerman, J. J. "The Science of Adhesive Joints". Academic Press, 1960. B.
(11) Bodner, M. J. "Symposium on Adhesives for Structural Applications". Interscience Publishers, 1961. B.
(12) Bogue, R. H. "The Chemistry and Technology of Gelatin and Glue". McGraw-Hill Book Company, 1922. A.
(13) Braude, F. "Adhesives". Chemical Publishing Company, 1943. A, B.
(14) Braulthecht, C. A. "Starch—Its Sources, Production and Uses". Reinhold Publishing Company, 1953. A, B.
(15) Buchan, S. "Rubber to Metal Bonding". London, Crosby, Lockwood and Son, 1960. A, B.
(16) Catton, N. L. "The Neoprenes, Principles of Compounding and Processing". E. I. duPont de Nemours and Company, 1953. A.
(17) Clark, J., et al. "Adhesion and Adhesives, Fundamentals and Practice". John Wiley and Sons, 1954. B.
(18) Davis, C. C., et al. "The Chemistry and Technology of Rubber". Reinhold Publishing Company, 1937. A.
(19) DeBruyne, N. A., et al. "Adhesion and Adhesives". Elsevier Publishing Company, 1951. A.
(20) DeBruyne, N. A., et al. "Structural Adhesives". London, Lange, Maxwell, Springer, 1952. B.
(21) Delmonte, J., et al. "The Technology of Adhesives". Reinhold Publishing Company, 1947. A.
(22) Dombrow, B. A. "Polyurethanes". Reinhold Publishing Company, 1957. B.

(23) Epstein, G. "Adhesive Bonding of Metals". Reinhold Publishing Company, 1954. B.
(24) Fisher, H. L. "The Chemistry of Natural and Synthetic Rubber". Reinhold Publishing Company, 1957. A.
(25) Guttman, W. H. "Concise Guide to Structural Adhesives". Reinhold Publishing Company, 1961. B.
(26) Hader, T. H. "Casein and Its Uses". Chemical Publishing Company, 1938. A.
(27) Hurd, J. "Adhesives Guide". London, Cable Printing and Publishing Company, Ltd., 1959. B.
(28) Kerr, R. W. "Chemistry and Industry of Starch". Academic Press, 1950. A.
(29) Knight, R. A. G. "Adhesives for Wood". Chemical Publishing Company, 1952. B.
(30) Lee, H. "Epoxy Resins". McGraw-Hill Book Company, 1957. A.
(31) McGregor, R. R. "Silicones and Their Uses". McGraw-Hill Book Company, 1954. A, B.
(32) McGuire, E. P. "American Adhesives Index". Padric Publishing Company, 1962. B.
(33) McGuire, E. P. "Packaging and Paper Converting Adhesives". Palmerton Publishing Company, Inc., 1963. A.
(34) Neuss, W. H. "Testing of Adhesives". Tappi Monograph No. 26, 1963. A, B.
(35) Newhall, R. C. "Metal to Metal Adhesives for the Assembly of Aircraft". Western Business Publications, 1955. B.
(36) Perry, H. A. "Adhesives for Reinforced Plastics". McGraw-Hill Book Company, 1954. B.
(37) Perry, T. D. "Modern Wood Adhesives". Pitman Publishing Company, 1944. A, B.
(38) Salzberg, H. K., et al. "Casein and Its Industrial Applications". Reinhold Publishing Company, 1961. A, B.
(39) Scherer, R. "Casein, Its Preparation and Technical Utilization". London, Scott, Greenwood and Son, 1921. A.
(40) Semon, W. L. "Synthetic Rubber". John Wiley and Sons, 1954. B.
(41) Skeist, I. "Epoxy Resins". Reinhold Publishing Company, 1958. A.
(42) Skeist, I. "Handbook of Adhesives". Reinhold Publishing Company, 1962. A, B.
(43) Stainsby, G. "Recent Advances in Gelatin and Glue Research". Pergamon Press, 1958. A.
(44) Standage, H. C. "Cements, Pastes, Glues and Gum", 1931. A, B.
(45) Tappi Monograph No. 22. "Synthetic and Protein Adhesives for Paper Coating", 1961. A.
(46) Whistler, R., et al. "Industrial Gums". Academic Press, 1959. A.
(47) Vail, J. G. "Soluble Silicates". Reinhold Publishing Company, 1952. A.

2. SPECIFICATION TECHNOLOGY

There are two types of documents used throughout industry to describe bonding materials. These are (1) specifications and (2) standards.

Specifications are essentially definitions covering the characteristics of the adhesive required for satisfactory performance in the intended bonding application. They define these characteristics in measurable terms, establish the limits of quality and uniformity which can be subsequently verified by testing, and distinguish between an acceptable and an unacceptable product.

Standards, on the other hand, limit the characteristics within specific ranges based on sound engineering experience. Standards cover forms, grades, types, sizes and test procedures. They are used to reduce costs, promote interchangeability and facilitate replacement of parts.

Bonding agents are described by Government, National, Industrial and International specifications and standards. However, the performance characteristics of bonding materials are covered predominantly by Government specifications, although occasionally some are released under the other designations. The National, Industrial and International documents are essentially standards concerning themselves primarily with testing procedures and with the limitation of forms, types, grades and sizes.

The Government documents are released as Federal and Military specifications and standards and as Commercial Standards and Simplified Practices Recommendations. National standards are released by organizations such as The American Standards Association, American Society for Testing and Materials, etc., for use by many industries. Industrial standards are released by organizations such as the National Association of Glue Manufacturers, Pressure Sensitive Tape Council, etc., generally for use by one industry. International standards are those developed by both American and foreign organizations to facilitate international trade. Names and addresses of standarization agencies are given in Table I.

TABLE I. STANDARDIZATION ORGANIZATIONS AND ADHESIVE MATERIALS SOCIETIES

Adhesives Manufacturers Association of America
441 Lexington Avenue
New York 17, N. Y.

American Dental Association
222 East Superior Street
Chicago 11, Illinois

American Standards Association
10 East 40th Street
New York 17, N. Y.

Building Research Institute
2101 Constitution Avenue
Washington 25, D. C.

Commodity Standards Division
U. S. Department of Commerce
Washington 25, D. C.

Defense Supply Agency
U. S. Department of Defense
Washington 25, D. C.

Federal Supply Service
General Services Administration
Washington 25, D. C.

Forest Products Research Society
417 North Walnut Street
Madison 5, Wisconsin

Gummed Industries Association, Inc.
415 Lexington Avenue
New York 17, N. Y.

National Association of Glue Manufacturers, Inc.
663 Fifth Avenue
New York 22, N. Y.

Packaging Institute, Inc.
342 Madison Avenue
New York 17, N. Y.

Pressure Sensitive Tape Council
1201 Waukegan Road
Glenview, Illinois

Research & Engineering Council of The Graphic Arts Industry, Inc.
411 K Street, N. W.
Washington 5, D. C.

Rubber and Plastic Adhesive and Sealant Manufacturers Council
159 North Dearborn Street
Chicago 1, Illinois

Society of Automotive Engineers
29 West 39th Street
New York, N. Y.

Society of Plastics Industry, Inc.
250 Park Avenue
New York 17, N. Y.

Technical Association of the Pulp and Paper Industry
360 Lexington Avenue
New York 17, N. Y.

Wallpaper Council, Inc.
509 Madison Avenue
New York 22, N. Y.

GOVERNMENT SPECIFICATIONS AND STANDARDS

Federal Specifications

Federal specifications are administered by the General Services Administration and are developed by either a civilian or military agency depending upon interest and requisite technical staff. The specifications after preparation are forwarded to other interested Government agencies for coordination and approval, whereupon they are released as Regular Federal Specifications.

Whenever there is an immediate need and insufficient time exists for processing through all interested departments, they may be released as Interim Federal Specifications by the particular agency prior to release as Regular Specifications.

At various times the availability of certain materials may become critical. The Government releases Emergency Specifications whose primary purpose is to conserve critical materials. These specifications do not modify or supersede the basic Federal specification but are released as an addition thereto, to be used as an alternate whenever feasible to effect conservation. Currently there are no Emergency Specifications covering bonding materials.

Federal specifications are designated by an identification system consisting of three parts. The first part is composed of from one to three capital letters identifying the Federal procurement group to which the item belongs (see Table II). The second part is a single letter which is the first letter of the title of the specification. The third part is the serial number determined by its alphabetical location within the procurement group. Thus, MMM-A-100 covers *Adhesive, Animal-Glue.*

Interim specifications are designated in the same manner as Regular Federal Specifications except two zeros precede the serial number and in parenthesis after the serial number is a code giving the assigned agency responsible for the development and maintenance of the specification and the preparing activity within the agency responsible for the actual development and preparation of the specification. Thus, MMM-A-00130 (GSA-FSS) covers *Adhesive, Contact* issued by the General Services Administration and prepared by the Federal Supply Service. Each Interim Federal Specification carries a preamble directly under the title which explains the significance of the specification. Further, when an Interim Specification supersedes an existing Regular Federal Specification it will be so stated in the preamble.

Emergency Specifications are also designated in the same manner as Regular Federal Specifications except one zero precedes the serial number. When an Emergency Specification is issued, a notice is published calling attention to the optional specification and the material which it intends to conserve. The notice carries the same symbol as the basic specification, and each notice is numbered consecutively using Arabic numbers.

TABLE II. FEDERAL SPECIFICATION PROCUREMENT GROUP DESIGNATIONS

A	Aircraft, Boats, and Ships	AA	Furniture	ZZ	Rubber and Rubber Goods
B	Animals	BB	Gases	AAA	Scales
C	Animal Products	CC	Generators and Motors	BBB	Suits and Uniforms
D	Arms (Small)	DD	Glass and Glassware	CCC	Textiles (Yardage)
E	Artillery	EE	Groceries	DDD	Textile Products
F	Boilers, Engines, and Tanks	FF	Hardware	EEE	Tobacco and Products
G	Books and Printed Matter	GG	Instruments	FFF	Toilet Articles
H	Brooms and Brushes	HH	Insulating Materials	GGG	Tools
J	Cable and Wire (Insulated)	JJ	Knit Goods, Netting and Webbing	HHH	Vegetables
K	Canvas Articles	KK	Leather and Leather Goods	JJJ	Vegetable Products
L	Cellulose Products and Synthetic Resins	LL	Livestock, Poultry and Marine Products	KKK	Vehicles
M	Ceramics	MM	Lumber and Timber	LLL	Wood Products
N	Cereals and Products	NN	Lumber Products	MMM	Adhesives
O	Chemicals	OO	Machinery	NNN	Laboratory Equipment and Supplies
P	Cleaning and Polishing Materials	PP	Meats and Sea Food	OOO	Reserved
Q	Coal and Products	QQ	Metals	PPP	Packaging and Packing
R	Coal Tar and Products	RR	Metal Products		
S	Cooking and Heating Apparatus Furnaces and Ovens (Nonelectrical)	SS	Minerals and Products (Nonmetallic)		
T	Cordage, Twine, and Products	TT	Paints, Pigments, Varnishes and Products		
U	Drugs and Medicines	UU	Paper and Products		
V	Dry Goods and Notions	VV	Petroleum and Products		
W	Electrical Apparatus	WW	Pipe, Pipe Fittings, Plumbing Fixtures, Tubes and Tubing (Metallic)		
X	Explosives	XX	Pumps		
Y	Fruits	YY	Recreational Articles		
Z	Fruit Products				

Source: "Index of Federal Specifications, Standards, and Handbooks". General Services Administration, Federal Supply Service, 1964.

Federal specifications are modified by amendments or by complete revisions. Amendments are used when only minor changes are made; each carries the specification symbol, the amendment number in Arabic numerals and the date. Only one amendment is in existence at any one time. Subsequent minor changes are made by superseding amendments; these include changes still in effect at the date of issue and are indicated by Arabic numerals.

Revisions of Federal specifications are made when significant changes are introduced. They are indicated by the addition of a letter a, b, c, etc., to the basic symbol.

Federal Standards

Federal standards covering bonding materials are limited to testing procedures, although occasionally they also define engineering and product standards. Bonding material test standards establish uniform test procedures for use by the Government, suppliers, and fabricators, in order to reduce rejections due to noncomparable test procedures. A typical test standard is Federal Test Method Standard No. 175, *Adhesive, Methods of Testing.*

Federal standards are identified by Arabic numerals and the date of issue. Interim Federal Standards contain a double zero before the serial number. The date of issue, change notice, amendment or revision is given in each document. Each revision is identified by a small letter and each change notice and amendment by an Arabic numeral. Only the change notice used to amend Federal standards, issued in loose leaf form, is not cumulative.

Military Specifications

Military specifications are administered by the Department of Defense. The Military specification is developed only by a Military department, and each is assigned a custodian from that department. The custodians may prepare the specification or have it assigned to a joint agency such as the Aeronautical Standards Group (ASG). Custodianships are shown on the last page of the specification as well as other agencies within the Military departments having an interest in the specification.

After preparation they are coordinated and approved by the interested departments and activities. These are called Coordinated Military Specifications; that is, they have been coordinated through the Army, Navy and Air Force. When an item is only of interest to one Military department or if insufficient time exists for prosecution through all interested Military departments, it can be released as a Limited Coordination Specification.

Military specifications are designated by an identification system also consisting of three parts. The first part MIL is an abbreviation for Military. The second part is a single capital letter which is the first letter of the title of the specification. The third part is the serial number. Thus, MIL-A-5540 covers *Adhesive, Polychloroprene.*

Limited Coordination Military Specifications are designated in the same manner as Coordinated Military Specifications but in addition carry a code in parenthesis immediately after the serial number giving the activity issuing the specification. Thus, MIL-A-18065 (SHIPS) covers *Adhesive, High Initial Bond* issued by the U S Navy, Bureau of Ships. If a Limited Coordination Specification becomes coordinated, the suffix is dropped.

Military specifications are modified in a manner similar to Federal specifications. Amendments for minor changes are indicated by Arabic numerals and the date of issuance. Revisions to Military specifications for major modifications are indicated by the use of a capital letter beginning with A and continuing in alphabetical sequence immediately following the basic serial number. The modifications supersede previous amendments and revisions.

Whenever a Military specification becomes obsolete and revision is delayed, a Limited Coordination Specification can be released to cover the necessary requirements. These specifications carry the same number as the basic specification except two zeros are placed in front of the serial number, and in addition a suffix in parenthesis after the serial number indicating the activity issuing the limited coordination change and the notation "Used in Lieu of" is added. Thus, MIL-C-002861B (SHIPS) covers *Cement, Insulation, High Temperature* issued by the U S Navy, Bureau of Ships to be used in lieu of MIL-C-2861A.

There are some military specifications which have not been converted as yet to the MIL designation. They carry the obsolete identification symbols such as JAN, USAF, U S ARMY, U S NAVY, etc.

Military Standards

Military standards, like Federal standards, are issued to eliminate waste and improve efficiency in operations. They define the characteristic limitations applying to bonding materials and test methods.

Military standards are designated by the symbols MIL-STD and MS depending upon the manner in which they are released. MIL-STD standards are released in book form and MS standards in sheet form.

Military standards are further classified into Coordinated Standards and Limited Coordinations Standards. The Coordinated Standards, like Military specifications, have been concurred in by all interested activities. The Limited Coordination Standard is issued by one department to satisfy an immediate need for covering an area unique to the single department.

The Coordinated Standards are designated by the symbol reflecting the type of standard, an Arabic numeral, and the issue date. The Limited Coordination Standard also carries a code identifying the issuing activity. Typical examples of coordinated standards are (1) MIL-STD-401, *Sandwich Constructions and Core Materials; General Test Methods* and (2) MS 16698, *Tape, Pressure-Sensitive Ad-*

hesive. A typical Limited Coordination Standard is MS 35500(CE), *Cement, Neoprene, Vulcanizing.*

Military standards are changed by either complete revisions or revised pages. Revisions are indicated by the addition of a capital letter to the serial number and revised pages by the date of revision.

Qualified Products List

For certain Government specifications, lists of products are released when (1) the nature of time consuming tests would cause an undue delay in the delivery of the product, or (2) where the unsatisfactory performance of the product may endanger lives. This procedure is known as qualification testing.

All Government specifications which require qualification testing indicate this requirement. Section 3 of the specification will contain a statement, usually in paragraph 3.1, that the product to be supplied should have been tested and passed the qualification tests. Section 4 will describe the tests to be made. Section 6 will contain a statement that the right is reserved to reject bids on products which have not been tested for inclusion on the Qualified Products List. The name and address of the activity to be contacted to arrange for qualification testing is also given.

The Qualified Products List contains a designation of the product, the supplier's name and address, including the address of the plant from which the sample was submitted, the laboratory performing the test and the test report number.

Qualified Products Lists are designated by the symbol QPL followed by the number of the associated specification and an Arabic number to identify the issue of the list. Thus, QPL-PPP-T-76 is the list associated with Federal Specification PPP-T-76, *Tape, Pressure-Sensitive Adhesive Paper Water Resistant* and QPL 5090 is the list associated with Military Specification MIL-A-5090, *Adhesives, Heat Resistant, Airframe Structural, Metal to Metal.*

Qualified Products Lists are modified by complete revisions or amendments. A revision constitutes the issuance of a new list and is identified by a succeding suffix number: QPL-PPP-T-76-3 is the revision of QPL-PPP-T-76-2. An amendment consists of the addition of sheets containing only the changed listing. The amendments are identified by date and number, are cumulative and supersede previous amendments.

Government Indexes

Federal and Military specifications and standards are catalogued into two indexes. The *Index of Federal Specifications, Standards and Handbooks* is a complete listing of all Federal specifications and standards issued under the jurisdiction of the General Services Administration. It also includes a select number of Military specifications and standards used by Federal agencies and is issued once a year. Supplements containing new specifications are released on a monthly basis.

Military specifications and standards are catalogued into the Department of Defense *Index of Specifications and Standards.* It consists of three parts. These are the alphabetical, numerical and Federal Supply Classification (FSC) Listing indexes. The latter is used to group together similar products. FSC No. 8040 is used for adhesives.

Each volume of the Military index is published annually with cumulative supplements appearing bimonthly.

The Federal index and the Military index are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., on a modest subscription basis.

Federal specifications and standards can also be purchased from the Superintendent of Documents. The purchase price is given in the index. Copies of individual Military specifications and standards can be obtained from Naval Supply Depot, 5801 Tabor Ave., Philadelphia, Pennsylvania, Attn: Code DCI.

Commercial Standards and Simplified Practices Recommendations

Commercial Standards and Simplified Practices Recommendations are administered by the Commodity Standards Division of the Department of Commerce. These Standards and Practices are developed through coordinated efforts of the Commodity Standards Division, suppliers, consumers and testing laboratories.

Commercial standards are developed to establish a common groundwork and clear understanding between buyers and sellers concerning (1) terminology, (2) types, sizes, forms and grades of materials and products, (3) testing methods and (4) end use characteristics. One of the distinct advantages of preparing a Commercial Standard is that industry itself writes its own specification. When a majority of the concerned organizations approves the standard, it becomes official. Once promulgated, an industrial committee is chosen to maintain the standard. A product conforming to a Commercial Standard may be labeled accordingly including the use of a hallmark, if any.

Commercial Standards are designated by a three part identification system. The first part is the symbol CS, an abbreviation of Commercial Standard, the second part the serial number and the third part, the year in which the specification is released or last revised. Thus, CS 181-52 covers *Water-Resistant Organic Adhesive for Installation of Clay Tile.*

Minor revisions are made by means of amendments starting with number 1. These amendments are added immediately after the designation.

Simplified Practice Recommendations are developed to eliminate superfluous varieties, sizes, types and grades of materials. They are also designated by a three part coding system. The first part is the symbol R, the second part by the serial number, and the third part by the date of issue or the last revision. Thus, R 85-52 covers *Adhesive Plaster.*

No Qualified Products Lists are made for either Commercial Standards or Simplified Practice Recommendations; however, the documents do list adhesive suppliers assisting in preparation of the documents.

Commercial Standards and Simplified Practices Recommendations are tabulated in Catalog No. 978 and Catalog No. 979, respectively. Both are available from the Commodity Standards Division, U S Department of Commerce, Washington 25, D. C. The index lists the sale price of each standard or recommendation which is generally available from the Superintendent of Documents.

NATIONAL SPECIFICATIONS AND STANDARDS

American Standards Association

This association is a federation of trade organizations, technical societies, professional groups, consumer agencies, and many companies, founded in 1918 for the purpose of clearing and coordinating standards on a national level. It processes standards on practically every conceivable subject and is recognized as a standardizing agency on an international level.

To be qualified as an American Standard, a standard must have been accepted and approved by all groups, organizations, and agencies within the American Standards Association concerned with the scope and provisions of the standard. It is a voluntary standard for use by industry but is sometimes adopted for mandatory use by a Government agency.

American Standards are prepared by either adoption of existing standards promulgated by other organizations or by development through Section Committees in areas where a need for standards is demonstrated. Existing standards such as those of the American Society for Testing Materials, National Electrical Manufacturers Association, etc., are submitted to the American Standards Association for approval. If approved, the standard is given an ASA designation; however, it also retains its original title and numerical designation.

American Standards Association standards are designated by a five part identification system. The first part ASA is an abbreviation of the organization's name. The second part is the project letter(s) of the field within which the standard is catalogued (see Table III). The third part is the class number designating a specific group of materials within the indicated field. The fourth part is the serial number for a specific material. The fifth part is the year of issue or latest revision. Thus, ASTM specification ASTM D119-57T, *Rubber Insulating Tape* which has become an ASA standard is designated ASA C59.6-1958. A detailed breakdown of code numbers for the standards is found in the American Standards Association Index of Standards.

TABLE III. DESIGNATION SYSTEM FOR AMERICAN STANDARDS ASSOCIATION

FIELD	PROJECT LETTER
Acoustics, Vibration, Mechanical Shock, and Sound Recording	S
Automotive	D
Chemical Industry	K
Civil Engineering and Construction	A
Commercial Standards	CS
Drawing Symbols and Abbreviations	Y
Electrical Engineering	C
Ferrous Metals and Metallurgy	G
Gas Burning Appliances	Z21
Materials Handling	MH
Mechanical Engineering	B
Mining	M
Miscellaneous	Z
Nonferrous Materials and Metallurgy	H
Nuclear	N
Office Equipment and Supplies	X
Petroleum Products	Z11
Photography and Motion Pictures	PH
Pulp and Paper Industry	P
Rubber	J
Textile Industry	L
Thermal Insulating Materials	Z98
Wood Industry	O

Source: "Catalog of American Standards." American Standards Association. 1964.

American Society for Testing and Materials

This society, commonly referred to by the symbol ASTM, develops specifications and standards for materials, test procedures, definitions, forms, charts, tables and practices. The standards are national in scope and have achieved significance in international trade.

ASTM specifications and standards are developed by committees of specialists, such as ASTM Committee D-14 for Adhesives, drawn from persons identified with user interests, manufacturer interests and (neutral) general interests. Prior to adoption these documents are issued as Tentative Specifications and Standards. They represent the latest thinking and practice on the subject covered.

After adoption they are identified formally as an ASTM specification or standard.

ASTM standards are designated by a four part identification system. The first part ASTM is an abbreviation of American Society for Testing and Materials. The second part consists of a capital letter drawn from A through F (see Table IV) to indicate the type of material or nature of the standard. The third part is the serial number. The fourth part is the last two numbers of the year during which the standard is released or the year of the last revision. Thus, ASTM D907-60 covers *Definition of Terms Relating to Adhesives* released in 1960.

TABLE IV. DESIGNATION SYSTEM FOR ASTM SPECIFICATIONS AND STANDARDS.

A	Ferrous Metals
B	Nonferrous Metals
C	Cementatious, Ceramic, Concrete and Masonry Materials
D	Miscellaneous Materials
E	General Testing Methods and Definitions
F	Materials for Specific Applications

Source: "ASTM Standards." American Society for Testing and Materials. 1961.

Tentative specifications are designated in a manner similar to regular ASTM specifications and standards, except that they carry the capital letter T after the code number. Thus, ASTM D1002-53T covers *Test for Strength Properties of Adhesives in Shear by Tensile Loading* released in 1953.

Society of Automotive Engineers

This association, commonly referred to as SAE, issues six types of documents covering materials, fittings, equipment and recommended practices. These documents constitute (1) SAE Standards, (2) SAE Recommended Practices, (3) Aeronautical Material Specifications, (4) Aeronautical Standards, (5) Aeronautical Recommended Practices and (6) Aeronautical Information Reports.

SAE Standards and Recommended Practices are developed for use by the automotive industry but are commonly used by other industries. The SAE Standards are based on established engineering practices and the Recommended Practices on accepted engineering principles which are used as guides towards simplified engineering procedures. SAE Standards and Recommended Practices are published in the annual SAE Handbook. SAE Standards and Recommended Practices are designated by a two part system consisting of the symbol SAE and a serial number. These documents do not currently cover bonding materials.

Aeronautical Material Specifications, Standards, Recommended Practices and Informational Reports are released by the SAE for use by the Aeronautical industry. These are also widely used by many other industries. Aeronautical Materials Specifications cover materials and processes based on established metallurgical and nonmetallic practices in the aircraft industry.

Aeronautical Material Specifications are designated by a two part identification system. The first part is the symbol AMS and the second part the serial number consisting of four numerals. Thus AMS 3690 covers *Adhesive Compound, Epoxy, Room Temperature Curing.* Revisions are designated by the addition of a capital letter, beginning with A, after the serial number.

Aeronautical standards cover (1) design standards conforming with established engineering practices in the aircraft industry, (2) parts standards conforming with established engineering practices in the engine, propeller, accessory equipment of aircraft and (3) other aeronautical specifications that do not fall within the AMS category. They are designated by a two part identification system. The first part is the symbol AS and the second part the serial number.

Aeronautical Recommended Practices are dimensional designs or performance characteristics based on engineering practices used in the aircraft industry. They are intended for use as guides towards standardization of engineering practices. These documents are designated also by a two part identification system. The first part is the symbol ARP and the second part the serial number.

Aeronautical Information Reports are used to disseminate data which do not lend themselves to the SAE classification system. These reports are designated again by a two part identification system. The first part is the symbol AIR and the second part the serial number.

Society of the Plastics Industry

This society, commonly referred to as SPI, is a federation of suppliers, consumers and professional groups concerned with plastics and adhesives. Their activities deal with the development of quality standards, research and other matters of interest. These are compiled in the SPI Handbook. This handbook contains detailed information on practically all subjects of interest to the plastics industry including bonding agents for plastics as well as voluntary standards for plastics materials and fabricated products. These voluntary standards are promulgated by the Standards Division of the U S Department of Commerce.

The SPI, through its Epoxy Resin Formulators Division, releases standards for the testing of adhesive materials. These are designated by a three part identification system. The first ERF is an abbreviation of the division's name. The second part is the serial number. The third part is the last two numbers of the year during which the standard is released. Thus, ERF 4-62 covers *Method of Test for Long-Time Creep of Epoxy Compounds* released in 1962.

INDUSTRY SPECIFICATIONS AND STANDARDS

American Dental Association

This association is a federation of technical personnel serving the dental profession. It prepares specifications covering dental materials and cements. These specifications are designated by a two part identification system. The first part ADA is an abbreviation of the association's name. The second part is the serial number. Thus, ADA 8 covers *Dental Zinc Phosphate Cement.*

Products submitted for conformance to ADA specifications are tested at the National Bureau of Standards. If the product meets the requirements of the specification, the trade name and supplier's name are published in the *Journal of the American Dental Association.*

Adhesives Manufacturers Association of America

This association, commonly referred to as AMA, is a federation of adhesive manufacturers. It does not engage in specifications and standardization. The association, however, has published two bulletins on adhesives for food packaging applications.

Building Research Institute

This institute, commonly referred to as BRI, is an association of suppliers and technical personnel serving the building trades. It does not release specifications and standards. However, its Committee on Adhesives and Sealants has prepared a number of texts covering symposiums on adhesives, sealants, foams and sandwich construction for building applications.

Forest Products Research Society

This society is an association of technical personnel serving the wood products industry, including activities with adhesives for these products. It does not release specifications or standards but does publish the *Forest Products Journal* in which adhesive developments are reported.

The Gummed Industries Association

This association is a federation of manufacturers of adhesive tapes and label papers. It does not release specifications or standards. It does, however, cooperate with the U S Department of Commerce on the preparation of Simplified Practice Recommendations such as R114-63 covering *Gummed Kraft Paper Sealing Tape* released in 1963.

National Association of Glue Manufacturers

This association is a federation of basic manufacturers of animal glue. It has prepared standards specifically for the sampling and testing of these glues. These standards are designated by title only.

Packaging Institute

The Packaging Institute, commonly referred to as PI, is a federation of technical personnel and organizations serving the packaging industry. It does not release specifications or standards. The Institute, however, carries on symposiums covering the testing and evaluation of packaging adhesives as well as publishing a monograph on carton adhesives.

Pressure Sensitive Tape Council

This council is an association of adhesive tape manufacturers. It prepares standards for the testing of adhesive tapes. These standards are designated by a two part identification system. The first part PSTC is an abbreviation of the council's name. The second part is the serial number. Thus, PSTC-1 covers *180° Peel Adhesion.* Revisions are indicated by the date change only. Tentative standards are designated similar to PSTC standards, except that they carry the word tentative after the code number.

Research and Engineering Council of the Graphic Arts Industry

This council is an association of technical personnel and organizations serving the graphic arts industry. It does not release specifications or standards. The association, however, has published a text covering a symposium on adhesives for printing applications.

Rubber and Plastic Adhesive and Sealant Manufacturers Council

This council is an association of adhesive and sealant manufacturers. It releases product standards covering dry wall, ceramic tile, building trades and contact bond adhesives. A Hallmark program has been established to provide identification of products of assured quality to guide industry in the buying and use of adhesives.

Technical Association of the Pulp and Paper Industry

This association is a federation of suppliers and technical personnel serving the pulp and paper industry. It releases two types of documents: standards and routine control methods, both covering the testing of adhesives. The standards are designated by a four part identification system. The first part is the symbol T, the second part the serial number, the third part one of the symbols os (official standard), ts (tentative standard), or sm (suggested method) and the fourth part the last two numbers of the year in which the standard was released. Thus, T-463 os-60 covers *Adhesiveness of Gummed Paper Tape* released in 1960. The routine control methods are designated by a two part identification system. The first part is the symbol RC and the second part the serial number. Thus, RC 272 covers *Bonding Strength of Adhesives on Flexible Adherends.*

Additionally, the association has released a monograph on test methods oriented towards specific adhesive materials such as animal glue, casein, etc., as well as monographs covering symposiums on protein and synthetic adhesives.

Wallpaper Council

The council is an association of wallpaper manufacturers. It does not release specifications covering adhesives. It does, however, cooperate with the U S Department of Commerce in the preparation and release of Commercial Standards. Additionally, through its Standards Committee, it determines the need and application of standards for its member manufacturers.

INTERNATIONAL SPECIFICATIONS AND STANDARDS

International Organization for Standardization

This organization, commonly referred to as ISO, consists of national standardizing agencies located throughout the world. It is affiliated with the American Standards Association. The ISO acts in a consulting capacity to its members in accordance with a nation's interest in a given project field.

The ISO recommendations are designated by a three part identification system. The first part is the symbol R, the second part the serial number and the third part the year in which the recommendation was released. Thus, R36-1957 covers *Determination of the Adhesion of Vulcanized Natural or Synthetic Rubbers to Textile Fabrics* released in 1957.

International Electrotechnical Commission

This commission, commonly referred to as IEC, was founded in 1904. However, since 1947 it has been affiliated with the ISO as a technical division. The IEC coordinates and unifies practices on electrical products including materials and further assists in the coordination of activities of other international organizations.

The IEC recommendations are designated by a two part identification system. The first part is the symbol IEC and the second part the serial number. Thus, IEC 85 covers *Recommendations for the Classification of Materials, for the Insulation of Electrical Machinery and Apparatus in Relation to Their Thermal Stability in Service.*

Pan American Standards Organization

This organization has been recently formed to facilitate trade among the Pan American Nations. It operates in a similar fashion to other international standardizing agencies.

BIBLIOGRAPHY

1. "Adhesive Council Sets Long Range Programs." Adhesive Age, December 1961.
2. "Adhesive and Sealant Council, Scope and Objectives of Committees." Rubber and Plastic Adhesive and Sealant Manufacturers Council, December 1962.
3. Booth, S. F. "Standardization Activities in the United States." U. S. Department of Commerce. Miscellaneous Publication 236, 1960.
4. "By-Laws." Research and Engineering Council of the Graphic Arts Industry, Inc., December 1960.
5. "Catalog of American Standards." American Standards Association, Inc., 1964.
6. "Commercial Standards." Catalog No. 978. U. S. Department of Commerce, 1964.
7. "Current Publication List of the Packaging Institute." Packaging Institute, 1962.
8. "Forest Products Research Society." Forest Products Research Society, 1963.
9. "Guide to Dental Materials." American Dental Association, 1964.
10. Haskin, M. P. "How the Government Buys." Materials and Methods.
    Part 1, "Federal and Military Specifications." February 1954.
    Part 2, "Qualified Products Lists." March 1954.
    Part 3, "Military and Federal Standards." April 1954.
11. "How American Standards Are Made." American Standards Association, Inc. PM 156.
12. "Index of Federal Specifications, Standards, and Handbooks." General Services Administration. Issued annually.
13. "Index of Specifications and Standards." Department of Defense. Issued annually.
14. "Index of Standards and Suggested Methods." Technical Association of the Pulp and Paper Industry, 1963.
15. Kaidanovsky, S. P. "Guide to Materials Standards and Specifications."
    Part 1, "Government and National Standards." March 1958.
    Part 2, "Iron and Steels." April 1958.
    Part 3, "Non Ferrous Metals." May 1958.
    Part 4, "Plastics and Rubber." June 1958.
    Part 5, "Nonmetallics." July 1958.
    Part 6, "Finishes and Coatings." August 1958.
16. MacNiece, E. H. "Industrial Specifications." John Wiley, 1953.
17. Melnitsky, B. "Profiting from Industrial Standardization." Conover-Mast Publications, 1953.
18. "Pressure Sensitive Tape Council's Aims and Objectives." Pressure Sensitive Tape Council, 1963.
19. Private Communication. Adhesives Manufacturers Association of America, 1963.
20. Private Communication. The Gummed Industries Association, Inc., 1963.
21. Private Communication. National Association of Glue Manufacturers, Inc., 1963.
22. Private Communication. Wallpaper Council, Inc., 1963.
23. "Publications, 1963-64." Building Research Institute, 1963.
24. "Simplified Practice Recommendations." Catalog No. 979. U. S. Department of Commerce, 1964.
25. "Society of Automotive Engineers Handbook." Society of Automotive Engineers, Inc. Issued annually.

26. Society of the Plastics Industry, Inc. "Plastics Engineering Handbook." Reinhold Publishing Company, 1960.
27. "Specifications and Standards of Nongovernment Organizations." ANA Bulletin No. 147, February 1962.
28. "Specifications and Standards, Use of." ANA Bulletin No. 143, September 1958.
29. "ASTM Standards." American Society for Testing and Materials, Inc., 1961.
30. "The ASA System." American Standards Association, Inc. PN 125a.
31. "U. S. Government Purchasing and Specifications Directory." Small Business Administration, 1963.

3. PAPER AND FABRIC ADHESIVES

Paper and fabric are extensively converted into useful products by adhesive bonding. These products range from simple glued paper assemblies to complex structures such as pontoons and aircraft balloons. Adhesives for these paper and fabric base products fall into three general categories. These are (1) paper assembly, (2) fabric assembly and (3) packaging and labeling adhesives. The latter are covered in Chapter 9.

PAPER ASSEMBLY ADHESIVES

These bonding materials are conveniently catalogued into temporary, straight paper assembly and mixed paper assembly adhesives.

Temporary Adhesives

These adhesives are intended for holding paper products together for short periods of time, such as in drafting room operations. They are supplied as pressure-sensitive paper tapes, which provide sufficient strength during assembly but can be easily removed by peeling without tearing the substrate (Reference 1).

Straight Paper Assembly Adhesives

These adhesives are intended for general purpose bonding of paper. They are available in water-remoistenable, paste, liquid and solid varieties; each offers specific advantages.

Water-Remoistenable Adhesives. These are available as gummed tapes. They are easily applied without any processing other than wetting the surface. None of them are suitable for applications subject to continuous high humidity or immersion in water. Two general classes are available: one for preparing the tapes and the other for the finished tapes. Gum arabic and gum tragacanth are two of a number of adhesives used for the preparation of the finished tape.

Gum arabic, employed predominantly for postage stamps and labels, is also used occasionally in the liquid state (Reference 2). It provides good resistance to blocking (sticking together) caused by high humidity. Gum tragacanth, because of its brittle nature, is compounded with plasticizers prior to preparation of the tape (Reference 3). However, it finds more use as an antiblocking agent with other water-remoistenable adhesives and as a thickening agent for starch and protein adhesives.

The gummed tapes in die-punched shapes are used for reinforcing punched holes of loose leaf sheets (Reference 4) and in transparent or opaque cloth and transparent paper tapes for mending and reinforcing paper (Reference 5).

Liquid Adhesives. These are ready-to-use materials which bond after evaporation of the organic or water solvent. The organic solvent base products are water resistant. Rubber cements containing flammable organic solvents bond paper without wrinkling, curling or shrinking the stock (References 6, 7). Further, they can be removed when dried by rubbing off without any discoloration of the paper substrate. Mucilage, containing water as a solvent, is a moderately quick setting adhesive but may induce some untoward wrinkling (Reference 8). It is mold resistant because of added preservatives.

Paste Adhesives. These are similar to the liquid adhesives in that they are ready to use and bond after evaporation of the small amount of solvent used in the formulation. They are not as readily applied, but do not cockle, wrinkle or warp paper despite the presence of water as the solvent. The paste, dependent upon type, may have its brushing qualities improved by small additions of water (Reference 9).

Solid Adhesives. These require preparation of a solution prior to use. Rosin, however, can also be used as a hot melt adhesive provided special processing equipment is available (Reference 10). When used as a hot melt, almost instantaneous bonding can be achieved. This adhesive has good water resistance but poor resistance to organic solvents.

Mixed Paper Assembly Adhesives

These adhesives are compounded to adhere paper primarily to other materials and secondarily to other paper stock. They are available in liquid and solid varieties.

The liquid adhesives, like the aforementioned straight paper assembly liquid adhesives, are ready-to-use materials and bond upon evaporation of the solvent. Cellulose nitrate, known as the original *household* cement, is suited for bonding paper, fabrics, glass, leather, metals and some plastics giving water resistant joints (References 11, 12). The vinyl adhesives bond the same materials as do the cellulosic counterparts but without any of their flammability hazards; however, they do not give the same moisture resistance (References 13, 14).

The solid adhesives, such as powdered starch, require preparation of a solution in water prior to use. They can bond paper to cloth. This starch adhesive will hold paper-cloth components together despite impact from bullets when used as targets (Reference 15). They are not water resistant.

FABRIC ASSEMBLY ADHESIVES

These bonding materials are designated as straight fabric, coated fabric and mixed fabric assembly adhesives.

Straight Fabric Assembly Adhesives

These adhesives are intended for general purpose bonding of fabric assemblies ranging from construction of tents to repair of bed linen. They are available in liquid and tape form.

These liquid adhesives are also ready-to-use materials which bond after evaporation of the organic solvent. Nitrile rubber cements provide flexible joints which are resistant to water and temperatures as high as 160 F (Reference 16). They are suitable for applications subject to severe outdoor exposure such as patching of tents.

The tape adhesives provide ready application of the bonding material to the fabric assembly joints. Nitrile rubber cemented tape, analogous to the aforementioned liquid nitrile cements, gives identical shear properties but approximately ½ the peel strength (Reference 17). It is suitable for manufacturing tent seams, reinforcing panels and stress distribution patches. Thermoplastic resin impregnated cotton tapes are used to repair fabrics, especially bed linen, by merely ironing on the tape directly over the area to be repaired (Reference 18). The patch can sustain laundering in hot water.

Coated Fabric Adhesives

Fabrics for certain applications are coated with vinyl resins or rubber to provide better resistance to water, weathering and handling. Liquid adhesives are specifically compounded for these coated materials.

Vinyl coated fabrics can be bonded with polyvinyl chloride (Reference 19), synthetic rubber (Reference 19), vinyl-phenolic modified rubber (Reference 20) and vinyl modified rubber (Reference 21) base adhesives. They are all room temperature curing and resistant to water.

Neoprene coated fabrics are bonded with neoprene adhesives which, dependent on type, are either room temperature or elevated temperature curing (Reference 22). These adhesives are suitable for the manufacture and repair of life vests, pontoons and other life saving equipment used in water.

Other rubber coated fabrics can be bonded with room temperature curing natural rubber base adhesives (Reference 23). They are also suitable for aircraft balloons and for life saving equipment used in water.

Mixed Fabric Assembly Adhesives

Many of the mixed paper assembly adhesives such as cellulose nitrate (References 11, 12), vinyl (References 13, 14) and starch

(Reference 15) previously discussed, are suitable for mixed fabric assemblies. In addition, there are others compounded specifically for mixed fabric assemblies. They are all ready-to-use liquids.

Oleoresins are suitable for bonding cotton fabric to wood which will be used in water for such things as floats and boat hulls (Reference 24). The adhesive prevents migration of dilute salt water into the assembly.

Nitrile rubber adhesives are used for bonding fabric to synthetic rubber, plastics and metals giving flexible joints having good resistance to lubricating oils and some resistance to aromatic fuels (Reference 25).

Adhesives offering specific environmental resistance characteristics are available for bonding plain, plastic and rubber coated fabrics to a multitude of materials. The first is suitable for joints subject to air, water or oil exposure (Reference 26). The second, dependent on type, is also suitable for gasoline exposure (Reference 27). The third is specifically for applications where contact with aromatic fluids is expected (Reference 28). None of these adhesives should be used for manufacturing or repairing life saving equipment. In these cases use the aforementioned neoprene and natural rubber adhesives (References 22, 23).

BIBLIOGRAPHY

Paper Assembly Adhesives

Temporary

(1) UU-T-93 Tape, pressure-sensitive adhesive, paper, drafting, 14 October 1960. No QPL.

Straight Paper Assemblies

(2) JJJ-A-20 Acacia, technical (gum arabic), 24 January 1958. No QPL.
(3) JAN-G-96 Gum tragacanth (for use in ammunition), 25 October 1944. No QPL.
(4) UU-R-196 Reinforcements, gummed (cloth), 20 February 1952. No QPL.
(5) UU-T-101 Tape, gummed; mending and reinforcing (paper and cloth), 18 June 1959. No QPL.
(6) ZZ-C-191 Cement; rubber (artists' and photographers' and cold patching), 10 December 1959. No QPL.
(7) MMM-A-00185 Adhesive, rubber (for paper bonding), 22 January 1963. No QPL.
(8) MMM-M-792 Mucilage, 15 January 1960. No QPL.
(9) MMM-M-177 Adhesive, paste, office and photomounting, 21 January 1964. No QPL.
(10) LLL-R-626 Rosin, gum; rosin, wood; and rosin, tall oil, 21 May 1957. No QPL.

Mixed Paper Assemblies

(11) MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.
(12) MIL-A-11238 Adhesive, cellulose nitrate (ordnance use), 18 September 1962. No QPL.

(13) MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 1 July 1963. No QPL.
(14) MIL-C-18726 Cement, vinyl alcohol-acetate, 11 June 1956. No QPL.
(15) MIL-A-17682 Adhesive, starch, 6 May 1963. No QPL.

Fabric Assembly Adhesives

Straight Fabric Assemblies

(16) MIL-C-2399 Cement, liquid, tent patching, 28 January 1960. No QPL.
(17) MIL-C-10668 Cement, liquid and cemented tape, for tent construction, 29 April 1953. No QPL.
(18) MIL-T-40102 Tape, thermoplastic adhesive for mending bed linen, 22 January 1960. No QPL.

Coated Fabrics

(19) MIL-A-22611 Adhesives, for polyvinyl chloride-coated cloth, 18 August 1960. No QPL.
(20) MIL-A-52222 Adhesive, for repair of poncho lightweight with hood, 14 May 1962. No QPL.
(21) MIL-A-52264 Adhesive, synthetic-rubber; nitrile-rubber and vinyl-resin base (for bonding prefabricated airfield and road surfacing membrane), 15 January 1963. No QPL.
(22) MIL-A-5540 Adhesive, polychloroprene, 20 February 1963. Has QPL.
(23) MIL-C-5539 Cement; natural rubber, 9 January 1950. Has QPL.

Mixed Fabric Assemblies

(24) MIL-G-413 Glue, marine and aviation marine (waterproof), 7 August 1952. No QPL.
(25) AMS-3685 Adhesive, synthetic rubber, Buna-N type, 1 December 1951. No QPL.
(26) MIL-C-4003 Cement; general purpose, synthetic base, 19 March 1954. Has QPL.
(27) MIL-A-5092 Adhesive, rubber (synthetic and reclaimed rubber base), 27 August 1952. Has QPL.
(28) MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding), 7 November 1960. No QPL.

4. WOOD ADHESIVES

Wood adhesives fall into three general categories. The first is for straight wood assemblies, including plywood manufacture and veneering applications. The second is for specific mixed wood assemblies such as wood/metal, wood/plastics, etc. The third is for general purpose wood bonding applications.

STRAIGHT WOOD ASSEMBLY ADHESIVES

Straight wood assembly adhesives are designated by many systems, e. g., chemical composition, process requirements, etc. However, from the standpoint of the user, the durability index is more useful. Under this system, adhesives are classified according to service conditions into the following classes: interior adhesives, semidurable adhesives and weatherproof adhesives.

Interior Adhesives

Interior adhesives are used for applications subjected to normal indoor temperature conditions where relative humidities are not high and do not fluctuate widely. Animal glues (Reference 1), liquid glues (Reference 1) and vinyl emulsions (Reference 2) are commonly used for these applications.

Semidurable Adhesives

Semidurable adhesives are used for applications subjected to severe conditions for limited periods of time. These bonding materials deteriorate slowly and ultimately fail completely. Urea (Reference 3) and casein (Reference 4) adhesives are used for bonding wood which will be subjected to these environmental conditions. Processing techniques required of fabricators using urea adhesives are available (Reference 31).

Weatherproof Adhesives

Weatherproof adhesives are used for applications subjected to severe conditions for protracted periods. They are also suitable for marine service. These adhesives are more durable than the wood itself and are virtually indestructible by weather, mold and heat. Phenolics, resorcinols and melamines are used for these applications (References 5, 6, 7, 8). Processing techniques required of fabricators using the lower temperature curing (Reference 32) and the higher temperature curing (Reference 33) phenolic, resorcinol and melamine adhesives are also available.

MIXED WOOD ASSEMBLY ADHESIVES

Many adhesives suitable for strictly wood joints fail to adhere other materials to wood or give weak joints. Wood is a porous substance. The adhesive soaks into the pores of the wood and holds the joint together, in part, mechanically, by strong fingers of glue. Simultaneously, the fingers of glue react with the surfaces they contact, providing intermolecular forces which further add to the strength of the joint. However, when an adhesive contacts nonporous substances such as metals, etc., the mechanical adhesion is small. Only the intermolecular forces are significant. Many straight wood adhesives do not possess the chemical requirements to bond other materials. For example, they do not wet the surfaces adequately and therefore can not sufficiently contact the surface to chemically react, if indeed they do. Further, the adhesive may not be sufficiently elastic to distribute the stresses encountered in service when two dissimilar substances are joined. Finally, they may not possess desirable processing or performance properties for a specific joint. Consequently, adhesives for these situations are compounded for specific dissimilar material joints.

Thus, adhesives for these assemblies are best classified for the user according to the specific joints they can effect. These are for wood/metal, wood/paper, wood/leather, wood/plastics, wood/cotton fabric and wood/plaster or concrete joints.

Wood/Metal

There are a number of adhesives available for bonding wood to metal. Casein-latex, vinyl-phenolics, nylon-phenolics, rubber-phenolics, epoxies and two-stage adhesive systems consisting of a metal primer and a straight wood working glue such as urea, phenolic, resorcinol or melamine are typical.

However, unlike straight wood assembly adhesives, metal/wood adhesive specifications do not give the chemical composition since they are considerably more complex and, therefore, difficult to specify in measurable terms. These specifications, nevertheless, classify the adhesives according to intent: structural or nonstructural.

Structural wood/metal adhesives (Reference 9) are used in both nonsandwich and sandwich panel constructions carrying primary loads. Nonstructural wood/metal adhesives are used where external loads are relatively small. They are suitable for adhering wood insulation, such as cork, to metals (Reference 10) and chipboard to terneplate, tinplate and zincplate, the latter where water, oil, and mold resistance is not required (Reference 11).

Wood/Paper

Many of the room temperature curing, straight wood assembly adhesives can be used to affix paper to wood. However, there are adhesives which have been specifically compounded for this purpose. They are predominantly used in labeling operations. Gum arabic (Reference 12), sodium silicate (Reference 13), cellulose nitrate (Reference 14), varnish (Reference 15) and compounded mixtures (Reference 16) are typical ones used. Chapter 8 lists the adhesives used specifically for labeling purposes.

Wood/Leather

Leather can be adhered to wood using polyvinyl acetate (Reference 17) and solvent-based neoprene cements (Reference 18). However, polyvinyl acetate emulsion compounded for straight wood bonding has also been found suitable for this purpose (Reference 2).

Wood/Plastic

Wood/Plastic joints are effected with many adhesives. Typical are: (1) the ureas (Reference 4), (2) phenolic, resorcinol and melamine base adhesives (References 7, 8) and (3) the solvent-base neoprenes (Reference 18). Unfortunately, specifications covering the first two groups of adhesives do not quote mechanical properties to be expected from these joints. These have to be developed experimentally. Nevertheless, of these two groups, the urea bonded joints are expected to have inferior moisture resistance.

Wood/Cotton Fabric

Cotton fabric and other cellulosic materials can be adhered with room temperature curing, straight wood adhesives, cellulosics, rubber and synthetic resin adhesives. However, oleoresins have been specifically compounded for this purpose (Reference 19).

Wood/Plaster or Concrete

Wood is sometimes bonded to plaster or concrete in architectural applications. The adhesives are mixtures containing compounded bitumens, vinyl emulsions, synthetic resins or rubbers, etc. Wood/plaster or concrete adhesives are used to adhere prefabricated acoustical materials to inside walls and ceilings of rooms (Reference 20) and the bonding of cork carpets to concrete, wood, etc. but not steel flooring (References 21, 22).

GENERAL PURPOSE ADHESIVES

General purpose adhesives are unusual. They have the property of adhering practically any combination of materials providing joints ranging from weak temporary bonds to those suitable for moderate structural loads. Typical are acrylic, epoxy, rubber and vinyl adhesives. It is interesting to note that none of the specifications covering these adhesives use wood as an adherend to define the adhesive properties. Nevertheless, each specification claims suitability for wood. Consequently, allowable design values must be obtained for each wood joint utilizing any of these adhesives.

Acrylic Adhesive

General purpose acrylic adhesive consisting of cyanoacrylate monomer is intended for the rapid bonding of porous and non-porous surfaces (Reference 23). The adhesive is exceedingly expensive, and the bonds are not completely waterproof. It should be used only in cases where high speed, room temperature curing is the prime consideration.

Epoxy Adhesives

There are two general purpose epoxy adhesives, one offering an option on curing conditions (Reference 24), and the other for room temperature curing operations, although curing at 160 F is acceptable (Reference 25). These adhesives are suitable for structurally joining wood to itself and to metals, glass and plastics.

There is an additional epoxy adhesive which is intended solely for metal bonding, but experience has shown it can be used for specialized wood bonding applications (Reference 26). This adhesive, according to type, has outstanding resistance to elevated temperature.

The processing techniques required of fabricators using epoxy structural adhesives are available (Reference 34).

Rubber Adhesives

There are three rubber base adhesives for general purpose bonding work. The first is for bonded joints which are subjected only to air, water or oil immersion (Reference 27). The second, depending on type, can also resist gasoline (Reference 28). The third is specifically for applications where contact with aromatics (toluene) is expected (Reference 29).

Vinyl Adhesive

General purpose vinyl adhesive consisting of 22-6% polyvinyl alcohol-acetate in toluene is intended for bonding of impervious surfaces such as metals, phenolics, ureas, cellulose nitrate and acetate sheets (Reference 30). However, it is also effective with wood, paper and cloth.

BIBLIOGRAPHY

Straight Wood Assembly Adhesives

Interior Adhesives

1. MMM-A-100 Adhesive, animal-glue, 10 December 1963. No QPL.
2. MMM-A-193 Adhesive, vinyl acetate resin emulsion, 25 August 1959. No QPL.

Semidurable Adhesives

3. MMM-A-00125 Adhesive, casein type, water and mold resistant, 1 July 1963. No QPL.
4. MMM-A-188 Adhesive: urea-resin-type (liquid and powder), 8 November 1960. No QPL.

Weatherproof Adhesives

5. MIL-A-5534 Adhesive; high-temperature setting resin (phenol, melamine and resorcinol base), 15 June 1951. No QPL.
6. MIL-A-22397 Adhesive, phenol and resorcinol resin base (for marine service use), 8 September 1960. Has QPL.

7. MIL-A-46051 Adhesive, room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine base), 20 November 1961. Has QPL.
8. MMM-A-00181 Adhesive, room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine resin), 9 March 1964. No QPL.

Mixed Wood Assembly Adhesives

Wood/Metal

Structural

9. MIL-A-928 Adhesive; metal to wood, structural, 31 March 1955. Has QPL.

Non-Structural

10. MIL-A-18065 Adhesive, high initial bond, 17 December 1959. Has QPL.
11. MIL-A-45059 Adhesive for bonding chipboard to terneplate, tinplate, and zincplate, 24 April 1958. No QPL.

Wood/Paper

12. JJJ-A-20 Acacia, technical (gum arabic), 24 January 1958. No QPL.
13. O-S-605 Sodium silicate solutions, 1 September 1960. No QPL.
14. MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.
15. MIL-A-3941 Adhesive, paper label, water-resistant, 19 March 1959. No QPL.
16. MIL-V-6093 Varnish, decalcomania, adhesive, 4 April 1961. Has QPL.

Wood/Leather

17. MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 1 July 1963. No QPL.

Wood/Plastics

18. MMM-A-00130 Adhesive, contact, 2 October 1961. No QPL.

Wood/Cotton Fabric

19. MIL-G-413 Glue, marine, and aviation marine (waterproof), 7 August 1952. No QPL.

Wood/Plaster or Concrete

20. MMM-A-00150 Adhesive for acoustical materials, 3 October 1962. No QPL.
21. O-P-106 Paste, linoleum, 17 October 1939. No QPL.
22. MMM-A-00137 Adhesive, linoleum, 11 February 1963. No QPL.

General Purpose Wood Adhesives

Acrylic

23. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.

Epoxy

24. MIL-A-8623 Adhesive, epoxy resin, metal to metal structural bonding, 23 September 1960. Has QPL.
25. MIL-A-14042 Adhesive, epoxy, 17 July 1959. No QPL.
26. MIL-A-005090 Adhesives, heat resistant, airframe structural, metal to metal, 22 April 1963. Has QPL.

Rubber

27. MIL-C-4003 Cement; general purpose, synthetic base, 19 March 1954. Has QPL.
28. MIL-A-5092 Adhesive, rubber (synthetic and reclaimed rubber base), 27 August 1952. Has QPL.

29. MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding), 7 November 1960. No QPL.

Vinyl

30. MIL-C-18726 Cement, vinyl alcohol-acetate, 11 June 1956. No QPL.

Adhesive Process Specifications

31. MIL-G-6803 Gluing, application of cold-setting resin (urea type), 25 July 1961.
32. MIL-A-5433 Adhesive, application of room-temperature and intermediate-temperature setting resin (phenol, resorcinol, and melamine base), 30 November 1954.
33. MIL-A-5535 Adhesive, application of high-temperature-setting resin (phenol, melamine and resorcinol base), 12 March 1951.
34. MIL-A-9067 Adhesive bonding, process and inspection requirements for, 16 March 1961.

5. RUBBER ADHESIVES

In the design and construction of equipment, it sometimes becomes necessary to join rubber to itself as well as to other components, such as metals, plastics, etc. The choice of adhesive is in part predicated by the type of rubber to be bonded and in part by the environmental conditions to be imposed on the bonded composite.

There are currently many rubbers suitable for selected conditions (see Table I). However, each rubber can be bonded only with specific adhesives. These adhesives can be conveniently catalogued for the user into the following categories: (1) straight rubber assembly adhesives, (2) mixed rubber assembly adhesives for joints such as rubber/paper, rubber/metal, etc., and (3) general purpose rubber bonding adhesives.

STRAIGHT RUBBER ASSEMBLY ADHESIVES

Adhesives for rubber to rubber bonding can be classified using many systems. However, a classification based on the type of rubber that can be bonded is currently more suitable for the engineer. This system covers the bonding of natural, butyl, nitrile, silicone and heterogeneous rubber combinations, including the neoprenes and SBR rubbers.

Natural Rubber

Natural rubber has been replaced by its synthetic counterparts for many applications. However, there are a number of applications where the use of natural rubber is still satisfactory.

One of the largest single uses is in aircraft tires, including the inner tubes and pneumatic cases. Two adhesives (Reference 1) are employed for the bonding and repair of these natural rubber base components. The first adhesive is a vulcanizing cement intended for capping, retreading and vulcanized repairs of casings and inner tubes. This adhesive does not contain any reclaimed or synthetic rubbers. It cures during the vulcanization of the adherends, which is usually in 45 minutes between 260 and 280 F. The second adhesive is a room temperature curing cement used in conjunction with cured-back, uncured-front repair patches for inner tubes.

There is an additional natural rubber base cement for room temperature bonding work (Reference 2). It provides a peel strength of at least 5 pounds per inch of width.

Butyl

Butyl rubber exhibits very low air permeability. As a consequence, it is not surprising that it finds extensive use in pneumatic constructions, notably automotive inner tubes. Two adhesives are available for effecting bonds at room temperature on butyl adherends (References 3, 4). Both adhesives, however, are based on natural rubber. The latter (Reference 4) is also effective for bonding natural rubber.

Nitrile

Nitrile rubber has excellent resistance to aromatic fuels. An adhesive is available for bonding nitrile rubber intended for severe service conditions such as those encountered in fuel cell applications (Reference 5).

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 one week immersion in aromatics.

Silicones

Silicone rubber possesses excellent resistance to both low and high temperatures. Adhesives are available for bonding silicones, as well as silicones to metals (Reference 6); the latter are covered subsequently under mixed rubber assemblies. These adhesives are either one or two-part systems which cure at room temperature under contact pressure.

Heterogeneous Rubber Adherends

There are certain adhesives which are not specific for any one type of rubber. These are the heterogeneous rubber adhesives.

One of the largest single uses for these joining materials is in the rubber tire industry. Unlike the previously described adhesives which are specific for either natural (References 1, 2, 3) or butyl (References 3, 4) rubbers, these bonding materials can be used interchangeably with natural, SBR and butyl rubbers. Two types are available (Reference 7). The first, a vulcanizing cement consisting of a natural rubber base, is cured during the vulcanization of the adherends, usually at 280 F for 45 minutes. The second is a cold cure cement intended only for repairing inner tubes.

Other heterogeneous rubber adhesives are suitable for bonding neoprene rubber coated fabrics (Reference 8). They provide reliable high joint strengths, making them suitable for the manufacture and repair of airships, rubber boats and life saving equipment. These adhesives, according to type, are available in both the room temperature and elevated temperature curing varieties.

There are two additional lower strength heterogeneous rubber adhesives. The first is for bonding vulcanized SBR, nitriles and neoprenes to natural or synthetic rubber using room temperature cures under contact pressure (Reference 9). The second is for mak-

TABLE I. CLASSIFICATION OF RUBBERS (1)

Environmental Resistance		MIL-STD-417 Classification (2)						
General	Specific	Type	Class	Type	Common Name	Chemical Composition	Standard ASTM Symbol	Other Symbols
Nonoil resistant			RN	Natural	Natural	Isoprene	NR	–
		R	RS	Synthetic	SBR	Styrene butadiene	SBR	GRS, Buna-S
			RS	Synthetic	Butyl	Isoprene-isobutylene	11R	GRI
			RS	Synthetic	Polybutadiene	Butadiene	–	–
Oil resistant	Very low swell	S	SA	Synthetic	Thiokol	Polysulfide	—	GR-P
	Low volume swell		SB	Synthetic	Nitrile	Acrylonitrile-butadiene	NRB	Buna-N
			SB	Synthetic	Urethane	Diisocyanate-polyester or polyether	–	–
	Medium volume swell		SC	Synthetic	Neoprene	Chloroprene	CR	GR-M
			SC	Synthetic	Hypalon	Chlorosulfonated polyethylene	–	–
Temperature resistant	Low and high temperature resistant	T	TA	Synthetic	Silicone	Polysiloxane	–	–
	High temperature & fluid resistant		TB	Synthetic	Acrylic	Ethyl acrylate-acrylonitrile	–	–
			TB	Synthetic	Fluorocarbon	Vinylidene fluoride - hexafluoropropylene	–	–

TABLE I. CLASSIFICATION OF RUBBERS (Continued)

Vinylidene fluoride-chlorotrifluoroethylene	–	–

(1) Adapted from Hall, D. R., "Rubber – An Engineering Material for the Petroleum Industry", ASME Paper No. 61-PET-15, 1961.

(2) ASTM-SAE designation D735 and J14 is identical with MIL-STD-417, except no class designations are used for Type R rubbers.

Courtesy: *Rubber Age*

ing both vulcanized and unvulcanized bonds of natural, SBR and neoprene to natural and synthetic rubber (Reference 10). The vulcanized bonds are made at 310 F for 30 minutes under 500 psi pressure, and the unvulcanized bonds are achieved under contact pressure after 30 minutes at room temperature.

There is further a specialty adhesive based on sodium silicate specifically for surface coating compression rubbers on intaglio presses to prevent listing of printing sheets (Reference 11).

MIXED RUBBER ASSEMBLY ADHESIVES

Adhesives are compounded for specific dissimilar rubber joints. These are best classified for the user according to the specific joint they can effect. These are for rubber/paper, rubber/metal and rubber/fabric joints.

Rubber/Paper

An adhesive has been specifically compounded for adhering paper, especially labels, to rubber (Reference 12). It is brushable, dries tack-free in 5 minutes and hard in no more than 16 hours. The adhesive does not cause bleeding, smearing, or running of stencil ink (TT-I-559), colored borders of labels or discoloration of paper stock. The adhesive film resists water, oil, subnormal and elevated temperatures, weathering and is flexible.

This adhesive can also adhere paper to soft wood, fiberboard, black or galvanized iron, glass, tin and enamel painted metal.

Rubber/Metal

Two adhesives are available for bonding rubber to metal. The first is for bonding neoprene, SBR and nitrile rubbers to steel (Reference 13). It is brushable, cures at room temperature and finds particular usage in bonding rubber coated gaskets to steel. It resists salt water, but it is not particularly useful at elevated temperatures.

The second is suitable for bonding silicone rubbers to aluminum where it is not possible to use heat and pressure to effect a cure (Reference 6). The adhesive is suitable for high moisture, oil or elevated temperature environments.

Rubber/Fabric

Natural rubber base adhesives are used for adhering (1) fabrics to fabric reinforced rubber as well as (2) fabric reinforced rubber to fabric reinforced rubber, especially in the manufacture of airships, balloons, pneumatic life rafts and life jackets (Reference 14). The adhesive is available in three types. The first type is self curing and is intended for use during manufacturing operations. The second type, air drying, is for emergency repairs, and the third type, self curing, is for permanent repairs. A separate catalyst is used with the first and third types and is incorporated in the second type.

GENERAL PURPOSE ADHESIVES

General purpose adhesives are capable of adhering practically any combination of materials, providing joints ranging from weak temporary bonds to those suitable for moderate structural loads. Typical are rubber, acrylic and epoxy adhesives. For the bonding of rubber, a classification system defining flexibility of the bond is helpful. The rubber base adhesives provide flexible joints, the acrylics and epoxies rigid joints. It is interesting to note that none of the rigid joint adhesives and some of the flexible joint adhesives do not use rubber adherends to define the expected adhesive properties. Nevertheless, experience has shown that they can bond rubber. However, allowable design values should be determined experimentally for each joint.

Flexible Bonds

Flexible bonds are achieved with the rubber base adhesives. There are six types available, four of which offer environmental resistance options, for general purpose bonding work.

The first is for bonding cotton duck, neoprene and polyvinyl chloride to aluminum which will be subjected to air, water and oil environments (Reference 15). It is not intended for manufacture and repair of aircraft, life rafts, etc. In these cases, the adhesives previously discussed should be used (References 8, 14).

The second is for bonding cotton duck, leather, felt, cork, vinyls and similar materials to themselves and to aluminum, steel, wood, laminates, rubber, etc., which according to grade can also resist gasoline (Reference 16).

The third is for bonding steel, cotton duck, explosives, rubbers, etc., where contact with aromatics is expected (Reference 17).

The fourth is for bonding fabric and synthetic rubber to plastics and metals where good resistance to lubricating oil and fair resistance to aromatic fuels is needed (Reference 18).

The fifth is for the manufacture of tents. It is available in liquid and tape form (Reference 19).

The sixth is intended primarily for patching of tents. It is also a liquid, brushable nitrile base adhesive (Reference 20).

Rigid Bonds

Rigid bonds are achieved with the acrylic and epoxy adhesives.

Acrylic Adhesive. This adhesive consisting of cyanoacrylate monomer is suitable for the rapid bonding of both porous and nonporous surfaces (Reference 21). The adhesive is exceedingly expensive, and the bonds are not completely waterproof. It should be used only in cases where high speed, room temperature curing is the prime consideration.

Epoxy Adhesives. There are two general purpose epoxy adhesives, one offering an option on curing conditions (Reference 22) and the other for room temperature curing operations, although curing at 160F is acceptable (Reference 23).

There is a third epoxy adhesive which is intended solely for metal bonding, but experience has shown it can be used for specialized rubber bonding applications (Reference 24). This adhesive, according to type, has outstanding resistance to elevated temperature.

The processing techniques required of fabricators using epoxy structural adhesives are available (Reference 25).

BIBLIOGRAPHY

Rubber To Rubber Adherend Bonding

Natural

1. MIL-R-7725 Repair and treading materials, aircraft pneumatic tire, 12 April 1957. No QPL.
2. MIL-C-12850 Cement, rubber, 30 June 1953. No QPL.

Butyl

3. ZZ-C-191 Cement; rubber (artists' and photographers' and cold patching), 10 December 1959. No QPL.
4. MMM-A-00182 Adhesive, rubber (for cold patching), 29 November 1962. No QPL.

Nitrile

5. MIL-A-9117 Adhesive, sealing, for aromatic fuel cells and general repair, 10 August 1962. Has QPL.

Silicone

6. MIL-A-25457 Adhesive, air-drying, silicone rubber, 18 March 1957. Has QPL.

Heterogeneous Rubber Adherends

7. ZZ-T-416 Tire rebuilding and tire and tube repair materials, 27 August 1959. No QPL.
8. MIL-A-5540 Adhesive, polychloroprene, 20 February 1963. Has QPL.
9. MIL-C-897 Cement, rubber (synthetic-rubber-to-synthetic-rubber-adhesion), 29 June 1950. No QPL.
10. MIL-C-23092 Cement, natural rubber, 4 December 1961. Has QPL.
11. O-S-605 Sodium silicate solutions, 1 September 1960. No QPL.

Rubber To Non-Rubber Adherend Bonding

Rubber/Paper Joints

12. MIL-A-3941 Adhesive, paper label, water-resistant, 19 March 1959. No QPL.

Rubber/Metal

13. MIL-A-1154 Adhesive, bonding, vulcanized synthetic rubber to steel, 4 April 1963. Has QPL.

Rubber/Fabric

14. MIL-A-5539 Cement; natural rubber, 9 January 1950. Has QPL.

General Purpose Rubber Adhesive Bonding

Flexible Joints

15. MIL-C-4003 Cement; general purpose, synthetic base, 19 March 1954. Has QPL.

16. MIL-A-5092 Adhesive, rubber (synthetic and vulcanized rubber base), 27 August 1952. Has QPL.
17. MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding), 7 November 1960. No QPL.
18. AMS 3685 Adhesive, synthetic rubber, Buna-N type, 1 December 1951. No QPL.
19. MIL-C-10668 Cement, liquid and cemented tape, for tent construction, 29 April 1953. No QPL.
20. MIL-C-2399 Cement, liquid, tent patching, 28 January 1960. No QPL.

Rigid Joints

21. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.
22. MIL-A-8623 Adhesive, epoxy resin, metal to metal structural bonding, 23 September 1960. Has QPL.
23. MIL-A-14042 Adhesive, epoxy, 17 July 1959. Has QPL.
24. MIL-A-005090 Adhesives, heat resistant, airframe structural, metal to metal, 22 April 1963. Has QPL.

Process Specifications

25. MIL-A-9067 Adhesive bonding, process and inspection requirements for, 16 March 1961.

6. PLASTICS ADHESIVES

There are two fundamental types of plastic materials: The thermoplastics and the thermosets. The thermoplastics, analogous to metals and waxes, melt under the application of heat and, like waxes, are soluble in selected solvents. The thermosets, on the other hand, are infusible under the action of heat and insoluble in the presence of solvents, although some may swell slightly.

The thermoplastics, because of the heat and solvent sensitivity, may be joined by heat or solvent welding, as well as by conventional adhesive bonding technology. The thermosets, because of their infusibility and insolubility, can be only joined with adhesives. Table I gives a list of the common thermoplastic and thermosetting materials.

Adhesives for bonding of plastics can be conveniently catalogued into three general categories. The first is for straight plastic assemblies; the second, for specific mixed plastic assemblies; and the third, for general purpose bonding applications.

STRAIGHT PLASTIC ASSEMBLY ADHESIVES

Straight plastic assembly adhesives are designated by the type of adherend to be joined, such as thermoplastic or thermosetting. Under this system, the thermoplastics can be joined by heat welding, solvent welding and adhesive bonding techniques and the thermosets only by adhesive bonding techniques.

Thermoplastics

Heat Welding. This technique produces joints approaching or equal to the strength of the parent plastic. The technique, similar to welding of metals, consists of heating the plastic adherends sufficiently with or without pressure until fusion occurs and then allowing the joint to cool.

Three techniques for applying the heat are used. The first, hot gas welding, consists of blowing hot gases against the plastic assembly and a plastic welding rod, usually of the same material as the parent plastic. The welding rod material melts and subsequently fuses with the assembly, yielding the finished joint. Some materials, such as the olefins, require inert gases to prevent breakdown of the plastic. Polyvinyl chloride, polyethylene, polypropylene, nylon and polyoxymethylenes can be joined using this technique.

TABLE I. COMMON THERMOPLASTIC AND THERMOSET PLASTICS

THERMOPLASTIC	THERMOSET
Acrylics	Alkyds (1)
Cellulosics	Epoxies
Cellophane	Furanes
Cellulose acetate	Melamines
Cellulose acetate butyrate	Phenolics (1)
Cellulose nitrate	Polyesters
Olefins	Resorcinols
Polyethylene	Silicones
Polypropylene	TAC polyesters
Polyamides	Ureas (1)
Nylon	
Polyesters	
Mylar	
Polyvinyls	
Polystyrene	
Polytetrafluoroethylene (Teflon)	
Polytrifluoromonochloroethylene (Kel F)	
Polyvinyl alcohol	
Polyvinylbutyral	
Polyvinyl chloride	
Polyvinyl fluoride	
Polyvinylidenes	
Polyvinylidene chloride	

(1) Thermoplastic varieties are available.

The second, heat sealing, consists of simultaneously dielectrically heating and applying pressure. The joint is effected in seconds. Most thermoplastics, with the exception of uncoated cellophane and polyethylene terephthalate (Mylar), can be sealed by this technique.

The third, spin welding, a specialized technique for joining cylindrical objects, consists of heating through friction induced by spinning one plastic adherend against another.

Table II gives the heat welding temperature ranges for thermoplastic materials.

Solvent Welding. This technique consists of introducing a solvent between the surfaces of the assembly, which makes the plastic soluble, and then allowing the solvent to evaporate slowly, leaving a consolidated joint. In some instances the solvent is embodied with the plastic to be bonded to provide better working characteristics and joints. These are called embodied cements or dopes. Table III gives a list of solvent weldable plastics with their suitable solvents. Applicable specifications covering these solvents are also given; however, since these specifications cover the solvent rather than bonding with these materials, they are not covered in Part II.

TABLE II. HEAT-WELDING TEMPERATURE RANGES FOR THERMOPLASTIC MATERIALS

FILM TYPE	RANGE (°F)
Cellophane (coated)	200 – 350
Cellulose acetate	400 – 500
Chlorotrifluoroethylene (Kel F)	415 – 450
Polyester (coated)	490
Polyethylene	250 – 375
Polystyrene (oriented)	220 – 300
Polyvinyl alcohol	300 – 400
Polyvinyl chloride and copolymers, nonrigid	200 – 400
Polyvinyl chloride and copolymers, rigid	260 – 400
Polyvinyl chloride nitrile rubber blend	220 – 350
Polyvinylidene chloride	285
Rubber hydrochloride	225 – 350
FEP (fluorinated ethylene-propylene copolymer)	600 – 750
TFE (tetrafluoroethylene polymer) (1)	700
CFE (chlorotrifluoroethylene polymer) (2)	420 – 440

(1) 35 psi bonding pressure is used plus a two hour afterbake at 90 F above maximum temperature service.
(2) 25–75 psi bonding pressure is used with a flux consisting of a mixture of CFE and fluorocarbon oil.

Courtesy: *Materials in Design Engineering* and *The Society of the Plastics Industry.*

Adhesive Bonding. Thermoplastic materials are joined by adhesive bonding. Typical are acrylic, cellulose, polyethylene, polyvinyl chloride, polyester and polystyrene plastics.

Acrylics are joined with two adhesive materials. Both are based on methyl methacrylate. However, one contains methylene chloride as a solvent to help soften the heat resistant acrylic varieties (Reference 1). The second is for the straight acrylics and contains no solvent (Reference 2). It can be used for the heat resistant acrylics, but has less desirable processing characteristics than the former adhesive.

Polyethylene is bonded with pressure-sensitive adhesive tapes commonly used for insulating polyethylene coated wires (Reference 3). The tape is activated by stretching it 100% and applying it to the polyethylene assembly. Fusion occurs in a few minutes.

TABLE III. SOLVENT WELDING OF THERMOPLASTIC MATERIALS

THERMOPLASTIC MATERIAL (1)	APPLICABLE SOLVENTS		SOLVENT SPECIFICATION (2)
Acrylic	Solvent Type		
	(1) Glacial acetic acid		O-A-76
	(2) Methylene chloride		—
	Dope Type		
	(1) Methyl methacrylate	50%	MIL-P-16413 or MIL-M-10851
	Methylene chloride	50%	—
Cellulose Acetate	Solvent Type		
	(1) Acetone		O-A-51
	(2) Cellosolve acetate		—
	(3) Ethyl acetate		TT-E-751
	(4) Methyl cellosolve		—
	(5) Methyl ethyl ketone		TT-M-261
	Dope Type		
	(1) Cellulose acetate	15%	MIL-P-14118 or MIL-P-16416
	Methyl cellosolve	25%	—
	Methyl ethyl ketone	60%	TT-M-261
Cellulose Nitrate	Solvent Type		
	(1) Butyl acetate		TT-B-838
	(2) Diacetone alcohol		O-D-306
	(3) Ethyl lactate		—
	(4) Methyl ethyl ketone		TT-M-261
	Dope Type		
	(1) Cellulose nitrate	10%	L-P-365
	Diacetone alcohol	90%	O-D-306
Ethyl Cellulose	Solvent Type		
	(1) Butyl alcohol		TT-B-846
	(2) Ethyl acetate		TT-E-751
	(3) Ethyl alcohol		O-E-760
	(4) Ethylene chloride		MIL-E-10662
	Dope Type		
	(1) Ethyl cellulose	10%	MIL-E-10853
	Ethyl acetate	45%	TT-E-751
	Ethylene chloride	45%	MIL-E-10662
Polyamides	Solvent Type		
	(1) Formic acid		—
	(2) Phenol		O-P-281
	Dope Type		
	(1) Polyamide	10%	MIL-P-3086 or MIL-P-17091
	Formic acid	90%	—
Polyvinyls Polystyrene	Solvent Type		
	(1) Ethyl naphthalene		—
	(2) Toluene		TT-T-548
	(3) Trichloroethylene		O-T-634
	Dope Type		
	(1) Polystyrene	10%	L-P-515
	Toluene	90%	TT-T-548

TABLE III. Solvent Welding of Thermoplastic Materials (Continued)

THERMOPLASTIC MATERIAL (1)	APPLICABLE SOLVENTS		SOLVENT SPECIFICATION (2)
Polyvinyl Alcohol	Solvent Type		
	(1) Water		–
	Dope Type		
	(1) Polyvinyl alcohol	5%	MIL-P-265
	Water	85%	–
	Glycerol	10%	O-G-491
Polyvinyl Chloride	Solvent Type		
	(1) Ethyl acetate		TT-E-751
	(2) Methyl ethyl ketone		TT-M-261
	(3) Methylene chloride		–
	(4) Cyclohexanone		–
	(5) Tetrahydrofuran		–
	Dope Type		
	(1) Polyvinyl chloride	15%	L-M-530 or MIL-P-20307
	Dioxane	15%	–
	Methyl ethyl ketone	70%	TT-M-261

(1) Olefins, polyesters (Mylar), polytetrafluoroethylene (Teflon), polytrifluoromonochloroethylene (Kel F) and polyvinyl fluoride cannot be solvent welded. Bonding is achieved by etching the material followed by conventional adhesive bonding technology.
(2) Specifications are tabulated in Appendix B.

Cellulosics, such as cellulose nitrate and cellulose acetate, are bonded with cellulose nitrate base adhesives (Reference 4). They are flammable, compatible with ammunition and can also join glass, leather, metals and textiles.

Polyester and polystyrene are bonded with styrene monomer (Reference 5). This adhesive shrinks considerably during cure, resulting in strain lines which may be objectionable in optical applications. It is usually modified with other resins to reduce this objectionable characteristic.

Polyvinyl chloride is one of the most widely used plastic materials. Applications range from plumbing pipe lines to protective covers such as raincoats. Polyvinyl chloride and rubber base adhesive materials are used for bonding these plastics. Plumbing lines use polyvinyl chloride adhesives which yield joints capable of sustaining 500 psi hydrostatic pressure (Reference 6). Vinyl coated fabrics can use polyvinyl chloride (Reference 7), synthetic rubber (Reference 7), vinyl-phenolic modified nitrile rubber (Reference 8) and polyvinyl chloride modified nitrile rubber (Reference 9) base adhesives for bonding work. They are all room temperature curing.

Thermosetting Plastics

Many thermosetting plastics are reinforced with fabrics to improve their mechanical properties. These laminates use paper, cotton, glass and asbestos reinforcement with polyester, epoxy, phenolic, etc., resins. Adhesives are available specifically for one combination of materials as well as those intended for bonding any combination of these laminate materials. Nevertheless, the adhesives for specific laminate materials will bond other combinations; however, exact design values have to be established experimentally for each combination.

Phenolic, resorcinol, melamine and furane base adhesives are used for bonding cotton fabric reinforced phenolic laminates (Reference 10). These adhesives, dependent on type, can be cured at room temperature, intermediate temperature (90-180 F up to five hours) and high temperature (180-350 F up to one-half hour). Shear strengths range between 1000 and 1800 psi. No loss in strength occurs by immersion in 180 F water for periods as long as 24 hours.

Phenolic, melamine and resorcinol base adhesives used for bonding wood can also be used for bonding rigid plastic laminates (References 12, 13). They can, again dependent on type, be cured at room temperature and at intermediate temperatures (95-190 F up to five hours). Exact design values must be determined for each laminate combination chosen.

Epoxy adhesives are available for bonding glass fabric reinforced polyesters where peel or cleavage loads are not expected (Reference 11). The adhesives are room temperature curing and have a shear strength of at least 1360 psi at room temperature. They should not be used above 200 F because of their significant loss of strength at higher temperatures.

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 specifically formulated for a particular type of joint. Those joints are plastic/wood, plastic/metal and plastic/plaster.

Plastic/Wood

Plastic laminate materials are bonded to wood generally for decorative purposes. Two fundamental types of adhesives are available. These are the contact adhesives providing rapid assembly and the slower assembly adhesives offering options on durability.

The contact adhesives, which are neoprene rubber base, require considerable caution in placing the laminate material since it will not slide for adjustment (Reference 14). This adhesive can also bond leather, wood, fabrics, unglazed ceramics, hardboard, carpet and core bases.

The slower assembly adhesives eliminate the problem of fitup techniques introduced by the neoprene base contact adhesives. The urea base adhesives offer only moderate resistance to water (Reference 15). They are available as one or two component systems; the latter require mixing prior to use. The phenolic, resorcinol and melamine base adhesives offer significant resistance to moisture and make durable, weatherproof joints (References 12, 13). They are also available as one or two part systems.

The processing techniques required of fabricators using these slower assembly adhesives are available (References 38, 39).

Plastic/Metal

Thermoplastic materials, such as acrylic, cellulose nitrate and polystyrene are joined to metals for optical, decorative, corrosion prevention and insulation purposes. The thermosetting plastic laminates are joined to metals for predominantly decorative and structural purposes.

Thermoplastics. Acrylic plastics because of their transparency are used in many optical applications. Acrylic canopies employed on aircraft and to a much lesser extent on boats and cars are installed in the metal substructure cushioned with a cork filled, sponge rubber, pressure-sensitive adhesive tape (Reference 16). On optical instruments, acrylic plastics are bonded to metal with polysulfide base adhesives (Reference 17) and the joint sealed with a noncuring polysulfide base adhesive (Reference 18).

Cellulose nitrate film is bonded to metal with reclaimed rubber base adhesives for both decorative and corrosion prevention purposes (Reference 19).

Cellular polystyrene is used for insulating metal against heat and cold. Isocyanate base adhesives activated with water are suitable for this purpose (Reference 20). However, good ventilation is required with this adhesive to reduce toxic hazards to personnel.

Thermosetting Plastics. Decorative plastic laminates are bonded to metals with neoprene-modified, phenolic base adhesives (Reference 21). They are particularly adaptable for adhering plastic tabletops to aluminum tables. The aforementioned contact adhesives can also be used for this purpose (Reference 14).

Epoxy laminates for moderate load structural purposes are joined to metals with room temperature curing polyester base adhesives even when mismatches and voids up to 0.020 inches must be bridged (Reference 22). The adhesive is thixotropic and will stay where it is laid, regardless of whether application is to a vertical or horizontal surface.

Plastic/Plaster

Bare and painted plaster bathroom and kitchen walls are subject to constant moisture and high humidity. Polystyrene tiles are occasionally used in these areas; they are laid with adhesive and the joints grouted (Reference 23). The adhesive has sufficient wet strength to keep the tiles from slipping on a vertical surface or falling from an overhead position during installation. It will also adhere these tiles to wood and concrete surfaces.

GENERAL PURPOSE PLASTIC ADHESIVES

There are a number of adhesive systems which are not specific for particular materials. They can be used with many plastic and nonplastic material combinations. However, where significant load carrying requirements are necessary, allowable design values must be determined. The acrylics, cellulose nitrate, epoxies, rubber and vinyl adhesives are suitable for these general purpose bonding applications.

Acrylic Adhesive

General purpose acrylic adhesive consisting of cyanoacrylate monomers is suitable for the rapid bonding of both nonporous and porous surfaces (Reference 24). The adhesive is exceedingly expensive, and the bonds are not completely waterproof. It should be used only in cases where high speed, room temperature curing is the prime consideration.

Cellulose Nitrate Adhesive

General purpose cellulose nitrate adhesive, commonly known as *household* cement, is used for repairing of plastics, cloth, wood, paper, china, glass, metal, leather and the anchoring of glass, metal and plastic laboratory equipment (Reference 25). They are flammable and cure at room temperature.

Epoxy Adhesives

General purpose epoxy adhesives for plastic and nonplastic material combinations are available for both electrical and structural applications.

The epoxy adhesives for electrical applications offer options on curing conditions. The room temperature curing variety is suitable for service up to 185 F (Reference 26), the intermediate temperature curing variety up to 250 F (Reference 27) and the high temperature curing variety up to 500 F (Reference 28). These adhesives are capable of bonding aluminum, corrosion-resistant steel, brass and many thermoset plastic materials.

The epoxy adhesives for structural applications offer options on curing conditions, temperature resistance and adaptability to sandwich constructions.

There are two general purpose epoxy adhesives: one offering an option on curing conditions (Reference 29) and the other for room temperature curing operations, although curing at 160 F is acceptable (Reference 30). Both have moderate temperature resistance.

A third epoxy adhesive is intended solely for metal bonding, but experience has shown it to be suitable for specialized plastics bonding. It has, dependent on type, outstanding resistance to temperatures as high as 500 F (Reference 31).

A fourth general purpose epoxy adhesive is intended for fabricating sandwich type structures from thin facing sheets and relatively thick honeycomb cores (Reference 32). This adhesive offers options on curing conditions and also has, dependent on type, outstanding resistance to temperatures as high as 500 F.

The processing techniques required of fabricators using epoxy adhesives are available (Reference 40).

Rubber Adhesives

There are four rubber base adhesives for general purpose bonding work, each offering specific environmental resistance options.

The first is for bonding cotton duck, neoprene and polyvinyl chloride to aluminum which will be subject to air, oil and water exposure (Reference 33).

The second is for bonding cotton duck, leather, felt, cork, vinyls, steel, wood, plastic laminates, rubber, etc., which according to type can resist gasoline (Reference 34).

The third is for bonding steel, cotton duck, explosives, rubber, plastic laminates, etc., where contact with aromatics (toluene) is expected (Reference 35).

The fourth is for bonding fabric and synthetic rubber to plastics and metals where good resistance to lubricating oil and fair resistance to aromatic fluids is needed (Reference 36).

Vinyl Adhesive

General purpose vinyl adhesive consisting of 22-26% polyvinyl alcohol-acetate in toluene is intended for bonding of metals, phenolics, ureas, cellulose nitrate, cellulose acetate, wood, paper and cloth (Reference 37). The adhesive produces strong, impact-resistant bonds.

BIBLIOGRAPHY

Straight Plastic Assembly Adhesives

Thermoplastic Plastics

1. MIL-A-8576 Adhesive, acrylic monomer base, for acrylic plastic, 4 October 1956. No QPL.
2. MIL-A-25055 Adhesive, acrylic monomer and polymer base for acrylic plastic, 17 June 1957. No QPL.
3. MIL-I-3825 Insulation tape, electrical, self-fusing, for use in electronic, communications and allied equipment, 27 March 1962. Has QPL.
4. MIL-A-11238 Adhesive, cellulose nitrate (for ordnance use), 18 September 1962. No QPL.
5. MIL-S-14195 Styrene monomer, 22 November 1955. No QPL.
6. MIL-A-22010 Adhesive, solvent type, polyvinyl chloride, 9 June 1961. No QPL.
7. MIL-A-22611 Adhesive, for polyvinyl chloride-coated cloth, 18 August 1960. No QPL.
8. MIL-A-52222 Adhesive, for repair of poncho lightweight with hood, 14 May 1962. No QPL.

9. MIL-A-52264 Adhesive, synthetic-rubber; nitrile-rubber and vinyl-resin base (for bonding prefabricated airfield and road surfacing membrane), 15 January 1963. No QPL.

Thermoset Plastics

10. MIL-A-927 Adhesive: synthetic resin (for phenolic laminates), 16 September 1952. Has QPL.
11. MIL-A-52194 Adhesive, epoxy (for bonding glass reinforced polyester), 22 January 1963. No QPL.
12. MIL-A-46051 Adhesive, room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine base), 20 November 1961. Has QPL.
13. MMM-A-00181 Adhesive, room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine resin), 9 March 1964. No QPL.

Specific Mixed Plastic Assembly Adhesives

Plastic/Wood

14. MMM-A-00130 Adhesive, contact, 2 October 1961. No QPL.
15. MMM-A-188 Adhesive: urea-resin-type (liquid and powder), 8 November 1960. No QPL.

Plastic/Metal

16. MIL-T-6841 Tape, adhesive, rubber and cork composition, 12 August 1957. Has QPL.
17. MIL-S-11031 Sealing compound, adhesive: curing (polysulfide base), 7 September 1951. Has QPL.
18. MIL-S-11030 Sealing compound, noncuring, polysulfide base, 28 July 1954. Has QPL.
19. MIL-A-13554 Adhesive for cellulose nitrate film on metals, 26 July 1954. No QPL.
20. MIL-A-46028 Adhesive, flashout, cold-setting (water cured), 29 January 1959. No QPL.
21. MIL-A-21366 Adhesive, plastic table top material to aluminum bonding, 11 May 1960. No QPL.
22. MIL-A-22434 Adhesive, polyester, thixotropic, 7 March 1961. No QPL.

Plastic/Plaster

23. CS 168-50 Polystyrene plastic wall tiles, and adhesives for their application, 15 July 1950. Has QPL.

General Purpose Plastic Adhesives

Acrylic

24. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.

Cellulosic

25. MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.

Epoxy

26. AMS 3690 Adhesive compound, epoxy, room temperature curing, 15 January 1960. No QPL.
27. AMS 3691 Adhesive compound, epoxy, medium temperature application, 15 January 1960. No QPL.
28. AMS 3692 Adhesive compound, epoxy, high temperature application, 15 January 1960. No QPL.

Adhesive Materials, Their Properties and Usage

29. MIL-A-8623 Adhesive, epoxy resin, metal to metal structural applications, 23 September 1960. Has QPL.
30. MIL-A-14042 Adhesive, epoxy, 17 July 1959. Has QPL.
31. MIL-A-005090 Adhesives, heat resistant, airframe structural metal to metal, 22 April 1963. Has QPL.
32. MIL-A-25463 Adhesive, metallic structural sandwich construction, 19 October 1961. Has QPL.

Rubber

33. MIL-C-4003 Cement; general purpose, synthetic base, 19 March 1954. Has QPL.
34. MIL-A-5092 Adhesive, rubber (synthetic and reclaimed rubber base), 27 August 1952. Has QPL.
35. MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding) 7 November 1960. No QPL.
36. AMS 3685 Adhesive, synthetic rubber, Buna-N type, 1 December 1951. No QPL.

Vinyl

37. MIL-C-18726 Cement, vinyl alcohol-acetate, 11 June 1956. No QPL.

Adhesive Process Specifications

38. MIL-G-6803 Gluing, application of cold-setting resin (urea type), 25 July 1961.
39. MIL-A-5433 Adhesive, application of room-temperature and intermediate-temperature setting resin (phenol, resorcinol and melamine base), 30 November 1954.
40. MIL-A-9067 Adhesive bonding, process and inspection requirements for, 16 March 1961.

7. METAL ADHESIVES

Adhesive bonding of metals is a comparatively recent development. The significantly different character of the metal surface does not lend itself to bonding using adhesives which are commonly employed for wood, rubber, plastics and paper.

Specialized adhesives have been developed which permit joining of metals. They accomplish bonding by a combination of certain reactions. The first is usually a prerequisite for structural or high load bearing joints. It consists of a chemical reaction between the adhesive and the metal surface, either directly or through an intermediate layer such as copper sulfide in rubber/brass joints. The second is usually for nonstructural or low load carrying joints. It consists of secondary bridging resulting from residual energy fields surrounding each molecule which cause mutual attraction between the adhesive and metal substrate.

Currently, adhesives for metals are conveniently classified into (1) straight metal assembly adhesives, (2) specific mixed metal assembly adhesives and (3) general purpose metal adhesives.

STRAIGHT METAL ASSEMBLY ADHESIVES

Adhesives for strictly metal assemblies are available for structural purposes involving high load carrying joints and for nonstructural purposes where little or no load is imposed on the joint.

Structural Adhesives

These adhesives provide the highest strengths currently available. Although some are room temperature curing, they usually require curing at elevated temperatures, especially when the joint is to sustain loads at high temperatures. These adhesives are available for nonsandwich and sandwich type structures.

Vinyl and epoxy base adhesives are used for structural metal assemblies. The vinyls, however, provide lower strength and less resistance to both water and organic fluid contact. They can be cured much more rapidly under pressure than the epoxies; nevertheless, they require very high bonding pressures, which limit their usage to flat assemblies (Reference 1).

There are seven epoxy adhesives suitable for structural metal bonding. Three of these are employed predominantly in electrical applications since they are specifically formulated to readily bond many of the metals used in electrical equipment construction. For this reason, they are commonly called electrical adhesives. They provide joints with strengths almost as high as the regular structural epoxy adhesives.

The electrical epoxy adhesives offer options on curing conditions. The room temperature curing variety is suitable for service up to 185 F (Reference 2), the intermediate temperature curing variety up to 250 F (Reference 3) and the high temperature curing variety up to 500 F (Reference 4).

The epoxy adhesives for structural applications also offer options on processing conditions. The first is room temperature curing, but curing at 160 F to reduce processing time is acceptable (Reference 5). It is suitable for service up to 160 F. The second offers options on curing conditions and has somewhat higher mechanical properties than the first (Reference 6). It is suitable for service up to 180 F. The third, also with processing options, offers outstanding resistance to temperatures as high as 500 F (Reference 7).

The fourth structural epoxy adhesive is for specialized bonding work involving sandwich structures. These structures are integrated sheet assemblies consisting of a thick lightweight material (honeycomb core) securely sandwiched between two thin hard sheets (facings), thus, the name sandwich panel (see Figure 1). This construction provides structures of improved strength and stiffness. It is used for parts requiring greater stiffness than can be achieved with straight sheet material of comparable weight or, conversely, to produce lighter parts of comparable stiffness. The epoxy adhesives used for these structures form fillets around each of the honeycomb cell walls to achieve the necessary bond strength. These adhesives offer options on processing conditions and have, dependent on type, outstanding resistance to temperatures as high as 500 F (Reference 8).

All of the aforementioned seven epoxy adhesives are also suitable for bonding plastics, rubber, wood and glass. However, allowable design values should be established experimentally for each nonmetal joint utilizing any of these adhesives.

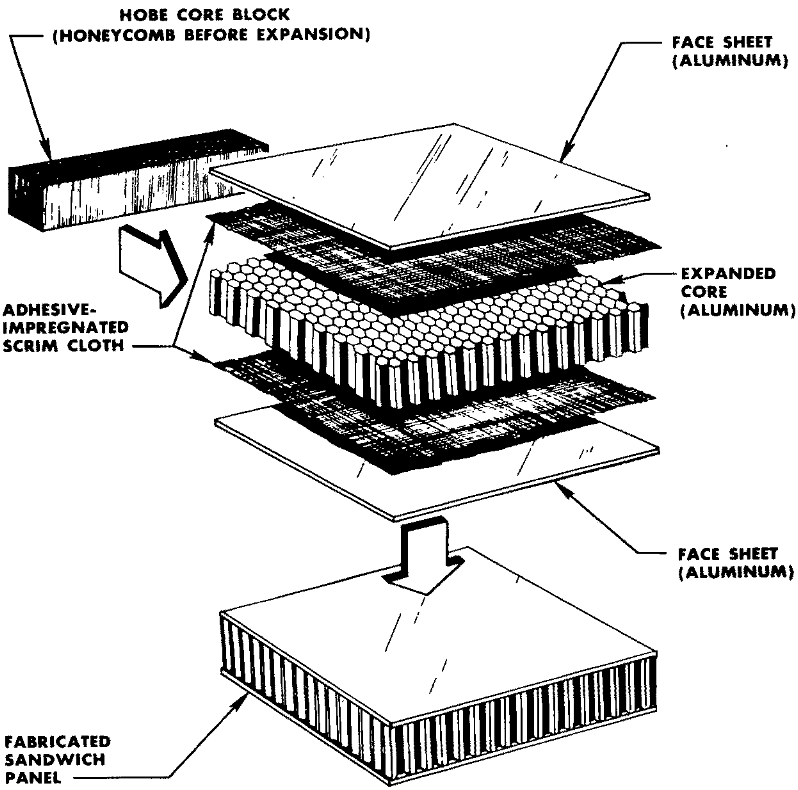
The processing techniques required of fabricators using epoxy adhesives are available (Reference 29).

Nonstructural Adhesives

These adhesives are used in bonding metal foils, plugging seams and set screws, preventing corrosion (see Chapter 11), repairing metal surfaces (see Chapter 11), adhering electrical insulation (see Chapter 9) and labeling materials (see Chapter 8).

Thin metal foils can be adhered to bare or painted metal substrates using polysulfide, neoprene or nitrile rubber base, room temperature curing adhesives (Reference 9). The resulting joint can sustain vibration and mechanical shock including impact. These adhesives are suitable for bonding metal identification plates.

Figure 1. Sandwich Panel Construction.



Metal parts may contain seams into which dirt and water tend to collect. These openings can be effectively sealed with pressure-sensitive adhesive tapes (Reference 10). Other metal parts such as metal ducts are not tight after assembly. Heated air, for example, will readily escape through the seams. Pressure-sensitive adhesive tapes, by bonding the joints, can reduce this leakage, provided the temperatures do not exceed 350 F (Reference 11).

Set screws are sometimes used to hold components together in an assembly. It may be desirable for reasons of appearance to seal and plug the openings. Ethyl cellulose cements in red, yellow, black and olive drab colors are available which dry tack free in four hours and hard in twenty four hours (Reference 12).

MIXED METAL ASSEMBLY ADHESIVES

In bonding a metal to a nonmetallic component, differences in surface composition of the adherends as well as different coefficients of expansion must be taken into consideration. A single adhesive, with the possible exception of specially compounded polyesters and epoxies, is not generally suitable for highly loaded dissimilar joints. These joints are effected readily with tie cements baked on the metal component to give the chemical adhesion necessary; then these coated metal substrates are bonded with an adhesive specific for the nonmetallic component and tie cement. Single adhesives are available for dissimilar joints subject to little or no load.

Thus, adhesives for these applications are best classified according to the type of loading conditions and the type of joint they can effect.

Structural Adhesives

Structural adhesives are available for metal/wood, metal/glass and metal/plastic laminate joints.

Metal/Wood. These bonding materials are available as a single and a double adhesive system (Reference 13). The former system is not suitable for sandwich panel construction, while the latter is adaptable to both sandwich and nonsandwich type structures. The latter system offers an option on the processing of the secondary or wood adhesive. The option consists of room temperature, intermediate temperature or high temperature curing conditions. The single adhesive system and the primary or metal adhesive of the double adhesive system are both cured at temperatures as high as 335 F. In areas where limited temperature or no heat can be applied, the double adhesive system is used, provided the metal constituents can be baked with the primary adhesive prior to assembly. Both types give essentially equivalent strength properties.

Metal/Glass. High strength joints are achieved with a double adhesive system (Reference 14). The metal component is coated with an oven baked neoprene modified adhesive and then the joint effected with a thermosetting adhesive, either liquid or film, cured at temperatures up to 275 F and 25 psi bonding pressure.

Metal/Plastic. A single polyester base adhesive has been formulated to bond epoxy laminates to stainless steel where voids up to 0.020 inches are to be bridged on vertical and horizontal surfaces (Reference 15). The adhesive is room temperature cured and should not be subjected to elevated temperature service.

Nonstructural Adhesives

Nonstructural adhesives are available for metal/rubber, metal/wood, metal/plastic and metal/paper joints.

Metal/Rubber. Neoprene, SBR and nitrile rubbers, especially in the form of gaskets, are bonded to steel with room temperature curing adhesives (Reference 16). They resist the action of salt water but are susceptible to elevated temperatures.

Silicone rubber moldings are bonded to metal with room temperature curing adhesives capable of withstanding high moisture, oil and elevated temperature conditions (Reference 17).

Metal/Wood. Corkboard is bonded to metal surfaces with both fast and slow setting adhesives; however, the slow setting adhesive is preferred in dead air spaces where fire or personnel hazards exist (Reference 18). Chipboard is bonded with adhesives to terneplate, tinplate and zincplate, producing low strength joints not possessing water, oil or moisture resistance (Reference 19).

Metal/Plastics. The bonding of plastics to metals is covered in Chapter 6.

Metal/Paper. The bonding of paper to metal is covered in Chapter 9.

GENERAL PURPOSE METAL ADHESIVES

General purpose adhesives provide joints suitable for nonstructural purposes. They are all single adhesive systems based on acrylic, cellulosic, rubber and vinyl materials.

Acrylic Adhesive

This adhesive, unlike the rest in this category, can provide high strength joints suitable for some structural purposes provided it is not subjected to moist or elevated temperature conditions (Reference 20). It should be used only where rapid room temperature bonding is the primary consideration, since it is exceedingly expensive. This adhesive will adhere practically any material to metal.

Cellulose Adhesive

This adhesive is known as the original *household* cement (References 21, 22). It will bond paper, fabric, glass, leather and some plastics to metal, under room temperature curing conditions.

Rubber Adhesives

There are four general purpose rubber adhesives for bonding materials to metal. Each gives an option on environmental resistance.

The first offers good resistance to air, oil and water exposure (Reference 23). It will bond fabrics, neoprene and polyvinyl chloride to metal.

The second, dependent on type, offers resistance to gasoline exposure (Reference 24). It will bond paper, fabrics, leather, wood, rubber and plastics including laminates to metal.

The third offers resistance to aromatic fluid exposure (Reference 25). Dependent on type, it can be cured at room temperature conditions. It will bond fabrics, rubber, plastics including laminates and explosives to metal.

The fourth offers good resistance to lubricating oil exposure and fair resistance to aromatic fuel exposure (Reference 26). It will bond fabric, rubber and plastics to metals.

Vinyl Adhesives

These adhesives compete with the cellulose adhesives in bonding materials to metals. They do not possess any of their flammability characteristics but offer inferior moisture resistance (References 27, 28).

BIBLIOGRAPHY

Straight Metal Assembly Adhesives

Structural

1. MIL-A-13792 Cement, vinyl acetate base, solvent type, 17 November 1954. No QPL.
2. AMS 3690 Adhesive compound, epoxy, room temperature curing, 15 January 1960. No QPL.
3. AMS 3691 Adhesive compound, epoxy, medium temperature application, 15 January 1960. No QPL.
4. AMS 3692 Adhesive compound, epoxy, high temperature application, 15 January 1960. No QPL.
5. MIL-A-14042 Adhesive, epoxy, 17 July 1959. Has QPL.
6. MIL-A-8623 Adhesive, epoxy resin, metal to metal structural bonding, 23 September 1960. Has QPL.
7. MIL-A-005090 Adhesives, heat resistant, airframe structural, metal to metal, 22 April 1963. Has QPL.
8. MIL-A-25463 Adhesive, metallic structural sandwich construction, 19 October 1961. Has QPL.

Nonstructural

9. MIL-A-22895 Adhesive, metal identification plate, 25 June 1962. No QPL.
10. MIL-T-17991 Tape; wing slot, waterproof, noncorrosive, pressure-sensitive, 16 April 1954. No QPL.
11. MIL-T-4053 Tape, pressure-sensitive adhesive, corrosion-resistant, 20 August 1962. No QPL.
12. MIL-C-13704 Cement, sealing or plugging, 7 November 1955. No QPL.

Mixed Metal Assembly Adhesives

Structural

Metal/Wood

13. MIL-A-928 Adhesive, metal to wood, structural, 31 March 1955. Has QPL.

Metal/Glass

14. MIL-A-14443 Adhesive: glass-to-metal (for bonding lenses), 17 October 1961. Has QPL.

Metal/Plastic

15. MIL-A-22434 Adhesive, polyester, thixotropic, 7 March 1961. No QPL.

Nonstructural

Metal/Rubber

16. MIL-A-1154 Adhesive, bonding vulcanized synthetic rubber to steel, 4 April 1963. Has QPL.

17. MIL-A-25457 Adhesive, air-drying, silicone rubber, 18 March 1957. Has QPL.

Metal/Wood

18. MIL-A-18065 Adhesive, high initial bond, 17 December 1959. Has QPL.
19. MIL-A-45059 Adhesive for bonding chipboard to terneplate, tinplate and zincplate, 3 February 1964. No QPL.

General Purpose Metal Adhesives

Acrylic

20. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.

Cellulosic

21. MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.
22. MIL-A-11238 Adhesive, cellulose nitrate (for ordnance use), 18 September 1962. No QPL.

Rubber

23. MIL-C-4003 Cement; general purpose, synthetic base, 19 March 1954. No QPL.
24. MIL-A-5092 Adhesive, rubber (synthetic and reclaimed rubber base), 27 August 1952. Has QPL.
25. MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding), 7 November 1960. No QPL.
26. AMS 3685 Adhesive, synthetic rubber, Buna-N type, 1 December 1951. No QPL.

Vinyl

27. MMM-A-180 Adhesive, polyvinyl acetate resin emulsion (alkali dispersible), 1 July 1963. No QPL.
28. MIL-C-18726 Cement, vinyl alcohol-acetate, 11 June 1956. No QPL.

Adhesive Process Specifications

29. MIL-A-9067 Adhesive bonding, process and inspection requirements for, 16 March 1961.

8. PACKAGING ADHESIVES

Packaging is a process employed for demonstrating, shipping and storing products. The packages are predominantly paper base, although recently plastics are being actively used. Adhesives are a basic component of every package. They fall into four general categories. These are for (1) carton manufacture, (2) carton closure, (3) packing and (4) labeling. Chapter 6 covers adhesives for plastics.

CARTON MANUFACTURE

Paper bags, spirally wound tubes and fiberboard cartons are the basic packaging forms. Silicate, animal glue, dextrin, jelly gum, resin emulsion, casein, rubber latex and hot melt adhesives are used to construct these basic forms. These adhesives offer wide adaptability to both treated and untreated paper base stocks and wide resistance to humidity and water. The relative performance characteristics are given in Table 1.

Paper Bags

Paper bags are constructed with a bottom and side seam which is joined with adhesives. The solvent base, water emulsion or hot melt varieties are suitable for waterproof bags (References 1, 2). Where water resistance is not required, the other adhesives such as the silicate glues can be used (Reference 3).

Spiral Tubes

Spiral tubes are constructed by winding adhesive coated paper on a mandrel. The thickness is determined by the number of laminations used. Silicate (Reference 3), dextrin (Reference 4) and animal glue (Reference 5) are used for this purpose.

Fiberboard Cartons

Fiberboard cartons are constructed from corrugated or laminated stock. Silicate glues are predominantly used for this purpose (Reference 3); however, dextrins are fast becoming competitive with the silicates. Unfortunately, no specifications are currently available covering dextrins for this purpose. Whenever waterproofness is required, the solvent base, water emulsion or hot melt adhesives (References 1, 2) are used to attach surface liners.

The corrugated stock is manufactured by taking a sheet of paper usually 9 mils thick, softening it by steaming, and forming it into corrugations on a steam heated, fluted roll. The adhesive is applied to the fluted tips using between 7 and 10 pounds per 1000 square feet for silicates and then a liner, usually between 10 and 30 mils thick, is applied under 150 psi bonding pressure. The other fluted side is coated with additional adhesive usually between 10 and 12 pounds per 1000 square feet for the silicates and a second liner pressed on under 15 psi bonding pressure.

The laminated stock is manufactured by taking adhesive coated sheets up to 6 pounds per 1000 square feet for silicates, stacking one upon the other, and bonding under pressures up to 800 psi. The silicate glue used here is usually modified with clay to have the viscosity between 200 and 500 centipoises.

CARTON CLOSURES

Paper bags and fiberboard cartons require adhesive bonding for closure. The spirally wound tubes use closures which are generally removable.

The same adhesives used for manufacturing the bag can be used for closing it (References 1, 2, 3).

Fiberboard boxes are sealed with adhesives consistent with the humidity requirements and surface conditions of the carton (References 6, 7). Silicate glues are used where moisture resistance is not required (Reference 3) and animal glues, compatible with explosives, for ammunition cartons (Reference 8).

Certain fiberboard cartons use paper wraps on the surface as covers. These are adhered with the solvent base, water emulsion and hot melt adhesives (References 1, 2). This operation is expensive because of the amount of hand labor involved.

Spirally wound fiberboard containers use pressure-sensitive adhesive polyester tapes whenever closure is necessary (Reference 9). These tapes, although readily removable, even at low temperatures, are suitable for temporary sealing. They are compatible with ammunition containers.

PACKING

Packing consists of (1) reinforcing and sealing cartons, (2) sealing container closures and (3) preservation applications.

Reinforcing and Sealing

Cartons are closed by mechanically locking the flaps or by adhesive bonding. These joints in many instances require sealing and additional reinforcement. These are accomplished with gummed and pressure-sensitive adhesive tapes. The choice of the tape is dependent upon the moisture and weathering resistance requirements, the type of surface to be adhered and the amount of expected load.

The basic reinforcing and sealing tapes which are not intended for severe moisture or environmental conditions are available in both the gummed (Reference 10) and pressure-sensitive adhesive (Reference 11) varieties. The pressure-sensitive tapes are more convenient but significantly more expensive than the gummed counterparts.

Three reinforced tapes are available where additional strength is necessary. The first (Reference 12), containing a glass, sisal or rayon fiber reinforcement with an asphalt or other coating, gives at least 35% better performance than the unreinforced tape (Reference 10). The asphalt coated tape is not generally suitable for food cartons. The second, containing unspecified reinforcing fibers, available with low and high elongations, provides the widest and highest strength characteristics for gummed tapes (Reference 13). The third (Reference 14) is a reinforced pressure-sensitive adhesive tape available, dependent on type, with some weathering resistance.

When high humidity and weathering resistance is necessary, gummed paper, pressure-sensitive cotton, vinyl and other tapes are available. The gummed paper tape provides the lowest mechanical strength of the water resistant types (Reference 15). The cloth base pressure-sensitive adhesive tape provides somewhat superior properties (Reference 16). The other pressure-sensitive tapes have comparable mechanical properties, but are much more resistant to penetration by water (References 17, 18). The latter, dependent on type, is intended for application to both the interior and exterior of cartons.

Sealing Container Closures

Certain containers containing screw caps and stoppers require subsequent sealing. This is readily accomplished with polyvinyl chloride base pressure-sensitive adhesive tapes because of their high elongation characteristics (References 17, 19). These tapes offer excellent resistance to weathering, sunlight, water, oils, solvents, acids and bases.

Preservation Applications

Pressure-sensitive adhesive tapes are used for preservation purposes. These include (1) protection of complex machinery from outdoor weathering, (2) protection of fragile materials during handling, (3) sealing vents and louvres of equipment and openings in dehydrated containers, (4) edging and mending documents for handling and subsequent storage and (5) waterproofing applications.

Weathering. Two types of pressure-sensitive adhesive tapes are available for protecting complex machinery such as missiles, rockets, airplanes and ground support equipment against the deleterious effects of outdoor weathering for protracted periods. One offers better moisture resistance (Reference 20) and the other, dependent on type, resistance to oil (Reference 21). The latter will not stain lacquers; and both types can be readily removed.

Handling. Whenever fragile materials are to be handled, asphalt coated gummed tapes (Reference 12) and vinyl pressure-sensitive adhesive tapes (Reference 22) will provide some measure of protection. Porcelain enamel can be protected against abrasion with the gummed tape.

Sealing. Certain equipment containers have openings which require sealing during shipment or storage. This can be accomplished readily with pressure-sensitive adhesive tapes (References 18, 19, 23). They have good resistance to moisture and can be easily removed.

Mending. Paper documents are subject to damage during handling and storage. Pressure-sensitive adhesive tapes using a laminated cellulose acetate-paper backing which accepts writing (Reference 24) and those using transparent and colored cellulose acetate and cellophane backings (Reference 25) are available for edging and mending these documents.

Waterproofing. Certain packages require waterproofing during storage. Asphalt (Reference 26) and mixtures of gutta percha rubber and coal tar pitch (Reference 27), applied by brushing, provide the necessary resistance. Pressure-sensitive adhesive polyester tapes are also useful for this purpose (Reference 9). These materials are compatible with explosives.

LABELING

Identification markings are made with (1) paper labels, (2) metal plates, (3) radioactive substances, (4) plastic tapes, (5) decalcomanias and (6) paint or ink. All of these markings are made with adhesives.

Paper

Paper labels can be obtained with either adhesive or nonadhesive backings. The adhesive backed labels, in rectangular, circular and elliptical shapes, with and without colored borders, are available with gummed backings activated with water or with pressure-sensitive adhesive backings which can be applied directly (Reference 28). These labels can be written upon and two hours after application cannot be removed without tearing the substrate or label. These and other labels described below can be protected against moisture and weathering with transparent vinyl (Reference 17) and polyester (Reference 40) tapes.

Nonadhesive backed labels can be bonded with a multitude of adhesives. Three nontoxic adhesives are available. One controls the flammability of the material during application by requiring a water emulsion base (Reference 29). The second may use a flammable organic solvent base (Reference 30). Nevertheless, both adhesives are fire resistant when dry. The former has outstanding resistance to moisture, but it is not intended for substrates subjected to flexing during service. These adhesives will adhere paper labels to wood, fiberboard, black oxide and galvanized iron, glass, tin, rubber and painted metal surfaces.

The third nontoxic adhesive for adhering paper labels is formulated from cellulose nitrate which is flammable (Reference 31). It is suitable for labeling soft wood, plywood and fiberboard.

Silicates are employed to adhere paper labels to paper and wood surfaces where moisture resistance is not required (Reference 3). Other adhesives for general purpose paper bonding can be used for labeling applications. These are covered in Chapter 3.

Metal

Metal plates are used for labeling equipment. These plates are also furnished with either adhesive or nonadhesive backings.

The adhesive backed metal plates, containing a solvent-activated film or a pressure-sensitive adhesive, are available in a multitude of sizes, markings and colors (Reference 32). The bonded plates can sustain weathering, salt spray, water, hydrocarbons, cleaning compounds, temperatures as low as -55F and abrasion without loss of adhesion.

The nonadhesive backed plates can be bonded directly to painted or unpainted surfaces with either polysulfide or rubber base adhesives (Reference 33). These adhesives can sustain vibration and mechanical shock including impact.

Radioactive Substances

Certain packaging applications require visual identification in locations free of light. These applications can be accommodated by bonding radioactive luminous compounds consisting of zinc sulfide and a radioactive substance (Reference 34). The adhesive, dependent on type, is suitable for exposure to air and for immersion in liquids.

Plastic

Plastics are used for labeling purposes, including color coding. They are more durable than paper but less than the metal counterparts. These labels are all adhesive backed and are used for (1) moderate temperature, (2) severe temperature and (3) extreme weathering applications.

Moderate Temperature. Cellulose acetate pressure-sensitive adhesive tapes are suitable for (1) labeling high value items and their shipping containers (Reference 35), (2) for resealing envelopes opened for inspection (Reference 36) and (3) for semipermanent and permanent color coding and labeling of containers (Reference 24). All three of the tapes can sustain 72 hours exposure to 120 F; and the latter two can withstand 30 hours exposure to 150 F. The first two labels are preprinted with a legend denoting their purpose, and the third is printable and available in a multitude of colors.

In certain packaging applications it is necessary to attach riders, premiums, samples or decorations. This is effectively implemented with double adhesive backed tapes which, dependent on type, use a transparent, translucent or opaque backing (Reference 37). The latter two are paper base. The tape can sustain radiation by ultraviolet light and temperatures as high as 150 F under high humidities without loss of adhesion, even to metals.

Electric circuits are marked with pressure-sensitive adhesive tapes stable as low as -80 F and as high as 180 F without affecting legibility of the printing (Reference 38). These tapes, dependent on type, can accept writing for use during field servicing operations where the preprinted tape varieties are not available.

Severe Temperature. Fluid lines are subject to severe temperature conditions. They are marked with pressure-sensitive adhesive tapes which are noncorrosive to the substrate and resistant to solvents and temperatures up to 325 F (Reference 39). The tapes are preprinted on silver or white backgrounds and can be used for other applications subject to similar severe temperature conditions. Lines operating at lower temperatures can use polyester tapes which are subsequently described (Reference 40).

Extreme Weathering. Polyvinyl chloride pressure-sensitive adhesive tapes are suitable for severe environmental exposure such as to sunlight, water, oils, solvents, acids, alkalies and abrasives (Reference 19). These tapes, dependent on type, are transparent, colored and printable. The colored tape can be used for color coding under these conditions.

An analogous polyester pressure-sensitive adhesive tape is suitable for similar environmental conditions including contact with Skydrol, except for exposure to acids and alkalies (Reference 40). It is furnished transparent or colored. The transparent tape can be used to protect labels and the colored tape for color coding.

Decalcomanias

Decalcomanias are used for special customized labeling applications (Reference 41). Once applied, they cannot be separated from bare or lacquered and enameled metal surfaces by scraping even with a knife or by immersion in water or naphtha.

Stencil Markings

Packages and equipment may require labeling with insignia, designs and letters. These markings are made by spraying or brushing paint or ink over stencils which are bonded to the surface to be labeled. The adhesive is a nonwater base material which can adhere stencils to painted surfaces (Reference 42). It will prevent seepage of paint under the stencil and can be readily removed from the substrate.

Pressure-sensitive adhesive tape precut into letters is also available for letter labeling (Reference 43). It will not lift under 90 pounds spray paint pressure, is not penetrated by the paint and can be removed without lifting any underlying paint.

TABLE I. PROPERTIES OF PACKAGING ADHESIVES.

	RESISTANCE		ADHESION	
TYPE	HUMIDITY	WATER	UNTREATED SURFACES	TREATED SURFACES (1)
Silicate	Good	None	Good	Poor (2)
Animal Glue	Good	None	Good	Poor
Dextrin	Good	None	Good	Poor (2)
Jelly Gum	Excellent	None	Good	Poor (2)
Resin Emulsions	Excellent	None (3)	Excellent	Poor (2)
Casein	Good	Good	Good	Poor (2)
Rubber Latex	Excellent	Good	Excellent	Good
Rot Melts	Excellent	Excellent	Excellent	Good

(1) Paper surfaces are treated with varnish, wax, resins, etc., to improve appearance, water resistance and weathering characteristics.
(2) The adhesive may be specially formulated to adhere to treated surfaces.
(3) The adhesive can be formulated for water resistance.

BIBLIOGRAPHY

Carton Manufacture

(1) MIL-A-140 Adhesive, water-resistant, waterproof barrier-material, 23 November 1951. Has QPL.
(2) MMM-A-00260 Adhesive, water-resistant (for sealing waterproof paper),' 15 October 1962. No QPL.
(3) O-S-605 Sodium silicate solutions, 1 September 1960. No QPL.
(4) MIL-A-13374 Adhesive, dextrin (spiral tube winding for ammunition containers), 20 December 1956. No QPL.
(5) MMM-A-100 Adhesive, animal-glue, 10 December 1963. No QPL.

Carton Closures

(6) MIL-A-101 Adhesive, water-resistant, for sealing fiberboard boxes, 12 March 1952. Has QPL.
(7) MMM-A-00250 Adhesive, water-resistant (for sealing fiberboard boxes), 15 October 1962. No QPL.
(8) MIL-G-20469 Glue (for use in loading ammunition), 27 November 1951. No QPL.
(9) MIL-T-43036 Tape, pressure-sensitive adhesive, plastic film, filament reinforced (for sealing fiber containers and cans), 29 March 1963. No QPL.

Packing

(10) UU-T-111 Tape; paper, gummed (sealing and securing), 14 September 1960. No QPL.
(11) PPP-T-76 Tape, pressure-sensitive adhesive paper (for carton sealing), 16 July 1963. No QPL.
(12) PPP-T-45 Tape, gummed, paper, reinforced, 15 September 1960. No QPL.
(13) MIL-T-4601 Tape; filament reinforced, gummed, 1 March 1954. No QPL.
(14) PPP-T-97 Tape; pressure-sensitive adhesive, filament reinforced, 12 December 1962. No QPL.

(15) UU-T-116 Tape, paper, gummed, water-resistant, 7 October 1952. No QPL.
(16) AMS 3810 Tape, adhesive, cloth back, 15 June 1953. No QPL.
(17) PPP-T-0070 Tape, pressure-sensitive, (packaging grade vinyl plastic film), 17 January 1964. No QPL.
(18) PPP-T-0060 Tape; pressure-sensitive adhesive, waterproof—for packaging and sealing, 30 November 1961. Has QPL.
(19) PPP-T-66 Tape; pressure-sensitive adhesive, vinyl plastic film, 11 December 1963. No QPL.
(20) MIL-T-43115 Tape, pressure-sensitive adhesive; for preservation and sealing, 23 October 1962. No QPL.
(21) MIL-T-22085 Tape, pressure-sensitive adhesive, preservation and sealing, 1 June 1961. Has QPL.
(22) HH-T-0025 Tape, pressure-sensitive adhesive, plastic (for electroplating), 17 January 1964. No QPL.
(23) HH-T-0029 Tape, pressure-sensitive adhesive, lead foil, 17 January 1964. No QPL.
(24) L-T-99 Tape, pressure-sensitive adhesive, identification (acetate fiber), 11 September 1958. No QPL.
(25) L-T-90 Tape, pressure-sensitive adhesive (cellophane and cellulose acetate), 13 January 1961. Has QPL.
(26) MIL-A-3029 Asphalt, waterproofing (for use in manufacturing of fiber ammunition containers), 17 April 1950. No QPL.
(27) MIL-C-20299 Compound, adhesive, waterproof, 21 November 1951. No QPL.

Labeling

(28) UU-L-49 Labels; paper, gummed, 8 August 1956. No QPL.
(29) MIL-A-52247 Adhesive: paper label, water resistant, water emulsion type, 18 June 1963. No QPL.
(30) MIL-A-3941 Adhesive, paper label, water-resistant, 19 March 1959. No QPL.
(31) MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.
(32) MIL-P-19834 Plates, identification, metal foil, adhesive backed, 30 September 1960. Has QPL.
(33) MIL-A-22895 Adhesive, metal identification plate, 25 June 1962. No QPL.
(34) TT-R-58 Radioactive-luminous-compound and adhesives, 9 April 1941. No QPL.
(35) MIL-L-26147 Label tape, pressure-sensitive adhesive, legended RUSH HI-VALUE, 26 February 1959. No QPL.
(36) MIL-T-2463 Tape, censorship, military censor-civil mails, 26 September 1950. No QPL.
(37) UU-T-91 Tape, pressure-sensitive adhesive, double-coated, 5 December 1962. No QPL.
(38) MIL-T-14379 Tape, pressure-sensitive adhesive; electric circuit marker, automotive, 25 May 1959. Has QPL.
(39) MIL-T-9906 Tape, aircraft tubing identification marker: noncorrosive, heat and solvent resistant, 27 March 1961. No QPL.
(40) L-T-100 Tape, pressure-sensitive adhesive, polyester film, 30 August 1960. No QPL.
(41) MIL-V-6093 Varnish, decalcomania, adhesive, 4 April 1961. Has QPL.
(42) MIL-A-3932 Adhesive, stencil, 29 October 1954. No QPL.
(43) UU-S-600 Stencil, pressure-sensitive, for vehicle identification, 12 August 1958. No QPL.

9. ELECTRICAL ADHESIVES

Electrical adhesives serve the dual purpose of bonding components together while simultaneously insulating them electrically. These adhesives are predominantly pressure-sensitive adhesive tapes. Whenever the application does not require insulation characteristics, bonding agents specific for the adherends, covered in other chapters, are used. There are, however, a select number of bonding materials intended for electrical applications in which no electrical characteristics are required. These adhesives are compounded specifically for joining materials commonly used in electrical equipment construction.

Electrical adhesive tapes provide a convenient method, if not the sole means in certain instances, for applying insulation to bare or partially insulated conductors. These tapes, which are in effect self-adhering insulation materials, consist of up to three components: a backing, the adhesive and a separator, the latter used when necessary to prevent blocking. Certain polyethylene and rubber tapes, however, combine the adhesive and backing into a single entity.

These tapes bond generally under hand pressure, either at ambient or elevated temperature. The former are called the pressure-sensitive adhesive tapes and the latter the pressure-sensitive thermosetting adhesive tapes.

Adhesive tapes 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.

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. These tapes are catalogued into primary insulation materials which are intended for direct contact against bare conductors and secondary insulation materials for overcoating and repair of primary insulation.

Primary Insulation Tapes

Rubber, polyethylene, polyvinyl chloride, teflon and glass base tapes are used for direct contact against bare conductors.

Rubber. This material was one of the first substances used for insulating electrical conductors. Currently, there are four rubber base adhesive tapes in common usage.

The first is the basic rubber splicing tape which is available in two grades (Reference 1). The first grade is intended for splicing wires and cables operating up to 600 volts, and the second, an ozone resistant type, for wire and cable splices operating at 2000 volts and over. Both tapes are cured at room temperature and the resulting insulated splice breakout does not conform to the original insulation contours.

The second is a specialized rubber tape intended for building up insulation on spliced electrical cables (Reference 2). Like the basic tape, it is cured at room temperature and the resulting insulated splice breakout does not conform to the original insulation contours.

The third is also a specialized rubber base tape (Reference 3) intended for use where the insulated splice breakouts must conform to the original insulation contours. It is available in two types. The first is for primary insulation applications and the second for secondary insulation applications; the latter are dealt with subsequently. Both types are molded at elevated temperature and pressure.

The fourth type is intended for insulating splices which must conform to original insulation contours and are subject to underwater usage (Reference 4). The tape is molded at elevated temperature and pressure. A tie cement is required.

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 5). This tape is similar to the rubber base tapes in that the backing and adhesive are one unit. It has, however, better electrical properties.

Polyvinyl Chloride. This tape is currently the most versatile for general splicing work, since it has high electrical resistance, thinness (reduced bulk), conformability, good storage life (2 years), resistance to chemicals and a low electrolytic corrosion factor (Reference 6).

Polytetrafluoroethylene. This tape is intended for insulating splices which are subjected to temperatures as high as 500 F. (Reference 7). They are satisfactory for underwater applications and unlike some of the rubber counterparts (Reference 4) 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.

Glass. These tapes (References 8, 9) are intended for effecting splices where high temperature resistance and the highest mechanical strength are necessary. Since glass has poor elongation qualities, it is also made available woven on the bias to make it adaptable for complex splices (Reference 9).

Secondary Insulation Tapes

Secondary insulation tapes are used for overcoating and repairing insulated conductors. Typical are friction and rubber tapes. The electrical properties are significantly lower than those of the primary insulation conductor tapes.

Friction. This tape is intended for general purpose work. It does not provide a moisture barrier and splice breakouts do not conform to original insulation contours (Reference 10). No special processing is required for application.

Rubber. Unlike the friction tape, the rubber tape is intended primarily for use where a moisture barrier is required and where splice breakouts must conform closely to the original insulation contours (Reference 3). They require elevated temperatures and pressures for application.

ELECTRICAL EQUIPMENT CONSTRUCTION AND REPAIR TAPES

In the construction and repair of electrical equipment, it is sometimes necessary to band or hold components together while simultaneously electrically insulating each of the constituents. Pressure-sensitive adhesive tapes provide one method for accomplishing both purposes.

Paper, cotton, cellulose acetate, polyethylene, polyester and glass base tapes are used for these purposes. These tapes with the exception of one polyester, one glass and polyethylene are all thermosetting materials; that is, they require heat for cure. They perform all the holding and insulating functions of the pressure-sensitive adhesive tapes but provide generally greater adhesion, higher solvent resistance and better temperature working capabilities.

These tapes are conveniently catalogued for the user according to their temperature resistance using the American Institute of Electrical Engineers (AIEE) classification system (see Table I).

Class A

Class A insulation tapes are suitable for use up to 105 C. Paper, cotton, cellulose acetate and polyethylene fall into this classification.

Paper. These tapes (Reference 11) are available in two styles, namely, flat and crepe. The crepe type is better suited for parts having odd shapes because of its better conformability characteristics.

Paper tapes are the most inexpensive electrical grade tapes. However, because of their comparatively high electrolytic corrosion factor, finished taped components have the lowest relative age life. Consequently, paper tapes are definitely not recommended for fine wires. They are acceptable for medium and heavy gage wires, since the amount of corrosion incurred on these wires is generally insignificant. Considerations, therefore, other than corrosion, usually determine the selection of other tapes over paper on larger gage wires.

These tapes are heat cured and commonly used for motor insulating, coil winding, repair of electric motors and reinforcing slot insulation.

TABLE I. TEMPERATURE LIMITATIONS OF ELECTRICAL MATERIALS

CLASS	TEMPERATURE °C, MAX
O	90
A	105
B	130
F	155
H	180
C	220 (1)

(1) Minimum.

Source: "General Principles Upon Which Temperature Limits are Based in the Rating of Electrical Equipment." American Institute of Electrical Engineers, Publication No. 1, 1957.

Cotton. This tape is available in one style only (Reference 11). Its properties and cost are similar to those of paper tapes except it has better mechanical strength. Consequently, it is used in preference to paper tapes whenever heavy wires are to be held in place or if armature coils are to be banded prior to forming.

This tape is heat cured and commonly used in small motors, dynamotor armatures, generators and transformer coils.

Cellulose Acetate. These tapes are available in two styles, namely, film and cloth (Reference 11). They are more expensive than the paper and cotton tapes. However, they have greater versatility because of the significantly lower electrolytic corrosion factor and better mechanical (viz., puncture resistance) and electrical properties. Components having small wire gages equal to or less than 28 can be handled with these tapes as well as those subjected to higher voltages.

The film tape has better resistance to moisture, higher dielectric strength under humid conditions and, because of its thinness, offers less build-up where space is at a premium.

These tapes are heat cured and commonly used in fine wire coils and transformers.

Polyethylene. These tapes are available in three thicknesses, namely, 7, 9 and 20 mils (Reference 11). They provide about the same minimum electrical properties as do the cellulose acetate film tapes. However, their mechanical strength, as well as puncture resistance, is inferior. Their advantage is that no heat, moisture or other preparation is necessary for application.

These tapes, because of their very low temperature resistance, cannot be used in certain conventional AIEE electrical insulation Class A applications where the upper temperature limit is expected for protracted periods. At the lower temperatures, they are useful where good dielectric strength and noncorrosiveness are required. They are commonly used where heat curing temperatures cannot be tolerated.

Class B

Class B insulation tapes are suitable for use up to 130 C. Polyester and certain glass base tapes fall into this classification.

Polyester. These tapes are available in two types (Reference 11). One is thermosetting, available in 2.5 and 3.5 mil thicknesses, and the other is pressure sensitive, available in 2.5 mil thickness.

These tapes are more expensive than the paper, cotton, cellulose acetate and polyethylene tapes. Nevertheless, they offer the best electrical properties and excellent mechanical strength second only to glass tapes. Their thinness assures minimum build-up in tight places, and because of its high adhesive-to-backing bond strength does not slip during application. These tapes should be considered where the cellulose acetate tape properties fall short of needed requirements. They can be used in applications ranging from fine wire to high voltage.

The pressure sensitive polyester tapes provide many of the same minimum properties as do the thermosetting polyester tapes. They are commonly used where heat curing temperatures of the thermosetting type cannot be tolerated.

Glass. This tape, generally containing a nonsilicone adhesive, is used where the highest mechanical strength is needed (Reference 11). Because of its relatively high electrolytic corrosion factor, it is not employed for fine wire applications.

This tape is heat cured and commonly used for securing coils and windings.

Class H

Class H insulation tapes are suitable for use up to 180 C. Only glass tape is currently available for applications subjected to these temperature conditions although polytetrafluoroethylene tape (Reference 7), previously discussed, is sometimes used.

Glass tape containing a silicone adhesive is used in applications requiring high temperature resistance and high mechanical strength (Reference 12). The tape needs no heat, moisture or other preparation prior to application. However, heating this tape at elevated temperatures improves its basic properties. It is commonly used for securing coils and windings.

ELECTRICAL CIRCUIT IDENTIFICATION TAPES

Identification tapes are intended for application over insulated conductors and, consequently, do not require specific electrical properties (Reference 13). These identification tapes are available in three types. The first type is printed with black letters on white and is intended for use during electrical manufacturing and assembly operations. The second is a nonprinted white tape, capable of accepting writing, and is intended for use during field servicing operations. The third is a transparent tape intended for laminating over the printable tape after circuit numbers have been printed. These tapes are commonly used for identifying automotive electric circuits.

ELECTRICAL CONSTRUCTION ADHESIVES

Whenever no specific electrical characteristics are required, components can be bonded with adhesives that are specific for the adherends. Epoxy adhesives, however, have been compounded for materials commonly used in electrical equipment construction. They are available in three operating ranges: -65 to 185 F (Reference 14); -65 to 250 F (Reference 15); and -65 to 500 F (Reference 16). The American Society for Testing and Materials has provided a standard for evaluating the electrical properties of these as well as other bonding agents. It is ASTM D1304, *Adhesives Relative to Their Use as Electrical Insulation.*

BIBLIOGRAPHY

Splicing Tapes

Primary Insulation Tapes:

1. HH-I-553 Insulation tape, electrical (rubber, natural and synthetic), 21 August 1962. No QPL.
2. MIL-T-17695 Insulation tape, electrical, filler type, flameproof, synthetic, 9 November 1960. No QPL.
3. MIL-T-13020 Tape, rubber unvulcanized, splicing and molding (Tapes TL-317/U and TL-318/U), 28 June 1956. No QPL.
4. MIL-T-22755 Tape, repair; magnetic minesweeping cable sheath, 11 December 1962. Has QPL.
5. MIL-I-3825 Insulation tape, electrical, self fusing, for use in electronic, communications and allied equipment, 27 March 1962. Has QPL.
6. MIL-I-7798 Insulation tape, electrical, pressure-sensitive adhesive, plastic, 25 September 1958. Has QPL.
7. MIL-T-23594 Tapes, pressure-sensitive adhesive, electrical; high temperature insulation, polytetrafluoroethylene, 8 February 1963. Has QPL.
8. MIL-I-18622 Insulation tape, electrical, pressure-sensitive adhesive, silicone rubber treated glass, electrical cable splicing, naval shipboard, 8 June 1960. No QPL.
9. MIL-I-22444 Insulation tape, electrical, self bonding silicone rubber treated bias weave glass, cable splicing, naval shipboard, 1 April 1962. No QPL.

Secondary Insulation Tapes:

10. HH-I-510 Insulation tape, electrical, friction, 20 June 1962. No QPL.

Electrical Equipment Construction Tapes

11. MIL-I-15126 Insulation tape, electrical, pressure-sensitive adhesive and pressure-sensitive thermosetting adhesive, 15 January 1964. No QPL.
12. MIL-I-19166 Insulation tape, electrical, high temperature glass fiber, pressure-sensitive, 19 July 1963. Has QPL.

Electrical Circuit Identification Tapes

13. MIL-T-14379 Tape, pressure-sensitive adhesive; electrical circuit marker, automotive, 25 May 1959. Has QPL.

Electrical Construction Adhesives

14. AMS 3690 Adhesive compound, epoxy, room temperature curing, 15 January 1960. No QPL.
15. AMS 3691 Adhesive compound, epoxy, medium temperature application, 15 January 1960. No QPL.
16. AMS 3692 Adhesive compound, epoxy, high temperature application, 15 January 1960. No QPL.

10. OPTICAL ADHESIVES

There are three 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, the optically inactive adhesives for affixing optical components to nonoptically active fixtures and the marking adhesives for adhering radioactive substances for visual displays.

OPTICALLY TRANSPARENT ADHESIVES

Optically transparent adhesives are used (1) to reduce the number of lens-to-air surface interfaces in multiple lens systems, thus cutting down on reflected light losses, (2) to adhere lens components of different refractive indices, such as in achromatic and apochromatic lenses in which images in the red, blue, etc., light are focused simultaneously and (3) to provide convenience in handling one lens complex rather than many lens components. Typical applications include camera and television lenses, range and height finders, military fire control instruments, telescopes, optical microscopes, contour projectors and magnifiers.

Glass and certain plastics are used when optical transparency or magnification are needed. A convenient system for designating transparent adhesives is based on the composition of the lens. Under this system, adhesives are defined as glass adhesives, plastics adhesives and general purpose adhesives adaptable for bonding both glass and plastics.

Glass Adhesives

Glass lenses are generally bonded with styrene modified polyester and styrene monomer base adhesives.

Styrene modified polyester (Reference 1) is the basic adhesive for bonding glass lenses. The limits of lint and dust particles in both the adhesive and activator are carefully controlled. Processing characteristics covering the manufacture, assembly and inspection requirements using this adhesive are available (Reference 16).

Styrene monomer (Reference 2) is used alone or as an ingredient of optical adhesives for bonding of glass lenses. However, when used alone, it undergoes significant shrinkage upon curing and can be used only where some shrinkage strains can be tolerated.

Plastics Adhesives

Plastic lenses are usually prepared from acrylic resins. Two adhesives are commonly used for adhering these lenses, both of which are based on methyl methacrylate. However, the first (Reference 3) contains methylene chloride as a solvent to provide a better mechanical lock on the harder heat-resistant acrylics. The second (Reference 4) is for essentially straight acrylics and contains no solvent. This adhesive can also bond the heat resistant acrylic lenses but offers poorer processing characteristics than the former adhesive.

General Purpose Adhesives

General purpose adhesives are adaptable for joining together any type of optical component. These adhesives are the modified acrylics and the oleoresin Canada balsam.

The general purpose acrylic adhesive is suitable not only for straight optical bonding but also for adhering optical components to metal, wood or plastic fixtures (Reference 5). The adhesive is a solventless, transparent cyanoacrylate which cures at room temperature under the action of atmospheric moisture and can be accelerated by painting the surfaces with catalyst prior to the application of the adhesive.

This adhesive is exceedingly expensive, and the bonds are not completely waterproof. It should be used only in cases where high speed, room temperature curing is the prime consideration.

Unfortunately, optical performance properties are not adequately defined and the mechanical properties are given using only metal adherends. Consequently, the user will have to establish allowable design values using this adhesive.

Canada balsam is an oleoresin exuded from the balsam fir *Abies Balsomoa* and contains no Oregon balsam, turpentine, colophony, spruce pitch or similar substances (Reference 6). It provides relatively weak joints consistent with natural base resins.

OPTICALLY OPAQUE ADHESIVES

In the construction of optical systems, it is sometimes necessary to adhere an optically active component to a fixture or to seal an optical system against entrance of moisture. Adhesives for these assemblies are best classified for the user according to the type of joint they can effect. Basically, these are for glass/metal or plastic/metal joints and general purpose adhesives adaptable to any type of optical lens/fixture joint.

Glass/Metal Adhesives

The rubber modified resin base adhesives are the basic materials used for bonding optical glass to metal (Reference 7). They are available as liquid or dry film systems. The liquid adhesive consists of two parts: the first, a neoprene modified thermosetting material, and the second, a modified thermosetting resin. The dry film adhesive system is also comprised of two parts. The first is a neoprene thermosetting material, identical to the one above, and the second, a fiberglass or polyamide reinforced film or an unsupported film.

Bonding is effected first by coating the metal surfaces with the neoprene modified material, then applying the liquid or film adhesive, followed by curing at pressures up to 25 psi and temperatures up to 275 F.

Plastic/Metal Adhesives

There are no adhesives specific for optical plastic/metal joints. Bonding of these components is carried out with general purpose optical adhesives.

General Purpose Adhesives

There are many adhesives adaptable for general purpose optical bonding. These are the polysulfides, rubber-cork adhesive tapes, epoxies, cellulosics and the previously discussed modified acrylics (Reference 5).

Polysulfides. There are two types of polysulfide adhesives. The first is the hardening type for making permanent joints, and the second is a nonhardening type used primarily for sealing applications.

The hardening polysulfide base adhesive is a two part system consisting of a black polysulfide base and an accelerator (Reference 8). Unless otherwise specified, 8 parts of accelerator to 8.5 parts polysulfide is used. At elevated temperatures, the adhesive produces no volatile constituents which craze or etch acrylic plastic lenses.

The noncuring polysulfide adhesive is available in two types (Reference 9). The first type has two classes, reflecting viscosity differences, and is for static sealing, while the second type is for rotary sealing applications and consists of 5.5 parts of the former type and one part grease. This adhesive also produces no volatile constituents during exposure to elevated temperatures which craze or etch acrylic plastic lenses. Additionally, it does not craze or crack stressed acrylic plastic.

Rubber-Cork Adhesive Tapes. These tapes are intended as a seal and packing for the installation of glass and acrylic plastic windshields, panels and windows (Reference 10). The tape consists of a backing composed of a mixture of granulated cork and a vulcanized sponge synthetic rubber binder calendared on print cloth coated with a synthetic or natural, but not reclaim rubber base adhesive, over which is applied a sized Holland cloth or polyethylene sheet liner.

The tape does not craze stressed acrylic plastic at elevated temperature.

Epoxies. There are two general purpose epoxy adhesives suitable for bonding glass or plastic optical components to metal, plastic or wood fixtures. The first (Reference 11) offers an option on curing conditions, and the second (Reference 12) is for room temperature curing operations, although curing at 160 F is acceptable.

There is an additional epoxy adhesive (Reference 13) which is intended for metal bonding, but experience has shown it can be used for specialized optical glass or plastic to metal joints. This adhesive, according to type, has outstanding resistance to elevated temperatures.

Since these adhesives define properties in terms of only metal adherends, the user will have to establish design values.

The processing techniques required of fabricators using epoxy adhesives are available (Reference 17).

Cellulosics. These cements are intended for sealing and plugging set screws in optical instruments (Reference 14). The paste cements are modified ethyl cellulose base materials available in red, yellow, black and olive drab colors, drying tack free in four hours and hard in twenty four hours.

OPTICAL MARKING ADHESIVES

Certain optical systems require the use of radioactive substances for specialized identification applications. An adhesive is available for adhering powdered radioactive luminous compounds consisting of zinc sulfide and a radioactive substance to various materials (Reference 15). It is available in two types. The first type is for exposure to air and the second for immersion in liquids.

BIBLIOGRAPHY

Optically Transparent Adhesives

Glass Adhesives

1. MIL-A-003920 Adhesive, optical, thermosetting, 11 July 1958. Has QPL.
2. MIL-S-14195 Styrene monomer, 22 November 1955. No QPL.

Plastic Adhesives

3. MIL-A-8576 Adhesive, acrylic monomer base, for acrylic plastic, 4 October 1956. No QPL.
4. MIL-A-25055 Adhesive, acrylic monomer and polymer base, for acrylic plastic, 17 June 1957. No QPL.

General Purpose Adhesives

5. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.
6. MIL-B-3469 Balsam, Canada, 5 July 1961. No QPL.

Optically Opaque Adhesives

Glass/Metal Adhesives

7. MIL-A-14443 Adhesive: glass-to-metal (for bonding of lenses), 17 October 1961. Has QPL.

General Purpose Adhesives

8. MIL-S-11031 Sealing compound, adhesive: curing (polysulfide base), 7 September 1951. Has QPL.
9. MIL-S-11030 Sealing compound, noncuring, polysulfide base, 28 July 1954. Has QPL.
10. MIL-T-6841 Tape, adhesive, rubber and cork composition, 12 August 1957. Has QPL.
11. MIL-A-8623 Adhesive, epoxy resin, metal to metal structural bonding, 23 September 1960. Has QPL.
12. MIL-A-14042 Adhesive, epoxy, 17 July 1959. Has QPL.
13. MIL-A-005090 Adhesives, heat resistant, airframe structural, metal to metal, 22 April 1963. Has QPL.
14. MIL-C-13704 Cement, sealing or plugging, 7 November 1955. No QPL.

Optical Marking Adhesives

15. TT-R-58 Radioactive-luminous-compound and adhesives, 19 September 1941. No QPL.

Adhesive Process Specifications

16. MIL-O-13830 Optical components for fire-control instruments, general specification governing the manufacture, assembly and inspection of, 7 December 1954. No QPL.
17. MIL-A-9067 Adhesive bonding process and inspection requirements for, 16 March 1961. No QPL.

11. BUILDING CONSTRUCTION ADHESIVES

Adhesives are used extensively in the building trades. The more significant applications are (1) road repair, (2) metal foundation repair, (3) corrosion prevention, (4) exterior wall construction, (5) roof construction and repair, (6) plumbing, (7) installation of thermal insulation, (8) interior wall construction, (9) painting and (10) floor covering installation.

ROAD REPAIR

Roads are constructed using either asphalt or concrete. Asphalt roads are repaired readily by repaving with heated asphalt. However, repair of concrete roadways requires more extensive effort. Nevertheless, these concrete repaving operations can be more simply made with adhesive materials.

Thoroughfares such as certain airplane runways and poor roadways may require the use of surfacing membranes for temporary service. These are laid using adhesive bonding techniques.

Concrete Roadways

Concrete pavements are subject to cracking, spalling and other damage during use. These defects are repaired with epoxy base adhesives to which concrete is added; they are applied by trowelling techniques (Reference 1).

An identical adhesive except that it contains 50% mineral filler already incorporated is used for grouting cracks in concrete pavements and for bonding portland cement concrete to hardened portland cement concrete (Reference 2). This adhesive can also bond pavement dowels in preformed holes.

Surfacing Membranes

Prefabricated airfield and road surfacing membranes in either continuous rolls or sewn fabric panels are joined to the existing structure with polyvinyl chloride modified nitrile rubber base adhesives (Reference 3). Normally, continuous rolls are joined with six inch single lap joints and sewn panels with ten inch single lap joints.

METAL FOUNDATION REPAIR

Iron and steel castings are used in building construction for fences, foundations and decorative purposes. Whenever flaws are found in these castings, a metallic iron filled cement, activated with water, is available for repairing minor but not structural defects (Reference 4). The cement, dependent on type, is suitable for repairing castings which are in service under water or in wet places, resisting both hot and cold and fresh or salt water.

CORROSION PREVENTION

In certain constructions it may be necessary to have contact between dissimiliar metals, which are subject to moisture contact. These conditions are sufficient to induce corrosion. Separation of the metals with pressure-sensitive adhesive tape will prevent the galvanic attack (Reference 5).

In other constructions it may be necessary to protect pipes not buried underground from corrosion by moisture, acids, alkalies, certain solvents and salts. Pressure-sensitive polyvinyl chloride (Reference 6) or polyester (Reference 7) adhesive tapes are useful for this purpose.

EXTERIOR WALL CONSTRUCTION

Walls are constructed by bonding bricks. These adhesives, commonly called mortars, are readily 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.

Moderate Temperature Service

These adhesives are available as hydraulic, epoxy resin base and pitch base mortars.

There are three distinct hydraulic mortars for wall construction work. Masonry cement, the most common, is used for above grade solid masonry construction not subject to frost action and as a general purpose masonry mortar (Reference 8). This cement is also available with water repellent properties. It is mixed with sand and activated with water.

Slag cement, when mixed with hydrated lime, is used for making masonry mortar and with portland cement for making concrete (Reference 9). It has compressive properties higher than the masonry cement mortar.

Silica cement is intended for bonding brick, especially for foundry use (Reference 10). It is activated with water.

Epoxy resin base mortars, activated by mixing with liquid polysulfide rubber, are used for bonding concrete bricks (Reference 2). Exposure to temperatures higher than standard atmospheric improves the mechanical properties.

Pitch base mortars are intended primarily for repairing walls (Reference 11). Available in many colors, they remain flexible at 0 C, do not bleed into paint and will not blister at temperatures as high as 70 C.

High Temperature Service

These mortars are available for both silica and fire clay brick installations. The silica brick mortar consists of ground silica which is activated with water and cured at room temperature (Reference 12). It is not suitable for fire clay installations. For these installations, mortar composed of a fire clay base and sodium silicate binder is used (Reference 13). This mortar is particularly useful for bonding fire brick where the service temperatures are too low to use the hot set mortars and too high for the moderate temperature service mortars. They are suitable for installations such as fireplaces, chimneys, incinerators and boiler furnaces, except where contact with rain or continuous dampness is expected.

Very High Temperature Service

These mortars, as distinct from the former two room temperature curing mortar types, require high temperatures to set them. There are four refractory mortars available.

Fire clay refractory mortar is used for fire clay brick installations such as furnace walls (Reference 14). This mortar has drying and firing shrinkages, sufficient to lead to cracks resulting in leakage of air and gas through the walls. When such leakage must be kept to a minimum, an alternate fire clay refractory mortar is used (Reference 15).

Grog base refractory mortar is used for bonding and fabricating fire clay shapes and installations including monolithic furnace walls, arches and boiler settings (Reference 16). Thermal spalling losses range between 5 and 10%, dependent on type.

Another grog base refractory mortar is used for closing out boiler walls where standard molded bricks cannot be used, as well as for boiler repair, corbels and installation around burner openings (Reference 17).

ROOF CONSTRUCTION AND REPAIR

Roofing is fabricated from bituminous, metal and wood materials. Adhesives are used to fabricate the roof structure, including the attachment of any needed insulation and vapor barriers, and to repair damaged surfaces.

Roof Construction

Roofs are constructed by laying over suitable foundations, fiberglass, roofing felts, wool roofing and roofing fabrics and joining these with fatty acid pitch base adhesives which provide permanent flexibility (Reference 18). Plastic flashings used in conjunction with bituminous roofing use either asphalt or coal tar base cements (Reference 19).

Polystyrene is used to insulate metal roofing. This insulation can be bonded with isocyanate base adhesives which are activated with water (Reference 20). This adhesive requires good ventilation to reduce toxic hazards to personnel.

Roof Repair

Asphalt and metal roofing are repaired with either asphalt or coal tar base cements (Reference 19). These adhesives are flexible as low as 0 C and will only sag slightly at temperatures as high as 140 F. Where somewhat higher temperature resistance or specific colors are required, fatty acid pitch base cements are used (Reference 21). The latter cements will not bleed into white paint.

PLUMBING

Plumbing lines are used to transport water, gas, steam, hot air and sewage. The pipelines are constructed by welding, screw thread connections or fitted connections such as bell and spigot joints. Generally no adhesive or sealant is necessary for welded piping and only occasionally for screw thread connections such as those carrying high temperature fluids.

Screw Thread Joints

High pressure steam lines sometimes use threaded joints. These joints are made tight against steam operating up to 950 F and 1200 psi pressure by using phenolic or cresylic base thread sealants (Reference 22).

Fitted Joints

These joints are neither liquid or gas tight and therefore require an adhesive or sealant to maintain the usefulness of the lines. Plumbing lines are made from plastic, metal or ceramic materials, while some plumbing fixtures are made only from ceramic materials.

Plastic. High impact polyvinyl chloride is used for drinking water pipe lines and underground lawn sprinkler systems. These pipes, after joining together with polyvinyl chloride adhesive, can sustain hydrostatic pressures as high as 500 psi (Reference 23).

Metal. Gas lines are sealed with calking lead, melted and poured into the joint (Reference 24). For inverted joints or in wet trenches, the lead is driven with a pneumatic hammer.

Water lines are sealed with calking lead (Reference 24) or sulphur jointing compounds (Reference 25); the latter is used with cast iron bell and spigot piping. Some leakage is to be expected with the sulphur jointing compound.

Steam lines containing fixed mechanical joints are made tight with paste type sealants similar to the thread sealants described above (Reference 22). Boiler casing joints are sealed with paste type sealants which reduce air leakage below 500 cubic centimeters per minute at 500 F under a pressure differential of 100 inches of water (Reference 26).

Hot air ducts are made from thin sheet metal. These ducts, connected by press fits, are not tight, resulting in considerable leakage. This leakage can be effectively eliminated with pressure-sensitive glass fabric tapes, provided temperatures do not exceed 350 F (Reference 27).

Sewer lines are sealed with calking lead (Reference 24), sulphur base jointing compounds (Reference 25), cold applied asphalt base materials (Reference 28) and hot applied asphalt, coal tar or plastic base sealants (Reference 29). Again, some leakage is to be expected with the sulphur jointing compounds.

Ceramic. Bell and spigot ceramic sewer lines are sealed with cold applied asphalt base sealants (Reference 28) and hot applied asphalt, coal tar or plastic base sealants (Reference 29).

Plumbing fixtures such as toilets requiring gasket connections to drainage systems use nonasphaltic sealants to give a water tight, gas tight, odor and vermin proof seal (Reference 30).

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. Primary insulation materials for rocket engines are given in Chapter 12.

Primary Insulation

Primary insulation materials are available for temperatures ranging from ambient to as high as 2800 F. For convenience, these materials can be divided into low, medium and high temperature service.

Low Temperature Service. These materials are suitable up to 1200 F. There are available (1) 85% magnesia suitable to 600 F (Reference 31), (2) asbestos filled binders, and depending on the binder, suitable between 300 (Reference 32) and 1000 F (Reference 31) and (3) hydraulic setting mineral wool filled binders suitable to 1200 F (Reference 32). These cements have thermal conductivities ranging between 0.7 and 1.8 BTU/in./hr/sq ft/°F depending on type and mean temperature difference.

Medium Temperature Service. These materials are suitable up to 1900 F. There are available (1) mineral wool fiber filled binders, and depending upon binder, suitable between 1500 F (Reference 33) and 1800 F (Reference 31), (2) compounded cements suitable to 1800 F (Reference 34), (3) vermiculite filled binders suitable to 1800 F (Reference 31) and (4) diatomaceous silica filled binders suitable to 1900 F (Reference 31). These cements have thermal conductivities ranging between 0.7 and 1.2 BTU/in./hr/sq ft/°F depending on type and mean temperature difference.

High Temperature Service. These materials are suitable up to 2800 F. They consist of refractory chrome ore filled binders and are intended for thermally insulating boiler water wall stub tubes, headers and as a combination gas seal where stub tubes form a water wall (Reference 35).

Secondary Insulation

Secondary insulation materials commonly used are cellular polystyrene, corkboard, glass cloth and asbestos cloth. The service temperature is limited by the thermal stability of these materials and the resulting thermal conductivity is dependent on the insulation material, adhesive, type of layup and mean temperature difference.

Cellular polystyrene is bonded to steel with water activated isocyanate base adhesives (Reference 20). This adhesive requires good ventilation to reduce toxic hazards to personnel.

Corkboard insulation is bonded to metals with either fast or slow setting adhesives (Reference 36). However, in dead air spaces, the slow setting adhesive should be used to reduce fire and personnel hazards.

Woven glass cloth insulation is bonded to piping, machinery and metal surfaces with fire resistant adhesives (Reference 37).

Woven asbestos cloth insulation is bonded to piping and machinery with asbestos fiber filled sodium silicate (Reference 38) and unfilled sodium silicate (Reference 39). These two silicates should not be used over painted metal surfaces or woven glass lagging since they react with these materials.

INTERIOR WALL CONSTRUCTION

Inside walls of rooms are generally plastered, followed by painting. In certain instances they may be covered instead with acoustical tiles, decorative plywood or laminates and ceramic or plastic tiles, the latter specifically for bathrooms and kitchens.

Plastered Walls

Two cements are used for plastering walls. These are Keene's cement and gypsum plaster.

Keene's cement when mixed with lime, sand and water is used for the scratch and brown coats (Reference 40). When mixed with water alone or gaged with lime putty it is used for the finish coat.

Gypsum plaster is available in five types (Reference 41). These are (1) neat plaster, (2) wood fibered plaster, (3) prepared sanded brown coat plaster, (4) prepared sanded scratch coat plaster and (5) calcined gypsum plaster. The first two, either with or without the addition of sand, and the second two, without the addition of sand, are used for the scratch and brown coats after activation with water. The last type, gaged with lime putty, is used for the finish coat.

Acoustical Tiled Walls and Ceilings

Acoustical tiles are laid with adhesive (Reference 42). The available adhesives, however, are not recommended as the sole means for holding acoustical tiles weighing more than 2.5 pounds per square foot to ceiling surfaces.

Decorative Plywood and Laminates

Neoprene base contact adhesives are used to bond plywood and decorative laminates to wood and metal walls from which paint and lacquer have been removed (Reference 43). This cement requires careful application of sheets because they will not slide for adjustment. An additional neoprene-phenolic adhesive, normally used for bonding decorative laminate table tops to aluminum, can be used for these applications (Reference 44).

Bathroom and Kitchen Walls

Polystyrene plastic tiles and ceramic tiles are used on walls that are subject to constant moisture contact. The tiles are attached with adhesives which are resistant to degradation by water. (References 45, 46).

PAINTING

Pressure-sensitive adhesive tapes are used frequently during painting operations for masking and stripping purposes. The surfaces to be painted are either bare or coated with lacquer, paint or enamel. The choice of the tape is predicated in part by the surface to be coated.

Bare Surfaces

Bare metal surfaces prepared for stripping operations are masked with pressure-sensitive adhesive tapes resistant to steam cleaning and water rinseable paint removers (Reference 47). When steam cleaning or treatment with paint removers is not employed, paper base masking tapes are used (Reference 48).

Lacquered Surfaces

Cellulose nitrate or acrylic-nitrocellulose base lacquers require a special paper base tape (Reference 49). This tape does not lift underlying lacquer when removed and is sufficiently resistant to prevent penetration of lacquer during application.

Painted and Enameled Surfaces

Painted and enameled surfaces use paper base tapes for masking operations (Reference 48). This tape does not lift underlying finishes and is sufficiently resistant to penetration by finishes during application. A primer is available for application over painted surfaces to increase the adhesion of pressure-sensitive adhesive tapes (Reference 50).

FLOOR COVERING INSTALLATION

Floor coverings are fabricated from asphalt, vinyl, rubber, cork and linoleum materials, available either in tiles usually 9 inch by 9 inch squares and in continuous sheets. These floor coverings are laid directly on wood, concrete and metal subfloors. The choice of adhesive is in part dependent on the composition of the floor covering and in part on the type of subfloor. However, regardless of end use, these adhesives are pastes, applied by trowelling techniques and cured at room temperature.

Asphalt Tiles

Asphalt tiles are laid to wood, concrete and metal subfloors with water base (References 51, 52) or solvent base (Reference 53) asphaltic adhesives. The processing and performance characteristics are essentially equivalent; however, the solvent base adhesive may require a primer prior to application over cement finished concrete slabs.

Vinyl Tiles

Vinyl asbestos tiles, like asphalt tiles, are laid with water base asphaltic adhesives (Reference 52). However, there is a latex adhesive available specifically for the laying of fire resistant grade vinyl tiles to metal subfloors (Reference 54).

Rubber Tiles

There are no specifications covering adhesives for the laying of rubber tiles. Nevertheless, experience has shown that water base asphaltic adhesives (Reference 52) and latex adhesives (Reference 54) will adhere rubber tiles.

Cork and Linoleum

Cork and linoleum are laid with water base cements (References 55, 56) to wood and occasionally to concrete subfloors. These cements do not perform satisfactorily against metal subfloors. Latex cement (Reference 54) should be used over metal subfloors.

BIBLIOGRAPHY

Road Repair

Concrete Roadways

1. MMM-B-00350 Binder, adhesive, epoxy resin, flexible, 22 June 1962. No QPL.
2. MMM-G-00650 Grout, adhesive, epoxy resin, flexible, filled, 29 June 1962. No QPL.

Surface Membranes

3. MIL-A-52264 Adhesive, synthetic-rubber; nitrile-rubber and vinyl-resin base (for bonding prefabricated airfield and road surfacing membrane), 15 January 1963. No QPL.

Metal Foundation Repair

4. QQ-C-100 Cement, iron and steel, 14 February 1964. No QPL. (See also MIL-C-1219 abstract.).

Corrosion Prevention

5. MIL-T-23142 Tape, pressure-sensitive adhesive, for dissimiliar metal separation, 10 May 1962. No QPL.

6. PPP-T-66 Tape, pressure-sensitive adhesive, vinyl plastic film, 11 December 1963. No QPL.
7. L-T-100 Tape, pressure-sensitive adhesive, polyester film, 30 August 1960. No QPL.

Exterior Wall Construction

Moderate Temperature Service

8. SS-C-181 Cement, masonry, 23 September 1960. No QPL.
9. SS-C-218 Cement, slag, 21 November 1960. No QPL.
10. HH-C-176 Cement; silica, 1 August 1933. No QPL.
11. SS-C-188 Cement, plastic, fatty acid pitch base, 1 February 1956. No QPL.

High Temperature Service

12. HH-M-630 Mortar, refractory, silica, 3 January 1964. No QPL.
13. HH-M-00611 Mortar, refractory, air setting, bonding (wet or dry types), 15 November 1962. No QPL.

Very High Temperature Service

14. HH-C-451 Clay; fire, ground, 28 June 1955. No QPL.
15. HH-M-622 Mortar; refractory, heat-setting, 24 June 1955. No QPL.
16. HH-R-191 Refractories; fire clay, plastic, 7 August 1952. No QPL.
17. MIL-P-15731 Plastic mix, refractory (Superduty, fire clay), 2 November 1960. Has QPL.

Roof Construction and Repair

18. SS-A-150 Adhesive compound, fatty acid pitch base (for use with fiberglass, roofing felts, roll roofing, roofing fabric), 6 April 1959. No QPL.
19. SS-C-153 Cement, bituminous, plastic, 1 August 1933. No QPL.
20. MIL-A-46028 Adhesive, flashout, cold-setting (water cured), 29 January 1959. No QPL.
21. SS-C-188 Cement, plastic, fatty acid pitch base, 1 February 1956. No QPL.

Plumbing

22. MIL-S-15204 Sealing compound, joint and thread, high temperature, 17 September 1962. Has QPL.
23. MIL-A-22010 Adhesive, solvent type, polyvinyl chloride, 9 June 1961. No QPL.
24. QQ-C-40 Calking: lead wool and lead pig, 15 April 1963. No QPL.
25. SS-C-608 Compounds, jointing; sulfur (for bell-and-spigot cast-iron pipe), 8 January 1947. No QPL.
26. MIL-S-17377 Sealing compound, boiler-casing, 2 August 1960. Has QPL.
27. MIL-T-4053 Tape, pressure-sensitive, adhesive (corrosion resistant), 20 August 1962. No QPL.
28. SS-S-168 Sealing compound, sewer, bituminous, two component, mineral filled, cold applied, 9 April 1962. No QPL.
29. SS-S-169 Sealer, joint, sewer, mineral filled, hot pour, 20 April 1954. No QPL.
30. HH-C-536 Compound; plumbing-fixture-setting, 20 April 1954. No QPL.

Installation of Thermal Insulation

Primary Insulation

31. HH-I-00500 Insulating cements, thermal, 24 May 1956. No QPL.
32. MIL-C-2908 Cements, finishing, insulation, 20 March 1960. No QPL.
33. HH-C-168 Cement, insulation; thermal, mineral wool, 26 April 1946. No QPL.

34. MIL-C-2861 Cement, insulation, high temperature, 17 September 1963. Has QPL.
35. MIL-P-15384 Plastic mix, refractory (water-wall, boiler, chrome ore plastic), 15 December 1959. No QPL.

Secondary Insulation

36. MIL-A-18065 Adhesives, high initial bond, 17 December 1959. Has QPL.
37. MIL-C-3316 Adhesives, fire-resistant, thermal insulation, 19 November 1960. Has QPL.
38. MIL-A-15199 Adhesive, asbestos cloth to pipe, insulation, 21 May 1959. No QPL.
39. O-S-605 Sodium silicate solutions, 1 September 1960. No QPL.

Interior Wall Construction

Plastered Walls

40. SS-C-00161. Cement, Keene's, 10 August 1956. No QPL.
41. SS-P-402 Plaster; gypsum, 5 May 1945. No QPL.

Acoustical Tiled Walls and Ceilings

42. MMM-A-00150 Adhesive for Acoustical materials, 3 October 1962. No QPL.

Decorative Plywood and Laminates

43. MMM-A-00130 Adhesive, contact, 2 October 1961. No QPL.
44. MIL-A-21366 Adhesive, plastic table top material to aluminum bonding, 11 May 1960. No QPL.

Bathroom and Kitchen Walls

45. CS 168-50 Polystyrene plastic wall tiles and adhesives for their application, 15 July 1950. Has QPL.
46. CS 181-52 Water-resistant organic adhesives for installation of clay tile, 12 July 1952. Has QPL.

Painting

47. MIL-T-22397 Tape, pressure-sensitive adhesive, for masking during paint stripping operations, 23 August 1963. No QPL.
48. UU-T-106 Tape, pressure-sensitive adhesive, masking, paper, 27 July 1959. No QPL.
49. MIL-T-21595 Tape, pressure-sensitive adhesive, paper masking, nonstaining, 6 July 1959. Has QPL.
50. MIL-P-3542 Primer, pressure-sensitive tape, 24 April 1958. No QPL.

Floor Covering Installation

51. SS-A-00138 Adhesive, asphalt, water emulsion type (for asphalt tile), 8 May 1952. No QPL.
52. MMM-A-115 Adhesive, asphalt, water emulsion type (for asphalt and vinyl asbestos tile), 3 January 1964. No QPL.
53. SS-A-128 Adhesive, asphalt, cut-back type (for asphalt tile), 3 July 1952. No QPL.
54. MIL-A-21016 Adhesive, linoleum and plastic tile, 28 November 1962. Has QPL.
55. MMM-A-00137 Adhesive, linoleum, 11 February 1963. No QPL.
56. O-P-106 Paste, linoleum, 17 October 1939. No QPL.

12. OTHER ADHESIVES

Adhesives have found extensive usage in many specialized applications. The pyrotechnic industry uses adhesives in manufacturing solid propellants for rocket technology and ammunition. The dental industry uses these cements for the restoration of tooth structure and the medical industry for minor and major corrective surgical procedures. Photographers use bonding materials for film processing and demonstration purposes. Foundries employ binders for sand molding of metal castings. Specialized adhesives are available for engine construction and insulation, finishing operations and sealing applications.

PYROTECHNIC ADHESIVES

Pyrotechnic materials are available as low explosives and high explosives. The low explosives undergo decomposition by a deflagration process. Burning starts at or near the surface and continues rapidly with the release of large quantities of hot gases. Deflagration is controlled by forming the low explosive into specific shapes and bonding plastic inhibitors in areas where burning is not desired. This process is used in solid rocket propellant and, in part, in gun ammunition technologies.

High explosives undergo decomposition by a detonation process. The explosives decompose almost instantaneously. This process requires considerable energy to cause detonation. Fuses containing highly reactive primary explosive materials are used to impart the initial detonation, which in turn provides sufficient energy to cause instantaneous decomposition of the high explosive. This process is used in gun ammunition technology.

Two classes of propellants are available. The first, the monopropellants, is based on nitrocellulose (single base) or nitrocellulose-nitroglycerine mixtures (double base) in which each molecule contains the necessary fuel and oxygen components for combustion. The second, the bipropellants, consists of mixtures of fuel and a separate oxidizer. The oxidizer is an inorganic crystalline material, such as ammonium perchlorate. The fuel is a plastic binder which holds the mixture in a uniform structure.

Adhesives are used in propellant, inhibitor, fuse and assembly operations of pyrotechnic material manufacture. They additionally find use in packaging of explosives, their positioning prior to firing and in their actual firing.

Propellant Manufacture

Monopropellants may be stored for long periods of time. During this storage period they may deteriorate, as had occurred with World War I ammunition. The deteriorated product, as well as new monopropellant destined for small arms and sporting ammunition, may be converted or made into safe stock by the use of animal glues (Reference 1). The deteriorated or new stock is put into solution and animal glue added as a protective colloid. This causes the mixture to coalesce into small balls for subsequent drying and loading into ammunition cases.

Bipropellants are manufactured using cellulose nitrate (Reference 2), polyisobutylene (References 3, 4) and polystyrene (Reference 5) binders. Recently phenolics, acrylics, synthetic rubbers and vinyls are being used. However, specifications covering these materials for this application are not yet available.

Inhibitors

The deflagration of propellant charges is controlled in part by bonding ethyl cellulose and cellulose acetate film in areas where burning is to be controlled. These materials are essentially nonburning when compared to the speed of propellant combustion. Cellulose nitrate adhesives are suitable for this purpose (Reference 6).

Fuses

Fuses consist of (1) tubular cotton or hemp cords containing slow burning gunpowder mixtures which are ignited by flame and (2) highly sensitive primer mixtures such as fulminates, azides, etc., which detonate by percussion or electrical means. These fuses, especially the former, become inactive if wet. Adhesives such as animal glue (References 7, 8, 9), gum tragacanth (Reference 10) and rubber mixtures (Reference 11) are available for sealing the fuse proper during manufacture against entrance of moisture. Teflon pressure-sensitive adhesive tape is employed during demolition operations for (1) making watertight seals around blasting cap and detonating cord, (2) splicing of firing cables to prevent shorting out of firing circuits, (3) making watertight seals around junctions of nonelectrical cap and safety fuse and (4) general use in underwater demolition (Reference 12).

Ammunition Assembly

Propellants, once processed, require loading, assembly and sealing of components, the latter especially against moisture. Pettman cement (Reference 13), vegetable glue (Reference 14) and cellulose nitrate (Reference 15) are used for these purposes. The latter will bond glass, leather, metals, textiles and some thermoplastics.

A specially formulated cellulose nitrate adhesive is also available specifically for sealing ammunition components (Reference 16).

Closures

Solid rocket propellant cases contain nozzles for exit of hot gases during firing. However, during storage these nozzles must be sealed to prevent entrance of moisture. Cellular polystyrene, which is readily blown away during firing, is bonded to the nozzle for this purpose. Isocyanate base adhesives which are activated with water are suitable (Reference 17). This adhesive must be used with good ventilation to reduce toxic hazards to personnel.

Packaging

Explosives are packaged for shipment and storage. The cartons must use adhesives which are compatible with the explosive.

Ammunition fiber containers use adhesives for temporary bonding of chipboard and metal for the period between the time of manufacture and loading of the ammunition into fiber containers (Reference 18). Water, oil and mold resistance are not available with this adhesive.

Dextrin (Reference 19) and animal glue (Reference 9), compatible with ammunition, are suitable for spirally wound tubes and fiberboard containers.

Pressure-sensitive adhesive tapes, also compatible, can be used for reinforcing and sealing ammunition cartons (References 20, 21, 22).

Waterproofing of ammunition components and cartons can be made with rubber (Reference 11) and asphalt base (Reference 23) materials.

Charge Location

During demolition operations it may be necessary to suspend explosive charges from an overhead or vertical position. Adhesive pastes capable of sustaining shear loads up to 225 grams per square inch at room temperature are available (Reference 24). These tacky pastes are applied to the substructure and the explosive charge pushed into it.

General Purpose Pyrotechnic Adhesives

Acrylic, epoxy, rubber and vinyl adhesives can be used for general purpose bonding work with pyrotechnic materials. However, in each case the specific adhesive must be checked for its compatibility with the explosive charge contacted. Picatinny Arsenal, Dover, New Jersey carries out these compatibility tests.

Acrylic adhesives offer high speed, room temperature curing; however, the adhesive is exceedingly expensive and not entirely waterproof (Reference 25).

Epoxy adhesives are slower curing (at room temperature) than the acrylics but are less expensive and have excellent mechanical properties and resistance to moisture (Reference 26).

Rubber cements are also slower curing but less expensive than the acrylics and, unlike the epoxies, have the distinct advantage of being ready to use directly from the container (Reference 27).

DENTAL ADHESIVES

Corrective dental surgery covers (1) the removal of localized diseased areas from single teeth, (2) the buildup of eroded teeth and (3) the complete replacement of the entire tooth structure. These operations require adhesive bonding technology.

Whenever a diseased section of a tooth is to be removed, the dental surgeon carves out a crater containing the diseased area and then fills it with an inlay or crown material. Under certain circumstances, the prepared cavity is lined with a coating or heat insulating base. When living tissue is removed from the root canals, these are sealed with cements prior to inclusion of the inlay material.

The inlay and some of the crown materials are cements. These are specialized adhesives which, rather than solely adhering two components together, become one of the adherends. If the inlay or crown materials are fabricated outside of the mouth, certain of these cements are used for adhering these restorations to the remaining tooth structure.

Cavity Liners

Certain liners are used prior to installation of the inlay or crown material whenever the cavity touches or is in close proximity to the tooth pulp structure.

Zinc oxide-oleoresin (Reference 28), zinc oxide-eugenol (Reference 29) and copper-zinc phosphate (Reference 30) cements are used to seal root canals and as a lining and pulp capping agent. The latter cement has potent germicidal activity but is more irritating to pulp tissue than the former two cements.

Varnishes consisting of natural or synthetic resins in nonirritating solvents are used to seal the dentinal tubules to reduce pulp damage induced by the acidic nature of subsequently used temporary cements (Reference 31).

Temporary Cements

The temporary cements are room temperature curing, relatively impermanent materials of low strength, which gradually dissolve in the mouth fluids. Zinc phosphate, copper phosphate, zinc oxide-eugenol and silicates are typical temporary cements.

Zinc phosphate cements are used primarily for adhering prefabricated restorations and secondarily for temporary fillings and as a heat insulating base under more permanent inlays (Reference 32). It has a water wet compressive strength of at least 12,000 psi.

Copper-zinc phosphate cements are used primarily for root canal fillings and temporary fillings in deciduous teeth and secondarily as heat insulating bases under permanent restorations where potent germicidal action is required (Reference 30). It has a water wet compressive strength of at least 15,000 psi.

Zinc oxide-eugenol cements are used primarily for temporary fillings, pulp capping and as a thermal insulating base under permanent restorations and secondarily for root canal restorations (Reference 29). These cements are the least irritating of all the cements, possess some antiseptic qualities due to the eugenol and have a water wet compressive strength of at least 1,000 psi.

Silicate cements are used primarily for anterior teeth restorations and secondarily for bonding translucent prefabricated restorations (Reference 33). This cement is the strongest of all the cements but because of its highly irritating nature cannot be used in deep cavities that are close to the dental pulp. It has a water wet compressive strength of at least 23,000 psi.

Permanent Cements

The permanent cements are room temperature curing materials which resist mechanical shock and the deteriorating action of mouth fluids for relatively long periods of time. Metal alloys such as amalgams, gold and platinum are typical permanent cements.

Dental amalgams consisting of mixtures of mercury (Reference 34) and silver (Reference 35) are by far the most extensively used permanent cement. This cement is a good conductor of heat and may require a heat insulating base in sensitive areas.

Gold foil is used for permanent restorations where maximum resistance to the deleterious action of mouth fluids is desired (Reference 36). The gold foil will weld at room temperature under pressure when its surface is freed of impurities. This is accomplished by heating the gold sufficiently to drive off all the absorbed gas molecules prior to the welding operation.

Platinum foil is occasionally used for permanent restorations either alone or condensed with gold foil in fabricating the restoration (Reference 37).

MEDICAL ADHESIVES

Corrective medical practices require materials which are sterile. Bonding materials used for surgical pack wrappers and bandages must retain their adhesive characteristics during and after steam sterilization.

Pressure-sensitive adhesive paper tapes are used for sealing surgical pack wrappers prior to steam sterilization (Reference 38). These tapes indicate by color change that medical equipment has been sterilized by steam. No color change occurs under dry heat.

A wide variety of bandages containing pressure-sensitive adhesives are available to the medical profession. Typical are the sterile cotton gauze (Reference 39) and absorbent (Reference 40) bandages as well as surgical adhesive plaster (Reference 41).

PHOTOGRAPHIC ADHESIVES

Photographic processes include (1) blocking and edging of negatives, (2) splicing of film, (3) sealing of photographic film cans and magazines, (4) mounting of photographic prints and (5) general photographic binder work. Each of these operations use adhesives.

Blocking and Edging

Negatives prior to preparation of prints may require blocking out of undesirable impressions as well as incorporating edging requirements. These are achieved with either black crepe paper (Reference 42) or translucent, ruby red plastic (Reference 43) pressure-sensitive adhesive tapes. The latter provides good color contrast with the negative.

Splicing

Photographic film and paper are spliced during processing and during demonstration operations. Black cellulose acetate pressure-sensitive adhesive tape is used during processing (Reference 44). It is suitable for aerial film. Transparent polyester pressure-sensitive adhesive tape is used for splicing film and tape, including connecting film to spools and to leaders for demonstration purposes (Reference 45).

Sealing

Photographic film cans and magazines are sealed during shipment and storage. Pressure-sensitive adhesive tapes are used for this purpose. Black polyvinyl chloride tapes (References 46, 47) and black crepe paper tapes (Reference 48) are available. None of the tapes fog undeveloped film, and the vinyl tapes provide good resistance against entrance of moisture.

Mounting

Once prints are made they are usually mounted in albums. Pressure-sensitive adhesive tape coated on both sides permits direct application (Reference 49). Paste (Reference 50) and rubber cements (References 51, 52) are specially formulated so that they will not curl, wrinkle or shrink the prints or album paper.

Binders

Certain photographic and lithographic processing may require binders. Gum acacia is suitable for this purpose (Reference 53). However, a small amount of plasticizer may be required to reduce the brittleness of this material.

FOUNDRY BINDERS

Complicated metal parts can be fabricated using sand molding techniques. The process consists of mixing binders with sand, activating with water, pouring the mixture over a pattern, allowing it to harden, removing the pattern and then casting the molten metal into the sand pattern. Dextrin (Reference 54) and fire clay (Reference 55) adhesives are used as the sand binders.

Foundry core sections are sometimes joined in building parts. Room temperature curing binders capable of sustaining temperatures as high as 3100 F without boiling or swelling out of the joint are available (Reference 56). These binders provide joints with strengths equal to or better than the solid core.

MISCELLANEOUS ADHESIVES

Bonding materials are employed in (1) engines and plumbing, (2) bonding of grinding disks, (3) sealing of smoke pots and (4) masking of parts during plating operations.

Engine Construction

Adhesives are used for bonding uncoated gaskets between the cylinder block and cylinder head of large engines as well as for assembling fuel lines, particularly the pipe ells at the fuel pump to prevent leakage of fluids (Reference 57). These adhesives do not blister, crack or check in the presence of ethylene glycol, alcohol, aromatic fluids or boiling water.

Rocket engines are subject to severe temperature exposure. Insulating cements, applied by trowelling or spraying, provide protection against these temperatures, even those produced by a blow torch (Reference 58). The cement has sufficient mechanical strength to resist impact loads greater than 15 foot-pounds.

Finishing Operations

Finishing operations involving grinding use abrasive disks which are backed with metal plates. This abrasive is adhesively bonded to prevent slippage and tearing during the grinding process (Reference 59). These adhesives sustain elevated temperatures induced by friction incurred during this finishing operation.

Sealing

Smoke pots when not in use are sealed with pressure-sensitive adhesive cotton tape which is cut on the bias (Reference 60). The bias cut permits more ready application to the surface to be sealed.

Plating

During electroplating operations, selected areas may require no plating. This can be achieved with masking tapes. Both vinyl (Reference 61) and lead foil (Reference 62) pressure-sensitive adhesive tapes are employed for the masking. The latter tape is particularly useful in hard chrome plating operations where a "thieving action" is desired.

BIBLIOGRAPHY

Pyrotechnic Adhesives

Propellant Manufacture

1. MIL-G-46030 Glue, animal (protective colloid), 2 November 1960. No QPL.
2. MIL-B-10854 Binder, cellulose nitrate-camphor (for pyrotechnic mixtures), 22 January 1951. No QPL.
3. MIL-P-14536 Polyisobutylene binder, 12 June 1957. No QPL.
4. MIL-P-13298 Polyisobutylene (for ordnance use), 11 March 1958. No QPL.
5. MIL-P-55025 Polystyrene, unmodified (for use as a binder in explosives), 23 June 1958. No QPL.

Inhibitors

6. MIL-A-3167 Adhesives (for plastic inhibitors), 21 August 1951. No QPL.

Fuses

7. MMM-A-100 Adhesive, animal-glue, 10 December 1963. No QPL.
8. JAN-C-338 Glue, animal, 30 April 1946. No QPL.
9. MIL-C-20469 Glue (for use in loading of ammunition), 27 November 1951. No QPL.
10. JAN-G-96 Gum tragacanth (for use in ammunition), 25 October 1944. No QPL.
11. MIL-C-20299 Compound, adhesive, waterproof, 21 November 1951. No QPL.
12. MIL-T-23594 Tapes, pressure-sensitive adhesive, electrical; high temperature insulation, polytetrafluoroethylene, 8 February 1963. Has QPL.

Ammunition Assembly

13. JAN-C-99 Cement, Pettman, 30 November 1945. No QPL.
14. MIL-G-3937 Glue, vegetable, 8 December 1954. No QPL.
15. MIL-C-11238 Adhesive, cellulose nitrate (for ordnance use), 18 September 1962. No QPL.
16. MIL-A-388 Adhesive and sealing compounds, cellulose nitrate base, 9 June 1959. No QPL.

Closures

17. MIL-A-46028 Adhesive, flashout, cold-setting (water cured), 29 January 1959. No QPL.

Packaging

18. MIL-A-45059 Adhesives for bonding chipboard to terneplate, tinplate and zincplate, 24 April 1958. No QPL.
19. MIL-A-13374 Adhesive, dextrin (spiral tube winding for ammunition containers), 20 December 1956. No QPL.
20. MIL-T-11291 Tape, adhesive, aluminum-backed (for use with ammunition), 24 July 1951. No QPL.
21. PPP-T-0060 Tape; pressure-sensitive adhesive, waterproof – for packaging and sealing, 30 November 1961. Has QPL.
22. MIL-T-43036 Tape, pressure-sensitive adhesive, plastic film, filament reinforced (for sealing fiber containers and cans), 29 March 1963. No QPL.
23. MIL-A-3029 Asphalt, waterproofing (for use in manufacture of fiber ammunition containers), 17 April 1950. No QPL.

Charge Location

24. MIL-A-374 Adhesive, paste, for demolition charges, 31 January 1953. No QPL.

General Purpose Pyrotechnic Adhesives

25. MIL-A-46050 Adhesive, special; rapid room temperature curing, solventless, 16 July 1963. No QPL.
26. MIL-A-14042 Adhesive, epoxy, 17 July 1959. Has QPL.
27. MIL-A-13883 Adhesive, synthetic-rubber (hot or cold bonding), 7 November 1960. No QPL.

Dental Adhesives

Cavity Liners and Temporary Cements

28. U-S-00156 Sealing compound, dental (root canal), 14 June 1957. No QPL.
29. U-C-208 Cement, zinc oxide and eugenol, dental, 11 March 1957. No QPL.
30. U-C-198 Cement, copper and zinc phosphates, dental, 23 January 1957. No QPL.
31. U-C-133 Cavity lining and thinner set, dental, 14 August 1957. No QPL.
32. U-C-211 Cement; zinc phosphate, dental, 13 December 1956. No QPL.
33. U-C-205 Cement, silicate; and accesories (dental), 13 February 1951. No QPL.

Permanent Cements

34. U-M-200 Mercury, dental, 30 March 1960. No QPL.
35. U-S-350 Silver alloy powders, dental, 16 April 1957. No QPL.
36. QQ-G-545 Gold; foil, cylinders (for dental fillings), 30 March 1951. No QPL.
37. QQ-P-428 Platinum foil (dental), 9 April 1957. No QPL.

Medical Adhesives

38. UU-T-118 Tape, paper, pressure-sensitive adhesive, hospital sterilizer, sealing, 3 April 1959. No QPL.
39. JJ-B-107 Bandages, self-adherent, 20 August 1952. No QPL.
40. DDD-B-0035 Bandages, absorbent, adhesive, 15 October 1963. No QPL.
41. U-P-401 Plaster, adhesive, surgical, 23 June 1959. No QPL.

Photographic Adhesives

Blocking and Edging

42. UU-T-123 Tape, pressure-sensitive adhesive, paper, photographic, 11 August 1960. No QPL.
43. MIL-T-40620 Tape, pressure-sensitive adhesive, lithograph, 6 April 1962. No QPL.

Splicing

44. MIL-T-4403 Tape, pressure-sensitive adhesive, cloth, aerial film splicing, 2 January 1953. No QPL.
45. MIL-T-26317 Tape, pressure-sensitive adhesive, transparent, film splicing, 27 October 1960. No QPL.

Sealing

46. MIL-T-4239 Tape, pressure-sensitive adhesive, vinyl-plastic, opaque, photographic, 30 October 1951. No QPL.
47. PPP-T-66 Tape; pressure-sensitive adhesive, vinyl plastic film, 11

December 1963. No QPL.

48. UU-T-123 Tape, pressure-sensitive adhesive, paper, photographic, 11 August 1960. No QPL.

Mounting

49. UU-T-91 Tape, pressure-sensitive adhesive, double-coated, 5 December 1962. No QPL.
50. MMM-A-177 Adhesive, paste, office and photomounting, 21 January 1964. No QPL.
51. ZZ-C-191 Cement; rubber (artists' and photographers' and cold patching), 10 December 1959. No QPL.
52. MMM-A-00185 Adhesive, rubber (for paper bonding), 22 January 1963. No QPL.

Binders

53. JJJ-A-20 Acacia, technical (gum arabic), 24 January 1958. No QPL.

Foundry Binders

54. MIL-D-17260 Dextrin (foundry use), 20 July 1953. No QPL.
55. MIL-C-17069 Clay, fire (binder for foundry molding sands), 27 August 1952. No QPL.
56. MIL-C-12769 Binder compound, foundry core, 21 November 1961. No QPL.

Miscellaneous Adhesives

Engines

57. MIL-C-10523 Cement, gasket, for automotive applications, 23 December 1952. No QPL.
58. MIL-C-22608 Compound, insulating, high temperature, 8 August 1960. No QPL.

Abrasives

59. MIL-C-14064 Cement: grinding disk, 22 June 1962. No QPL.

Smoke Pots

60. MIL-T-13222 Tape, adhesive, bias, 26 October 1954. No QPL.

Plating

61. HH-T-0025 Tape, pressure-sensitive adhesive, plastic (for electroplating), 17 January 1964. No QPL.
62. HH-T-0029 Tape, pressure-sensitive adhesive, lead foil, 17 January 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 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 sppears 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.

At the suggestion of certain adhesive bonding specialists, specifications canceled within the past year have been retained in both parts of this book. Once a specification is used in industry, there is some lead time necessary to phase out its use when it is canceled.

Appendix B lists all of the adhesive material specifications 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-90 TAPE, PRESSURE-SENSITIVE ADHESIVE (CELLOPHANE AND CELLULOSE ACETATE)

Issue: 13 January 1961 Revision: c Amendment: 1

SCOPE

This pressure-sensitive tape is intended for mending, reinforcing, securing, shielding and temporary identifications.

CLASSIFICATION

The tape is available in two types and four classes.

Type I
- Class A Cellophane, transparent
- Class B Cellophane, colored

Type II
- Class A Cellulose acetate, transparent, low reflectance
- Class B Cellulose acetate, transparent, glossy backed

PROPERTIES

CHEMICAL. The tape consists of a cellophane (Type I) or cellulose acetate (Type II) backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape, Type I, Class A and Type II, Classes A and B, is sufficiently transparent to read 5 point type. The other physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF L-T-90 TAPE

PROPERTY	TYPE I Class A	TYPE I Class B	TYPE II Class A	TYPE II Class B
Thickness, in., max	0.0035	0.0035	0.0035	0.0035
Tensile strength, lb/in., at 75 F, min	20	20	12	12
Opacity, %, max (1)	12	NR	12	12
Specular gloss, max (2)	NR	NR	11	NR

(1) UU-P-31, Method 151 or TAPPI No. T425m.

(2) Fed Test Method Std No. 141, Method 6101 or ASTM D523.

NR = No Requirement

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. An unwinding force no greater than 40 ounces and 30 ounces per inch of width, respectively, is necessary for both Type I and Type II tape as received and after 1 year storage. The tape is capable of being stored 1 year at 73 F in the original unopened package.

PERFORMANCE. The Type II tape adhered to bond paper (UU-P-121, Type III, 25%) after 72 hours at 150 F and 80% RH under ½ psi bonding pressure does not exude any adhesive sufficient to

L-T-90 (Continued)

cause blocking. Further, Type II, Class A tape will accept writing by pencil, pen, typewriter, etc. Type I adheres tenaciously to bond paper such that it cannot be removed without pulling fibers from the paper. The other performance properties are given in Table II.

TABLE II. PERFORMANCE PROPERTIES OF L-T-90 TAPE

PROPERTY	TYPE I Class A	TYPE I Class B	TYPE II Class A	TYPE II Class B
Peel, oz/in., at 75 F, max				
Initial (1)	20	20	12	12
After accelerated aging				
By light (2)	20	20	12	12
By heat, 150 F and 80% RH, 30 hr (3)	20	20	12	12
Shrinkage, %, max				
After accelerated weathering, 36 hr (4)	NR	NR	10	10
Tape separation, %, max				
After accelerated weathering, 36 hr (4)	NR	NR	15	15

(1) UU-P-31. Method 100, using a commercial polish ground stainless steel substrate (QQ-S-766).
(2) General Electric Type RS Sunlamp emitting 13.2 erythermal units for 30 hours (Type I) and 120 hours (Type II) at 120 F on tape adhered to glass. Type II has this peel strength after storing tape 1 year before application.
(3) Tape to a glass substrate.
(4) Fed Test Method Std No. 141, Method 6151 or ASTM D822, using tape adhered to stainless steel.
NR = No Requirement

FORM

The tape is available in the lengths and widths given in Table III. The Type I, Class B tape is available in black, (light, medium, and dark) blue, (light, medium, and dark) green, orange, red, white, yellow and yellow-orange.

L-T-90 (Continued)

TABLE III. AVAILABILITY OF L-T-90 TAPE

TYPE	CLASS	DISPENSER	DIAMETER OF CORE, IN.	WIDTH AND LENGTH OF TAPE, IN. (1)
I	A	Yes	1	½ x 200
				½ x 400
				¾ x 300
II	A	Yes	1	¾ x 180
I, II	A,B	No	1	½ x 1296
				¾ x 1296
I, II	A,B	No	3	(2) x 2592

(1) Three ½ inch splices may be encountered for rolls up to and longer than 1296 inches and one for rolls less than 1296 inches.
(2) These types and classes are available, unless otherwise specified, in ½, ¾, 1, 1½ and 2 inch widths.

QPL

Yes.

NOTES

(1) Use Type I tape for nonpermanent applications; Class A is for holding, covering, light packaging, sealing, shielding and general office use, and Class B for identification, charting, decorating, holding, light packaging and sealing applications.

(2) Use Type II tape for permanent applications; Class A, a dimensionally stable, long aging, invisible tape, is for mending of paper, documents and books and Class B, a dimensionally stable, long aging tape, for light holding, covering, shielding and sealing applications.

L-T-99 TAPE, PRESSURE-SENSITIVE ADHESIVE, IDENTIFICATION (ACETATE-FIBER)

Issue: 11 September 1958 Revision: a Amendment: None

SCOPE

This printable, pressure-sensitive adhesive tape is intended for labeling, identification and edging applications.

CLASSIFICATION

The tape is available in two types.

Type I Semi-permanent labeling and identification
Type II Permanent labeling, identification and edging

PROPERTIES

CHEMICAL. The tape consists of a laminated cellulose acetate plastic film and paper reinforcing tissue backing coated on the paper side with an unspecified adhesive. The laminating adhesive is either pigmented or unpigmented.

PHYSICAL. The tape is no more than 0.0065 inch thick for Type I and 0.0055 inch thick for Type II; both types have a tensile strength of at least 25 lb/in. of width and the unpigmented tapes are sufficiently transparent to read 10 point type. Any tape printing is specified by the user.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. There is no transferring or off-setting of the ink on printed tape when removed from a freely rotating roll at a rate of 15-20 inches per second even after storing the rolls 24 hours at 100 F.

PERFORMANCE. The tape adheres immediately and firmly without wrinkling, curling, breaking or lifting. The other performance properties are given in Table I.

L-T-99 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF L-T-99 TAPE

PROPERTY	TYPE I	TYPE II
Peel, oz/in., at 75 F, min		
Initial	20	14
After accelerated aging		
By light (2)	NR	14
By heat, 150 F and 80% RH		
Film, 30 hr (3)	NR	14
Roll, 7 days (4)	20	NR

(1) Tape is adhered to 302 or 304 stainless steel, Finish No. 4 (commercial polish ground).
(2) General Electric Type RS Sunlamp emitting 13.2 erythermal units for 60 hours at 120 F on tape adhered to glass.
(3) Tape to glass adherends.
(4) The roll radii do not distort more than ½ inch nor is there any offsetting or splitting when unwound at a speed of 5-7 inches per second.
NR = No Requirement

FORM

The tape is available in 72 yard rolls wound on 3 inch diameter cores and, unless otherwise specified, in ½, ¾, 1, 1½, and 2 inch widths. Each roll may contain up to 3 splices. Type I transparent tape is available in black, blue (light and medium), green (light and medium), orange, orange-yellow, red, yellow and white; Type II is available in black, brown, red and white.

QPL

No.

NOTES

(1) Use Type I for short time labeling applications such as files, containers, charts, etc. and colored tapes, with and without printing, for identifying metals, color coding, etc.

(2) Use Type II for long time labeling applications such as the above and also for edging documents, maps, charts, etc. for protection during storage or handling.

L-T-100 TAPE, PRESSURE-SENSITIVE ADHESIVE, POLYESTER FILM

Issue: 30 August 1960 Revision: a Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended where a high degree of resistance to solvents, oils, hydraulic fuels and weathering is required.

CLASSIFICATION

The tape is available in two types.

Type I Transparent, solvent resistant polyester

Type II Colored, solvent resistant polyester

PROPERTIES

CHEMICAL. The tape consists of a polyester film coated on one side with an unspecified adhesive.

PHYSICAL. The tape, both types, is no more than 0.003 inch thick, has a tensile strength of at least 17 lb/in. of width and an ultimate elongation of at least 70%. The Type I tape is capable of being printed on the adhesive side and the Type II on the backing side in accordance with the supplier's recommendations. Printing is specified by the user.

PROCESS. The tape requires no moisture, heat, or other preparation prior to or subsequent to application. There is no transferring or off-setting of the ink on printed tapes at 75 F, after aging 24 hours at 100 F, when removed at a rate of 15-20 inches per second. The tape can be stored for 6 months and tapes no more than 90 days old are shipped by the supplier.

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

L-T-100 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF L-T-100 TAPE

PROPERTY	TYPE I	TYPE II
Peel, oz/in., at 75 F, min (1)		
Initial	20	20
After accelerated weathering (2)	50	50
After 24 hr in water	20	20
After 72 hr in JP 4 fuel (MIL-J-5629)	20	20
After 24 hr in aromatic fuel (MIL-S-3136, Type II)	15	NR
After 72 hr in hydraulic fluid (MIL-F-7083)	20	20
After 72 hr in SKYDROL 500 hydraulic fluid	15	NR
After 168 hr at 180 F	50	50
After 20 hr accelerated adhesive weathering (2)	15	15
Corrosion on aluminum		
After 168 hr at 180 F (1)	None	None

(1) The tape is adhered to 2024 Alclad Aluminum (QQ-A-362).
(2) Fed Test Method Std No. 141, Method 6151.
NR = No Requirement

FORM

The tape is available in 72 yard rolls wound on 3 inch diameter cores. in ¼, ½, ¾, 1, 1½, and 2 inch widths. Each roll may contain up to 3 splices. Type I is colorless, and Type II is available in gold, silver and commercially available colors.

QPL

No.

NOTES

(1) Use Type I for applications requiring resistance to solvents, oils and hydraulic fluids. Typical applications are dissimilar metal separation on aircraft and covering of pressure-sensitive identification tapes on fuel lines of aircraft and vehicles.

(2) Use Type II for applications requiring weather resistance and long-time aging characteristics such as labels, decorative striping and color coding. Where solvent resistance is required, cover Type II with Type I.

O-P-106 PASTE, LINOLEUM

Issue: 17 October 1939 Revision: None Amendment: None

SCOPE

This adhesive is intended for installation of linoleum, cork carpets and other linoleum floor coverings.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of unspecified binders and inorganic fillers dispersed in water.

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

PROCESS. The adhesive is applied by trowelling in thicknesses of 1/32 inch, the linoleum laid and the joint cured 72 hours at room temperature under contact pressure. During storage the filler does not separate out.

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. A cleavage force of at least 8 pounds separates a 2 inch by 6 inch by 3/8 inch No. 1 common white pine board and a 2 inch by 8 inch by 1/8 inch thick battleship linoleum tile with unpainted burlap back after the joint using 4 grams of paste (on pine) is cured at 75 F for 72 hours under 10 pounds bonding pressure.

FORM

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

QPL

No.

NOTES

(1) Do not use this adhesive for bonding floor coverings to steel.

O-S-605 SODIUM SILICATE SOLUTIONS

Issue: 1 September 1960 Revision: b Amendment: None

SCOPE

This glue is intended for (1) sealing paper cartons, (2) affixing labels to paper and wood, (3) bonding asbestos cloth pipe lagging and (4) coating asbestos cloth pipe insulation and compression rubbers on intaglio printing presses.

CLASSIFICATION

The glue is available in three classes.

Class I 40° Baume
Class II 34° Baume
Class III 51.45° (average) Baume

PROPERTIES

CHEMICAL. The glue consists of sodium silicate containing alkali (expressed as percent sodium oxide) in the following quantities: Class I, 8.5 – 9.4; Class II, 6.0 – 7.0; and Class III, 13.5 – 14.3.

PHYSICAL. The Class I, II and III glues have viscosities of 85-550, 125-340, 1200-3000 centipoises at 25 C and specific gravities of at least 1.380, 1.283, 1.540-1.570, respectively.

PROCESS. The glue is applied by brushing, the joint closed (except Type III, see Note section No. 3) and cured at room temperature under contact pressure (no time specified).

PERFORMANCE. No performance properties are given.

FORM

The sodium silicate glue is available in 5 and 55 gallon containers.

QPL

No.

NOTES

(1) Use Class I for sealing paper cartons, affixing paper labels to paper and wood and coating asbestos pipe insulation and cement.

(2) Use Class II for adhering asbestos cloth pipe lagging and subsequent coating.

(3) Use Class III for surface coating compression rubbers on intaglio presses to prevent listing of printing sheets.

U-C-133 CAVITY LINING AND THINNER SET, DENTAL

Issue: 14 August 1947 Revision: b Amendment: None

SCOPE

This set is intended as a lining material for dental cavity walls and as a varnish for silicate cement restorations.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cavity lining consists of a solution composed of unspecified resins, plasticizers and solvents. The thinner is an unspecified volatile solvent.

PHYSICAL. The lining is turbid white with a pale pinkish-tan or yellow tint (see Note Section No. 1). The thinner is colorless, immiscible with water, free from unpleasant or irritating odors and not caustic to pulp tissue.

PROCESS. The thinner is added to the cavity liner, if necessary, the mixture applied by brushing and cured at least two minutes at mouth temperature under contact pressure.

PERFORMANCE. The film is tough, nontacky after two minutes air drying, waterproof, noncontracting, and will not lose adhesion from glass or change color or translucency after air drying 25 seconds followed by immersion in distilled water for 30 minutes.

FORM

The liquid cavity lining and thinner materials are each available in ½ ounce sealed wide-mouth bottles containing not less than than 14.8 ml of material.

QPL

No.

NOTES

(1) The yellow color is no darker than one equivalent to a solution composed of 18.0 grams ferric chloride hexahydrate, 2.5 ml ACS concentrated hydrochloric acid and 100 ml of USP purified water.

(2) This cavity liner provides a film-type lining which insulates the pulp from the restorations.

(3) The cavity lining solution is suitable as a protecting covering over silicate restorations.

U-C-198 CEMENT, COPPER AND ZINC PHOSPHATES, DENTAL

Issue: 23 January 1957 Revision: a Amendment: None

SCOPE

This cement is intended for the restoration of deciduous teeth where potent germicidal action is desired.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of two components. The solid component is composed of zinc oxide and at least 25 parts cuprous oxide. The liquid component is composed of phosphoric acid. The arsenic content of the mixed cement is not more than 0.0002%.

PHYSICAL. The cement when mixed in accordance with the standard consistency batch (see Process Section) compresses, three minutes after mixing under a load of 33 pounds over two square centimeters of mixed cement, to a film thickness of 0.0016 inch 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 consistency, the amount of powder necessary for each 0.5 ml 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 weighted flat glass plate load for seven minutes when applied three 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 has a water-wet compressive strength of at least 15,000 psi, seven days after mixing. The set cement (one hour at 99 F) does not lose more than 0.20% weight after seven days immersion in 99 F water.

FORM

The cement powder, unless otherwise specified, is available in one ounce bottles and the proper quantity plus 20% excess of liquid is available in sealed glass bottles.

QPL

No.

NOTE

(1) This specification is similar to American Dental Association Specification No. 8, "Dental Zinc Phosphate Cement".

U-C-205 CEMENT, SILICATE; AND ACCESSORIES (DENTAL)

Issue: 13 February 1951 Revision: a Amendment: None

SCOPE

This cement is intended for the restoration of anterior teeth.

CLASSIFICATION

The cement is available in six shades.

Shade 1	Light	Shade 4	Medium yellow-gray
Shade 2	Light yellow	Shade 5	Medium gray
Shade 3	Medium yellow	Shade 6	Light yellow-gray

PROPERTIES

CHEMICAL. The cement consists of two components. The solid component is composed of a silicate powder containing a pigment. The composition of the liquid component is not given. The water soluble arsenic content of the mixed cement is not more than 0.0002%.

PHYSICAL. The opacity, represented by the contrast ratio C0.70, is between 0.35 and 0.55.

PROCESS. The cement is activated by mixing the liquid and powder components, applied with a condenser or spatula and cured at mouth temperature under contact pressure. For establishing proper consistency, the amount of powder necessary for each 0.4 ml of liquid is determined when a 0.5 ml quantity of mixed cement is compressed into a circle of 25 mm diameter under a 2500 gram weighted flat glass plate load for eight minutes when applied two minutes after starting the mix. The cement sets between three and five minutes at 99 F.

PERFORMANCE. The cement has a water-wet compressive strength of at least 23,000 psi, 24 hours after mixing. The set cement (one hour at 99 F) does not lose more than 1.4% weight after 24 hours immersion in 37 C water.

FORM

The cement powder, unless otherwise specified, is available in ½ ounce bottles and the proper quantity plus 20% excess of liquid is available in leakproof glass containers.

QPL

No.

NOTE

(1) This specification is similar to American Dental Association Specification No. 9, "Dental Silicate Cement".

U-C-208 CEMENT, ZINC OXIDE AND EUGENOL, DENTAL

Issue: 11 March 1957 Revision: b Amendment: None

SCOPE

This cement is intended for (1) cementing orthodontic bands, (2) dressing seals, liners or steps under silicate and metal restorations, (3) temporary fillings and (4) general cementing operations.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of two components. The solid component is composed of USP or NF zinc oxide powder. The liquid component is composed of eugenol. Either the zinc oxide or eugenol component contains an unspecified, nonmetallic germicidal agent.

PHYSICAL. The zinc oxide and eugenol when mixed is white or light ivory in color, opaque to X-ray and is nontoxic.

PROCESS. The cement is activated by mixing the zinc oxide and eugenol components, applied with a condenser and cured at mouth temperature under contact pressure. For establishing proper consistency, the amount of zinc oxide necessary for each 0.4 ml of eugenol is determined when a 0.5 ml quantity of mixed cement is compressed into a circle of 25 mm diameter under a 2500 gram weighted flat glass plate load for seven minutes when applied three minutes after starting the mix. No gas is evolved during mixing and the cement sets between four and ten minutes at room temperature and between three and five minutes in the mouth.

PERFORMANCE. The cement does not irritate soft or hard oral tissues or discolor tooth structures. It has a water-wet compressive strength of at least 1000 psi, two hours after mixing.

FORM

The zinc oxide powder is available in 50 gram amber or blue-colored sealed bottles and the liquid eugenol in 15 ml amber or blue-colored sealed bottles. Any other ingredients in the bottles are specified on the lable.

QPL

No.

U-C-211 CEMENT, ZINC PHOSPHATE, DENTAL

Issue: 13 December 1956 Revision: a Amendment: None

SCOPE

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

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of two components. The solid component is composed of zinc oxide powder containing pigments and unspecified modifiers. The liquid component is composed of a mixture of aluminum phosphate and phosphoric acid and may contain buffers such as metallic salts. 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 compresses, three minutes after mixing under a load of 33 pounds over two sq cm of mixed cement, to a film thickness of 0.0016 inch 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. 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, "Dental Zinc Phosphate Cements".

U-M-200 MERCURY, DENTAL

Issue: 30 March 1960 Revision: a Amendment: None

SCOPE

This mercury is intended for the preparation of dental amalgams used in restoring lost tooth structure.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The liquid metal consists of mercury having no more than 0.02% non volatile residue.

PHYSICAL. The mercury has a bright mirror-like surface, free from film or scum and pours freely and in its entirety from a thoroughly clean glass or polyethylene container.

PROCESS. The mercury is processed as specified in Federal Specification U-S-350 (see abstract).

PERFORMANCE. No performance properties are given.

FORM

The mercury is available in commercial packages.

QPL

No.

NOTES

(1) This specification is similar to American Dental Association Specification No. 6, "Dental Mercury".

U-P-401 PLASTER, ADHESIVE, SURGICAL

Issue: 23 June 1959 Revision: c Amendment: None

SCOPE

This adhesive plaster is intended for corrective medical and surgical procedures.

CLASSIFICATION

The adhesive plaster is available in three types.

Type I Standard base fabric, nonwater repellent
Type II Waterproof-back material
Type III Napped cotton back cloth (moleskin)

PROPERTIES

CHEMICAL. The adhesive plaster consists of a cotton fabric (Type I), a cotton fabric made waterproof with cellulose ester resins (Type II) or a napped cotton moleskin (Type III) backing coated on one side with a new rubber, synthetic rubber, rubber substitute, but not reclaimed rubber either whole or in part, base adhesive. A polyethylene or crinoline (CCC-C-665, Type I, plain gauze) liner is used.

PHYSICAL. The adhesive plaster backing, Types I, II, and III, respectively, weighs at least 2.6, 3.8 (including waterproof coating), 9–10.5 oz/sq yd, has a tensile strength of at least 45, 45, 50 lb/in. of width, a yarn count per sq in. of at least 142,——,——, a weave pattern of plain,——,—— and contains 3.5, 3, 3 oz/sq yd of adhesive.

PROCESS. The adhesive plaster requires no moisture, heat or other preparation prior to or subsequent to application except for removal of the liner. Removal of the crinoline or polyethylene liner does not result in substantial distortion.

PERFORMANCE. The adhesive plaster has a shear strength at 37 C of at least 20 psi using a bakelite substrate (CCC-T-191, Method 5100).

FORM

The adhesive plaster is available in 5 forms. These are (1) uncut rolls, (2) cut rolls containing equal cuts, (3) cut rolls containing assorted cuts, (4) uncut spools and (5) cut spools whose dimensions and colors are given in Table II.

QPL

No.

U-P-401 (Continued)

TABLE II. AVAILABILITY OF U-P-401 ADHESIVE PLASTER

FORM	BACKING	COLOR	WIDTH, IN.	LENGTH, YD	CUTS PER 12 IN. ROLL	
					NUMBER	WIDTH OF CUT, IN.
Uncut rolls	Plain back	White, flesh	12	5	–	–
	Moleskin	White, flesh	12	5	–	–
Equal cut rolls	Plain back	White	12	10	48	¼
					24	½
					12	1
					8	1½
					6	2
					4	3
					3	4
		Flesh	12	10	12	1
					8	1½
					6	2
	Waterproof back	–	12	10	24	½
					12	1
					6	2
					4	3
Assorted cut rolls	Plain back	White	12	10	4	½
					3	1
					2	2
					1	3
					1	1 (1)
					2	2 (1)
					1	3 (1)
					1	4 (1)

U-P-401 (Continued)

TABLE II. AVAILABILITY OF U-P-401 ADHESIVE PLASTER (Continued)

FORM	BACKING	COLOR	WIDTH, IN.	LENGTH, YD	CUTS PER 12 IN. ROLL: NUMBER	CUTS PER 12 IN. ROLL: WIDTH OF CUT, IN.
	Waterproof back	—	12	10	4	½
					3	1
					2	2
					1	3
					1	1
					2	2
					1	3
					1	4
Uncut spools	Waterproof back	—	½	1½,5,10	—	—
			1	2½,5,10	—	—
			2	5	—	—
	Plain back	White	½	10,5	—	—
			1	1,2½,5,10	—	—
			2	5,10	—	—
			3	5	—	—
	Plain back	Camouflaged (2)	1	5	—	—
Cut spools	Waterproof back	—	1½	5	1	½
					1	¼
					1	¾

(1) On special order only.
(2) Camouflaged color is field brown. The cotton fabric backing is dyed brown with 2 ounces of Pontamine Brown B.T. concentrate per 100 pounds of backing material, unless otherwise specified.

U-S-00156 (GSA-FSS) SEALING COMPOUND, DENTAL (ROOT CANAL)

Issue: 14 June 1957 Revision: a Amendment: None

SCOPE

This compound is intended for sealing root canals of teeth.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The sealing compound consists of two components. The solid component is composed of 39-43% ACS zinc oxide with no more than 0.0002% arsenic, 28-32% ACS metallic silver, 11-15% thymol iodide and 14-18% unspecified resin. The liquid component is composed of unspecified oleoresins. Xylene is used as the solvent.

PHYSICAL. No physical properties are given.

PROCESS. The compound is activated by mixing for one to one and one-half minutes the liquid and solid components, applied with root canal instruments and cured 24 hours at mouth temperature under contact pressure. The sealer has a working time of ten minutes during which it remains soft, smooth and plastic.

PERFORMANCE. The sealer after 24 hours adheres tenaciously to glass such that it can be removed only by chipping it off.

FORM

The sealer is available in three bottles. The first contains 40 capsules each with approximately 1/10 gram of sealer powder. The second bottle containing at least 2.3 grams of sealing liquid is equipped with a dropper which gives the exact quantity of liquid to react with one capsule. The third bottle contains ¼ ounce of xylene solvent.

QPL

No.

U-S-350 SILVER ALLOY POWDERS, DENTAL

Issue: 16 April 1957 Revision: a Amendment: None

SCOPE

This silver alloy powder is intended for the preparation of dental amalgams used in restoring lost tooth structure.

CLASSIFICATION

The silver is available in two types.

Type I Filings
Type II Shavings

PROPERTIES

CHEMICAL. The silver alloy powder consists of at least 68% silver and 25% tin and not more than 5% copper and 2% zinc. The alloy may contain also gold or platinum.

PHYSICAL. No physical properties are given.

PROCESS. The silver powder and mercury (U-M-200) are titurated at least 1.5 minutes to a smooth plastic amalgamation, applied with a condenser and cured at mouth temperature under contact pressure. The amalgam is ready for condensation in not longer than three minutes and remains carvable (Frahm carver) for at least 15 minutes, but not longer than 20 minutes from start of amalgamation. The amalgam receives and retains a polish 24 hours after amalgamation.

PERFORMANCE. The amalgam flows no more than 4 percent when subject to a compressive load of 3,350 psi for 24 hours applied 3 hours after tituration. The dimensional change 24 hours after condensation is between 3 and 13 microns per centimeter. The amalgamated alloy will not produce excessive blackening when rubbed against the hand or white paper.

FORM

The silver alloy powder is available in glass bottles containing 1, 2 and 5 ounce troy net weights.

QPL

No.

NOTES

(1) The National Bureau of Standards tests the silver alloy powder for the purpose of establishing a list of certified materials.

(2) This specification is similar to American Dental Association No. 1, "Alloy for Dental Amalgam".

HH-C-168 CEMENT, INSTALLATION; THERMAL, MINERAL WOOL

Issue: 26 April 1946 Revision: None Amendment: None

SCOPE

This cement is intended for insulating purposes.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of mineral wool fiber including rock, glass, slag and unspecified binders.

PHYSICAL. The cement after molding and drying has a maximum density of 27 lb/cu ft and a thermal conductivity (Btu/in./hr/sq ft/°F) of no more than 0.70, 0.85, and 1.05 at mean temperature differences of 200, 500 and 700 F, respectively

PROCESS. The cement is activated by mixing with water (CS 131-46), applied by trowelling and cured 16 hours at 225 F under contact pressure. A wet coverage of at least 45 board feet (sq ft/inch thickness) per 100 pounds of dry material is obtained.

PERFORMANCE. The cement has a flatwise tensile strength of at least 3.0 psi at room temperature using steel adherends, a volumetric shrinkage upon drying of not more than 20%, a weight loss of not more than 10% during 6 hours exposure to 1500 F, and sufficient temperature resistance to show no adverse effects from heating one surface 96 hours at 1500 F.

FORM

The powdered cement is available in commercial packages.

QPL

No.

NOTES

(1) This specification supercedes in part Federal Specification HH-P-386 (now cancelled).

(2) This cement should be dried out promptly when applied directly to steel.

HH-C-176 CEMENT; SILICA

Issue: 1 August 1933 Revision: None Amendment: None

SCOPE

This cement is intended as a mortar for bonding silica bricks for foundry use.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of ground silica brick bats, (and/or) ground silica rock (quartzite) and siliceous fire clay containing not less than 88% total silica.

PHYSICAL. The dry, powdered cement is sufficiently fine to pass at least 99% through a U S Standard No. 30 mesh sieve and has a pyrometric cone equivalent of at least No. 26 (2903 F).

PROCESS. The cement is activated by mixing with water, applied by trowelling, the silica brick (HH-B-681) laid and the joint cured at room temperature under contact pressure (no time specified).

PERFORMANCE. No performance properties are given.

FORM

The dry, powdered cement is available in sacks containing not more than 150 pounds of cement.

QPL

No.

NOTES

(1) Do not use this cement with fire clay bricks.

(2) This specification was canceled 3 January 1964. Use HH-M-630 (see abstract).

HH-C-451 CLAY; FIRE, GROUND

Issue: 28 June 1955 Revision: e Amendment: None

SCOPE

This clay is intended for bonding installations of fire-clay brick subjected to high temperatures.

CLASSIFICATION

The clay is available in two classes and three grades.

Class C Commercial
Class F Fine
Grade 1 Superduty
Grade 2 High and slag-resistant duty
Grade 3 Low Duty

PROPERTIES

CHEMICAL. The clay consists of fire clay.

PHYSICAL. The Class C and F clay has sufficient fineness that after slaking 1 hr in water no more than 0.5% and ____ is retained on a U S Standard No. 6 mesh sieve, 5 and 0.5% on a No. 20 mesh sieve and ____ and 5% on a No. 30 mesh sieve. Grades 1, 2 and 3, both classes, have a pyrometric cone equivalent to at least No. 31 (1683 C), 27 (1640 C) and 23 (1605 C), respectively (ASTM C24).

PROCESS. The clay is activated by tempering the water, applied by trowelling, the fire-clay brick laid and the joint allowed to cure at elevated temperatures under contact pressure (time and temperature are not specified).

PERFORMANCE. No performance properties are given.

FORM

The powdered fire clay is available in commercial packages.

QPL

No.

NOTES

(1) These clays have drying and firing shrinkages greater than heat setting mortars (see HH-M-622), thus leading to more cracks. This results in leakage of air and gas through furnace walls, using this clay as a mortar. When such leakage must be kept to a minimum, use the heat setting mortar.

(2) This specification is similiar in part to ASTM C105, "Ground Fire Clay As a Mortar for Laying Up Fire-clay Brick."

HH-C-536 COMPOUND; PLUMBING-FIXTURE-SETTING

Issue: 20 April 1954 Revision: a Amendment: None

SCOPE

This compound is intended for forming a water-tight, gas-tight, odor-proof and vermin-proof seal for plumbing fixtures requiring gasket connections to the drainage system.

CLASSIFICATION

The compound is available in two types.

Type I Nonpreformed (bulk)
Type II Preformed (molded in a ring)

PROPERTIES

CHEMICAL. The compound consists of an unspecified, nonvolatile and nonasphaltic base, asbestos fiber (optional) and a germicide.

PHYSICAL. The compound can be bent 180° over a 1 inch mandrel at 32F, does not stain wood, concrete or tile surfaces and Type I is sufficiently fine to pass at least 99.6% through a U S Standard No. 325 mesh sieve.

PROCESS. The Type I adhesive is applied by brushing or rolled into a ring, the Type II laid in place, the joint closed and cured at room temperature under contact pressure (no time specified). Type I spreads readily on vitreous or metal surfaces, does not lump or liver in the container, and both types can sustain heat as high as 180 F for 5 minutes without any adverse effect on homogeneity, smoothness or plasticity of the compound.

PERFORMANCE. The compound is waterproof in that it does not allow the passage of water during a 72 hour period through a No. 14 mesh screen when coated with the Type I compound.

FORM

The Type I paste compound and the Type II in molded rings are available in commercial packages.

QPL

No.

HH-I-00500 INSULATING CEMENTS, THERMAL

Issue: 24 May 1956 Revision: None Amendment: None

SCOPE

This cement is intended for fabricating thermal insulation.

CLASSIFICATION

The cement is available in five types.

Type I 85% Magnesia (up to 600 F)
Type II Asbestos (up to 1000 F)
Type III Mineral wool (up to 1800 F)
Type IV Expanded or exfoliated vermiculate (up to 1800 F)
Type V Diatomaceous silica (up to 1900 F)

PROPERTIES

CHEMICAL. The Type I cement consists of a mixture of hydrated magnesium carbonate ($4Mg CO_3Mg(OH)2 \cdot 5H_2O$) and at least 10 percent asbestos; Type II cement consists of a mixture of Quebec Asbestos Producers Association Grade 7 or longer asbestos fiber and an unspecified heat resistant binder; Type III cement consists of a mixture of mineral wool and an unspecified heat resistant binder; Type IV cement consists of a mixture of expanded or exfoliated vermiculite and an unspecified heat resistant binder; Type V cement consists of a mixture of diatomaceous silica and an unspecified heat resistant binder.

PHYSICAL. The cement has a storage density (lb/cu ft) within ± 10 percent of the supplier's value (ASTM C164). The other physical properties of the cement are tabulated in Table I.

TABLE I. PHYSICAL PROPERTIES OF HH-I-00500 CEMENT

PROPERTY	TYPE I	II	III	IV	V
Thermal conductivity, Btu/in./hr/sq ft/°F, max (1)					
At mean temperature					
200 F	0.70	1.30	0.70	0.95	0.80
300 F	0.80	NR	NR	NR	NR
500 F	NR	1.60	0.85	1.10	1.00
700 F	NR	1.80	1.00	1.20	1.10

(1) ASTM C177.
NR = No Requirement

HH-I-00500 (Continued)

PROCESS. The cement is activated by mixing with water, applied by trowelling and cured 48 hours at 225 F under contact pressure. A dry coverage of at least 50, 18, 45, 60 and 35 board feet (sq ft/in. thickness) per 100 pounds of dry Type I, II, III, IV and V cements, respectively, is obtained (ASTM C166).

PERFORMANCE. The cement has a volumetric shrinkage upon drying of no more than 35, 40, 20, 18 and 30 percent for Types I, II, III, IV and V cement, respectively, a flatwise tensile strength to steel at room temperature of 3.0 and 2.5 for Types III and IV, respectively, and all types do not bake hard, burn or produce a flame at temperatures as high as 600 F.

FORM

The powdered cement is available in commercial packages.

QPL

No.

NOTES

(1) Type I is similiar to ASTM C193, "85 Percent Magnesia Thermal Insulating Cement."

(2) Type II is similiar to ASTM C194, "Asbestos Thermal Insulating and Finishing Cement."

(3) Type III is similiar to ASTM C195, "Mineral Filler Thermal Insulating Cement."

(4) Type IV is similiar to ASTM C196, "Expanded or Exfoliated Vermiculite Thermal Insulating Cement."

(5) Type V is similiar to ASTM C197, "Diatomaceous Silica Thermal Insulating Cement."

HH-I-510 INSULATION TAPE, ELECTRICAL, FRICTION

Issue: 20 June 1962 Revision: a Amendment: None

SCOPE

This pressure-sensitive tape is intended to restore wire and cable electrical insulation.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a cotton sheet backing impregnated with an unvulcanized friction rubber compound containing no free sulfur.

PHYSICAL. The tape is 0.015 ± 0.003 inch thick, has a tensile strength of 40 lb/in. of width, a dielectric strength of at least 1000 volts at RT (ASTM D149), no more than 1/8 inch width difference per 16 inch length (Parallelism) and no more than 12, 16, 24 and 32 pinholes per 3 yards for ¾, 1, 1½ and 2 inch wide tape.

PROCESS. The tape does not require moisture, heat or other preparation prior to or subsequent to application. It does not unwind faster than 15 inches per minute at 70 F under 4 pounds load per inch width after being wound under 10 pounds load per inch width and at 70 F after aging the tape 16 hours at 212 F (ASTM D573) using a 3 pound load per inch width of tape. The tape can be stored 8 months at ambient temperature.

PERFORMANCE. The tape when specified does not cause the blue-black color characteristic of copper sulphide after baking on copper 16 hours at 100 C.

FORM

The tape is available in 82.5 to 85 foot lengths in the widths specified in Table I.

QPL

No.

NOTES

(1) This specification is similar to ASTM D69, "Friction Tape for General Use for Electrical Purposes".

HH-I-553 INSULATION TAPE, ELECTRICAL, (RUBBER, NATURAL AND SYNTHETIC)

Issue: 21 August 1962 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced wires and cables operating at both normal and high voltages.

CLASSIFICATION

The tape is available in two grades.

Grade A Ozone resistant
Grade B Regular (600 volts and less)

PROPERTIES

CHEMICAL. The tape consists of unvulcanized or partially vulcanized natural rubber, synthetic rubber or a mixture of the two with a glazed cloth or parchment paper liner.

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

TABLE I. PHYSICAL PROPERTIES OF HH-I-553 TAPE

PROPERTY	VALUE
Thickness, in.	0.030
Thickness tolerance, ± in.	0.003
Tensile strength, psi, at 75 F, min (1)	250
Elongation, ultimate, %, at 75 F, min (2)	300
Dielectric strength, volts/mil, at 75 F, min (3)	350
Flexibility, °C, min (4)	−40

(1) Fed Test Method Std No. 601, Method 13021.
(2) Fed Test Method Std No. 601, Method 13031.
(3) Fed Test Method Std No. 601, Method 13321.
(4) The tape, after 2 hours conditioning at temperature, can be wound on a ¼ inch diameter glass rod without splitting, cracking, crazing or delaminating.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application except for removal of liner.

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

HH-I-553 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF HH-I-533 TAPE

PROPERTY	VALUE GRADE A	VALUE GRADE B
Fusion, lb/in., min (1)	3	4
Ozone resistance, cracking (2)	None	None

(1) Fed Test Method Std No. 601, Method 13131, except load during winding is 3.0 lb/in. of width. The tape is sufficiently tacky, such that it will adhere to itself in accordance with Fed Test Method Std No. 601, Method 13151, except Grade A uses 3 lb/in. load.
(2) Fed Test Method Std No. 601, Method 13021.

FORM

The tape is available in 15 foot rolls in ¾, 1, 1½ and 2 inch widths. The ¾ inch wide tape is also available in 30 foot lengths.

QPL

No.

NOTES

(1) The supplier sertifies that the tape passes Underwriters' Laboratories, Inc., Standard UL-510, for "Fire and Casualty Hazards."

(2) Use Grade A for splicing wires and cables operating at high voltages.

(3) Use Grade B for splicing wires and cables operating up to 600 volts and where ozone resistance is not required.

(4) Grade A is similiar to ASTM D1373 and ASA C59.37, "Ozone Resistant Rubber Insulating Tape." Grade B is similiar to ASTM D119 and ASA 59.6, "Rubber Insulating Tape."

HH-M-00611 (GSA-FSS) MORTAR; REFRACTORY, AIR-SETTING BONDING (WET AND DRY TYPES)

Issue: 15 November 1962 Revision: b Amendment: None

SCOPE

This mortar is intended for bonding firebrick where the service temperatures are too low to use ground fire clay or hot-set mortars and too high for hydraulic mortars.

CLASSIFICATION

The mortar is available in two types and three grades.

- Type I Wet
- Type II Dry
  - Grade 1 Medium duty
  - Grade 2 High duty
  - Grade 3 Super duty

PROPERTIES

CHEMICAL. The mortar consists of pulverized fire clay, mullite, fused alumina, calcined fire clay, cyanite, diaspore, ball clay, etc., intimately mixed with sodium silicate or materials other than hydraulic cements. Type I contains no more than 25% water (ASTM C92).

PHYSICAL. The mortar passes at least 95% through a U S Standard No. 40 mesh sieve and at least 99.5% through a No. 20 mesh sieve (ASTM C92).

PROCESS. The dry cement (Type II) is activated by mixing with water, both types applied by troweling or dipping, the brick laid and the joint cured 24 hours at room temperature under contact pressure. Type I can be converted to dipping consistency by addition of water. The consistency of Type II is varied by the amount of water added. The mortar can be stored at least six months in unopened containers.

PERFORMANCE. The mortar has a modulus of rupture of at least 200 psi (ASTM C198) and will not flow out of joints when Grade 1 is exposed to 2550 F, Grade 2, 2730 F and Grade 3, 2910 F (ASTM C199).

FORM

The mortar, Type I, is available in 50, 100 and 200 pound containers and Type II, in 100 pound bags.

QPL

No.

HH-M-00611 (Continued)

NOTES

(1) This mortar is suitable for firebrick installations including chimney linings and interior fireplaces.

(2) Do not use this mortar for installations which are subjected to rain or dampness.

(3) Dry tape mortar deteriorates rapidly and unless intended for use shortly after manufacture, should be stored in air tight containers.

(4) This specification is in part similiar to ASTM C178 and ASA A111.24, "Air-Setting Refractory Mortar (wet type) for Boiler and Incinerator Services".

HH-M-622 MORTAR; REFRACTORY, HEAT-SETTING

Issue: 24 June 1955 Revision: a Amendment: None

SCOPE

This mortar is intended for bonding fire clay bricks subjected to prolonged service at high temperatures.

CLASSIFICATION

The mortar is available in two grades.

Grade A Super duty and high duty
Grade B Slag-resistant duty

PROPERTIES

CHEMICAL. The mortar consists of fire clay materials similar to those used in the manufacture of fire clay brick.

PHYSICAL. The mortar after slaking in water for one hour passes at least 99.5% through a U S Standard No. 20 mesh sieve and at least 90% through a No. 40 mesh sieve (RR-S-366). Grade A has a pyrometric cone equivalent of at least 1683 C (No. 31) and Grade B at least 1640 C (No. 27) (ASTM C24).

PROCESS. The cement is activated by mixing with water, applied by trowelling in thicknesses up to 1/8 inch, the brick laid and the joint cured 24 hours at room temperature, followed by 18 hours at 110 C and 3 hours at 1500 C for Grade A and 1350 C for Grade B.

PERFORMANCE. The cement after cure has a linear shrinkage of not more than 12% and is sufficiently strong such that a pier consisting of two whole and two half brick-mortar combinations does not fall apart when lifted by the top brick.

FORM

The powdered cement is available in commercial packages.

QPL

No.

NOTES

(1) Use this mortar in preference to ground fire clay (HH-C-451) where tighter joints are needed to keep air and gas leakage to a minimum.

(2) This specification supercedes MIL-M-16299, "Mortar, Refractory, (High Temperature, Heat Setting)".

HH-M-630 MORTAR, REFRACTORY, SILICA

Issue: 3 January 1964 Revision: a Amendment: None

SCOPE

This mortar is intended for bonding silica bricks for foundry applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The mortar consists of ground silica brick bats, ground silica sand, or ground silica rock (quartzite) containing not less than 90% silica (ASTM C18).

PHYSICAL. The mortar is sufficiently fine for at least 99% to pass through a U S Standard No. 30 mesh sieve (ASTM C92) and has a pyrometric cone equivalent of at least No. 26 (ASTM C24).

PROCESS. The mortar is mixed with water, applied to the brick, the joint closed and cured at room temperature under contact pressure (no time specified).

PERFORMANCE. No performance properties are given.

FORM

The powdered mortar is available in commercial packages.

QPL

No.

NOTES

(1) Do not use this mortar with fire clay bricks.

HH-R-191 REFRACTORIES; FIRE CLAY, PLASTIC

Issue: 7 August 1952 Revision: a Amendment: None

SCOPE

This refractory is intended for fabricating and bonding fire clay shapes and installations including monolithic furnace walls, arches and boiler settings where the temperature is high enough to vitrify the hot face sufficiently so as to approach the strength of a fire-clay brick of corresponding quality.

CLASSIFICATION

The refractory is available in two classes.

Class I High Duty
Class II Super Duty

PROPERTIES

CHEMICAL. The refractory consists of grog and raw clay dispersed in water.

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

TABLE I. PHYSICAL PROPERTIES OF HH-R-191 REFRACTORY

PROPERTY	CLASS 1	CLASS 2
Pyrometric cone equivalent (1)		
No.	31	32.5
Temperature, °F	3056	3137
Thermal spalling, %, max (2)	10	5

(1) ASTM C24.
(2) Must be specified in the purchase order and evaluated per ASTM C180.

PROCESS. The refractory is activated by mixing with water to a stiff mud consistency, applied by trowelling followed by tamping, the brick laid and the joint cured at elevated temperature sufficient to vitrify the refractory (time and temperature are not specified). The refractory has a workability index between 15 and 35% deformation (ASTM C181) in that it reaches maximum bulk density by tamping between 10 and 30 times with a sand reamer.

PERFORMANCE. The cement after heating at 1400 C has a modulus of rupture of not more than 800 psi (ASTM C133). The maximum modulus of elasticity (optional with purchaser) and maximum linear change (ASTM C179) are for Class I after heating 5 hours at 1400 C, 4 x 10^6 psi and 3% and for Class II after heating 5 hours at 1500 C, 5 x 10^6 psi and 2.5%, respectively.

HH-R-191 (Continued)

FORM

The powdered refractory is available in commercial packages.

QPL

No.

NOTES

(1) The thermal spalling test is indicated as optional when the amount of fire-clay plastic refractory required does not exceed one ton. In these cases modulus of elasticity can be considered a requirement in lieu of the spalling test.

(2) This specification is in part similiar to ASTM C64 and ASA A111.8, "Refractories for Heavy Duty Stationary Boiler Service."

HH-T-0025 (GSA-FSS) TAPE, PRESSURE-SENSITIVE ADHESIVE, PLASTIC (FOR ELECTROPLATING)

Issue: 17 January 1964 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for stop off masking during electroplating operations and for providing abrasion resistance to parts during rough handling.

CLASSIFICATION

One type only.

PROPERTIES

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

PHYSICAL. The transparent tape is between 0.006 and 0.009 inch thick, has a tensile strength of at least 18 lb/in. of width and and elongation of at least 150%.

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape is resistant to water and most chemicals used in electrochemical operations, including plating baths up to 170 F. It has a peel strength of at least 15 oz/in. of width at room temperature using a commercial polished ground AISI 302 or 304 stainless steel adherend (Fed Test Method Std No. 00147, Method 10).

FORM

The tape is available in 36 yard rolls wound on 3 inch diameter cores in widths specified by the purchaser. Each roll may contain up to 3 splices.

QPL

No.

HH-T-0029 (GSA-FSS) TAPE, PRESSURE-SENSITIVE ADHESIVE, LEAD FOIL

Issue: 17 January 1964 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for stop off masking during electroplating operations and where a moisture-proof seal is required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a lead foil backing coated on one side with an unspecified adhesive and protected with a red cellophane or treated paper liner.

PHYSICAL. The tape is between 0.0045 and 0.0055 inch thick, has a tensile strength of at least 18 lb/in. of width, an elongation of at least 15% and a moisture vapor transmission rate not greater than 0.5 gm/100 sq in./24 hr.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application except for removal of the liner.

PERFORMANCE. The tape has a peel strength of at least 30 oz/in. of width at room temperature either as received or after 96 hours accelerated weathering using a commercial polished ground AISI 302 or 304 stainless steel adherend (Fed Test Method Std 00147, Methods 10, 63.

FORM

The tape is available in 36 yard rolls wound on a 3 inch diameter core in widths specified by the purchaser. Each roll may contain up to 3 splices.

QPL

No.

NOTES

(1) This tape is particularly useful in hard chrome plating where a "thieving action" is desired.

(2) This tape has the lowest moisture vapor transmission rate of any available tape.

JJ-B-107 BANDAGES, SELF-ADHERENT

Issue: 20 August 1952 Revision: None Amendment: None

SCOPE

This self-adherent bandage is intended for corrective medical procedures.

CLASSIFICATION

The self-adherent bandage is available in three sizes.

Size 1 2 inches by 5 yards
Size 2 3 inches by 5 yards
Size 3 Specified by purchaser

PROPERTIES

CHEMICAL. The self-adherent bandage consists of cotton gauze (CCC-G-101, Type II) impregnated with an unspecified adhesive.

PHYSICAL. The self-adherent bandage contains no more than 90 gr/sq yd of nontoxic adhesive and the gauze has a tensile strength of at least 14 lb/in. of width.

PROCESS. The self-adherent bandage requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The self-adherent bandage does not stick to skin or hair, adheres to itself and has a peel strength of at least 6.5 lb/in of width.

FORM

The self-adherent bandage is available in the sizes given in the Classification Section. Each bandage is securely wrapped in suitable paper and sealed to maintain sterility of the bandage.

QPL

No.

NOTES

(1) The packaged bandage is sterilized by high pressure steam. Chemical sterilization is not permissible.

(2) The supplier will provide a certificate of sterilization upon request.

QQ-C-40 CALKING: LEAD WOOL AND LEAD PIG

Issue: 15 April 1963 Revision: None Amendment: None

SCOPE

This calking compound is intended for sealing gas, water and sewer lines.

CLASSIFICATION

This calking compound is available in two types, three grades and three forms.

Type I Lead pig (Grade AA only)
Type II Lead wool (Grade AA, C and D)
Grade AA
Grade C
Grade D
Forms (Type I only)
Pigs
Ingots
Linked ingots

PROPERTIES

CHEMICAL. The caulking compound consists of lead composed of the ingredients tabulated in Table I.

TABLE I. CHEMICAL COMPOSITION OF QQ-C-40 CALKING COMPOUND

ELEMENT (1)	GRADE		
	AA (4)	C (5)	D (5)
Lead	99.70 (2)	99.70 (2)	99.82 (2)
Antimony and Arsenic (total)	0.02 (3)	0.02 (3)	0.002
Iron	–	–	0.002
Bismuth	–	–	0.025
Zinc	–	–	0.001
Copper	–	–	0.040-0.080
Silver	–	–	0.020
Tellurium	–	–	0.035-0.055
Tin	–	–	0.016

(1) All values are maximum, except where noted.
(2) Minimum.
(3) Antimony content only.
(4) Reclaimed lead for Grade AA is obtained by recovery of metallic lead and its alloys through the simple reclaiming process of melting, dressing and casting.
(5) Grade C and D calking lead is produced from ore or other materials by reduction, refining or other processes. Reclaimed lead is not acceptable.

QQ-C-40 (Continued)

PHYSICAL. No physical properties are given for Type I and Type II, Grade AA calking lead. Type II, Grades C and D calking lead is bright, silvery in color and all grades of Type II consist of fine strands of lead, and unless otherwise specified, are from 0.005 to 0.015 inch in diameter.

PROCESS. The compound is applied by either melting, pouring into the assembled joint and allowing to solidify at room temperature under contact pressure or by driving using a pneumatic hammer; the latter method produces no flaking or powdering.

PERFORMANCE. No performance properties are given.

FORM

Type I calking lead is available in (1) pigs weighing between 48 and 105 pounds each, (2) linked ingots (or notched bar ingots) consisting of from 3 to 6 ingots or bars, weighing between 3 and 6 pounds each, linked together by small segments which can be easily severed and (3) single ingots (or pot pieces) weighing from 3 to 6 pounds each. Type II calking lead is available in 5/8 to 3/4 inch diameter ropes weighing between 0.3 and 0.7 pounds per linear foot and supplied in 25, 50 and 100 pound quantities.

QPL

No.

NOTES

(1) Use Type I whenever it is practical to use cast lead, caulking techniques.

(2) Use Type II whenever it is impractical to use cast lead, such as inverted joints or in wet trenches. Lead wool calked joints will withstand greater displacement than cast lead joints without leaking. Use Grades C and D material whenever high density lead calking is required.

QQ-C-100 CEMENT, IRON AND STEEL

Issue: 14 February 1964 Revision: a Amendment: None

SCOPE

This cement is intended for repairing minor defects in iron and steel castings.

CLASSIFICATION

The cement is available in two classes.

Class 1 Dry
Class 2 Hydraulic

PROPERTIES

CHEMICAL. The cement consists of at least 77% metallic iron and no more than 25% unspecified binders. Class 2 contains no organic wetting agents.

PHYSICAL. No physical properties are given.

PROCESS. The cement is activated by mixing with water, applied by troweling and cured 24 hours at room temperature under contact pressure. Class 1 cement is applied only to thoroughly dry castings; Class 2 can be applied to wet castings.

PERFORMANCE. The cement does not separate from iron or steel castings or disintegrate when cooled rapidly from 1500 F to 60 F by dropping into cold water. A force of at least 200 pounds applied with a 1/8-inch diameter punch is necessary to perforate the cement or separate it from the castings. The cured cement can be sawed without chipping or crumpling.

FORM

The powdered cement is available in 8 ounce, 1, 2, 5 and 100 pound containers.

QPL

No.

NOTES

(1) Use Class 1 cement for iron and steel castings that are not continuously exposed to water.

(2) Use Class 2 cement for repairing castings which are in service in wet places or under water. It can resist hot or cold, fresh or salt water.

(3) The cement is not to be used to repair or conceal structural defects in castings.

(4) The cement should not be used on interior surfaces of components intended for pneumatic or hydraulic systems.

(5) Class 2 cement is slower drying than Class 1.

(6) This specification includes the requirements of MIL-C-1219 (see abstract).

QQ-G-545 GOLD; FOIL, CYLINDERS (FOR DENTAL FILLINGS)

Issue: 30 March 1951 Revision: None Amendment: 1

SCOPE

This gold foil is intended for restoring lost tooth structure.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The foil consists of 24 carat gold.

PHYSICAL. The surface of the foil is wrinkled. The other physical properties are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF QQ-G-545 GOLD

SIZE NO. (1)	DIAMETER, mm	LENGTH, mm
1/2	3 – 3-1/2	3 – 5
3/4	4 – 4-1/4	3-3/4 – 6
1	4-3/4 – 5	4-1/4 – 7
2	5-3/4 – 6	5 – 8

(1) The size number in industry indicates the weight in grains of a 4 inch square of foil.

PROCESS. The gold foil is rendered cohesive by warming in a flame, allowed to cool, applied to the cavity with a gold foil condenser and cured (welded) at mouth temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The gold foil is available in moisture-proof glass vials each containing 1/10 ounce troy net weight.

QPL

No.

QQ-P-428 PLATINUM FOIL (DENTAL)

Issue: 9 April 1957 Revision: b Amendment: 1

SCOPE

This platinum foil is intended for the restoration of lost tooth structure, especially for inlays and porcelain jacket matrices.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The foil consists of at least 99.9% platinum.

PHYSICAL. The foil, one mil thick, available in one pennyweight pieces, 1¼ inches wide and 3 5/8 inches long, is free from wrinkles. It has a thermoelectric potential of not more than 0.35 millivolts using a temperature difference of 1200 C.

PROCESS. The foil is applied with a condenser and cured (welded) at mouth temperature under contact pressure.

PERFORMANCE. The foil is sufficiently soft, such that one piece 63 mm in length wrapped around a 20 mm steel rod will spring open when the rod is stood up against a glass plate.

FORM

The platinum is available in 20,100 and 1000 foil piece containers.

QPL

No.

SS-A-128 ADHESIVE, ASPHALT, CUT-BACK TYPE FOR ASPHALT TILES

Issue: 3 July 1952 Revision: None Amendment: None

SCOPE

This adhesive is intended for the installation of asphalt tile.

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 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, 6, 30 and 55 gallon containers.

QPL

No.

NOTES

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

SS-A-00138 (GSA-FSS) ADHESIVE; ASPHALT, WATER EMULSION TYPE (FOR ASPHALT TILE)

Issue: 8 May 1952 Revision: None Amendment: None

SCOPE

This adhesive is intended for the installation of asphalt tile.

CLASSIFICATION

The adhesive is available in two classes.

Class 1 Clay type dispersing agent

Class 2 Chemical type dispersing agent

PROPERTIES

CHEMICAL. The adhesive consists of an asphaltic base material dispersed in water containing either a clay or chemical type dispersing agent.

PHYSICAL. The adhesive is homogeneous, free from offensive odors, does not develop mold on standing, and has a Brookfield viscosity at 75 F between 5,000 and 48,000 centipoises.

PROCESS. The adhesive is applied by trowelling using a standard notched trowel, air dried 20 minutes, 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. Any thickening occurring during storage can be dispersed by stirring.

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. The adhesive after air drying 48 hours at 75 F does not break down during 18 hours immersion in 5% sodium hydroxide resulting in solution turbidity or discoloration.

FORM

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

QPL

No.

NOTES

(1) Do not use Class 2 adhesive for on or below grade installations.

(2) Allow 10 days after installation using Class 2 adhesive before cleaning the tile.

SS-A-150 ADHESIVE COMPOUND, FATTY ACID PITCH (FOR USE WITH FIBERGLASS, ROOFING (FELTS, ROLL ROOFING, ROOFING FABRIC)

Issue: 6 April 1959 Revision: b Amendment: 1

SCOPE

This adhesive is intended for bonding and sealing joints of roll roofing, various fabrics, metal foils, etc, where permanent flexibility is required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an inorganic filler or pigment, a volatile solvent and a binder composed essentially of 45% cottonseed fatty acid pitch material containing at least 15% fatty acid.

PHYSICAL. The adhesive is a thick, homogeneous liquid containing 60% nonvolatiles after heating 3 hours between 105 and 110 C.

PROCESS. The adhesive is applied by brushing or spraying using an approximate coverage of 50 square feet per gallon of adhesive, air dried 10 minutes at room temperature, the joint closed and cured 96 hours at room temperature under contact pressure. Any thickening occurring during storage can be dispersed by stirring.

PERFORMANCE. The adhesive after drying 120 hours between 20 and 25 C does not blister, sag or slip more than ¼ inch during 5 hours exposure to 60 C on asphalt roof panels (SS-R-501, Grade A) or to 70 C on steel. It can be bent 180° on a ¾ inch mandrel at O C (1 hour exposure) without cracking or separating from an 0.016 inch thick steel panel. Further, it does not bleed into white paint (TT-P-102) during 48 hours air dry between 25 and 30 C. The adhesive withstands shear loads up to 17.5 psi without separating using No. 30 asphalt saturated felt adherends (HH-F-191).

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

NOTES

(1) The adhesive is available for repairing breaks, holes, open seams, blisters and for new roof installations.

SS-C-153 CEMENT, BITUMINOUS, PLASTIC

Issue: 1 August 1933 Revision: None Amendment: None

SCOPE

This cement is intended for (1) construction of plastic flashings in conjunction with bituminous roofing, (2) repair of asphalt and metal roofing and (3) as an expansion joint material for concrete and masonry.

CLASSIFICATION

The cement is available in two types.

Type I Asphaltic base
Type II Coal tar base

PROPERTIES

CHEMICAL. The cement consists of an inorganic filler, wholely or in part asbestos, an unspecified solvent and a nonvolatile bituminous binder. Type I binder is mainly asphaltic and Type II mainly coal tar.

PHYSICAL. The cement contains at least 70% nonvolatile matter after 24 hours exposure between 105 and 110 C and an ash content between 15 and 45%.

PROCESS. The cement is applied by trowelling in thicknesses between 1/16 and 1/8 inch, the joint closed and cured at room temperature under contact pressure (no time specified). Any thickening occurring during storage can be dispersed by stirring.

PERFORMANCE. The cement on smooth-surfaced prepared roofing asphalt saturated flashing and steel does not blister or sag more than 1/4 inch after 5 hours exposure to 140 F. It can be bent 180° on a 1 inch mandrel at OC (1 hour exposure) without cracking or separating from an 0.016 inch thick steel panel in 1/16 to 1/8 inch thicknesses.

FORM

The paste cement, unless otherwise specified, is available in commercial packages.

QPL

No.

NOTES

(1) Use Type I with flashing felt. Use either Type with coal type pitch for repair of metal roofs and as an expansion joint material for concrete and masonry.

SS-C-00161 (GSA-FSS) CEMENT; KEENE'S

Issue: 10 August 1956 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 For base and finish coat plastering
Type II For finish coat plastering

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 90% passes through a U S Standard No. 100 mesh sieve.

PROCESS. The cement is activated by mixing with water (See Note Section No. 1 and 2) to a consistency equivalent to a 28-32 mm penetration under a 150 gram weight plunger (Modified Vicat), applied by troweling and cured 24 hours at room temperature under contact pressure. Type I cement sets between one and four hours, and Type II between twenty minutes and three hours.

PERFORMANCE. The cement has a compressive strength of at least 2500 psi at room temperature.

FORM

The powdered cement, unless otherwise specified, is available in commercial packages.

QPL

No.

NOTES

(1) Type I (regular, standard, etc.) Keene's cement is intended for use with lime and sand as the plastering scratch and brown coats, and also for use either alone with water added only or gaged with lime putty for the finish coat of plaster.

(2) Type II (rapid finishing, etc.) Keene's cement is intended for use either alone with water added only or gaged with lime putty for the finish coat. This Type is intended for use where a finishing plaster is desired which sets more rapidly than the ordinary Keene's cement as indicated by Type I.

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

SS-C-181 CEMENT, MASONRY

Issue: 23 September 1960 Revision: e Amendment: None

SCOPE

This cement is intended for use in masonry mortar construction work.

CLASSIFICATION

The cement is available in two types.

Type I For use above grade in solid masonry construction not exposed to frost action.

Type II For general use where mortars for masonry are required.

PROPERTIES

CHEMICAL. The composition of the cement is not given.

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

TABLE I. PHYSICAL PROPERTIES OF SS-C-181 CEMENT

PROPERTY	TYPE I	TYPE II
Fineness, residue, No. 325 sieve, %, max (1)	15	15
Flow after suction, %, min	70	70
Staining, soluble alkali (Na_2O), %, max (2)	0.03	0.03
Soundness, autoclave expansion, %, max (3)	1.0	1.0
Air entrainment, vol %, min (4)	12	12

(1) Fed Test Method Std No. 158, Method 2111.
(2) Fed Test Method Std No. 158, Method 1401.
(3) Fed Test Method Std No. 158, Method 2211.
(4) Fed Test Method Std No. 158, Method 2401.

PROCESS. The mortar is prepared by mixing 1 part cement to 3 parts of blended sand consisting of 1½ parts graded Ottawa sand and 1½ parts 20-30 Ottawa sand. The mortar is activated by mixing with water, applied by trowelling, the brick laid and the joint cured 24 hours at room temperature under contact pressure. The mortar has an initial set of not less than 2 hours and a final set of not more than 24 hours (using the Gillmore method, Fed Test Method Std No. 158, Method 2231).

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

SS-C-181 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF SS-C-181 CEMENT BASE MORTAR

PROPERTY	TYPE I	TYPE II
Water repellency, grams (1)	5.0	5.0
Compression, psi, at 75 F, min (2)		
After 7 days	250	500
After 28 days	500	900

(1) After soaking cured 1 inch cubes 1 hour in ¼ inch water; this property must be specified in purchase order (see Note Section No. 1).
(2) Fed Test Method Std No. 158, Method 2301.

FORM

The cement is available in commercial packages.

QPL

No.

NOTES

(1) Water repellent cement intended to offer better resistance to the passage of water through masonry mortar will pass water repellency test given in Performance Section.

(2) This specification is similiar to ASTM C91 and ASA A1.3, "Masonry Cement."

SS-C-188 CEMENT, PLASTIC, FATTY ACID PITCH BASE

Issue: 1 February 1956 Revision: None Amendment: None

SCOPE

This cement is intended for repairing roofs, walls, foundations and as an expansion joint and caulking material.

SCOPE

One type only.

PROPERTIES

CHEMICAL. The cement consists of fatty acid, pitch, inorganic filler and coloring matter.

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

TABLE I. PHYSICAL PROPERTIES OF SS-C-188 CEMENT

PROPERTY	VALUE	
	Min	Max
Ash content, %		
Aluminum colored	37	50
Gray	25	40
Green	12	20
Natural (black)	15	25
Red	12	20
Solids content (1)	60	NR

(1) After 5 hours between 100 and 105 C.
NR = No requirement

PROCESS. The cement is applied by trowelling in thicknesses between 1/16 and 1/8 inch, the joint closed and cured at room temperature under contact pressure (no time specified).

PERFORMANCE. The cement after drying 120 hours between 20 and 25 C does not blister, sag or slip more than ¼ inch during 5 hours exposure to 70 C. It can be bent 180° on a 1 inch mandrel at 0 C (1 hour exposure) without cracking or separating from an 0.016 inch thick steel panel in 1/16 to 1/8 inch thicknesses. The cement does not stain white paper even after 1 hour exposure between 50 and 55 C nor does it bleed into white paint (TT-P-102, Class A) applied 5 days after drying.

FORM

The paste cement is available in gallon containers.

QPL

No.

SS-C-218 CEMENT, SLAG

Issue: 21 November 1960 Revision: a 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) containing not more than 8% unhydrated oxide and at least 60% water quenched blast-furnace slag composed of calcium silicates and aluminosilicates in the following ratio

$$\frac{CaO + MgO + 1/3\, Al_2O_3}{SiO_2 + 2/3\, Al_2O_3} \geq 1.0$$

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
Manganic oxide (Mn_2O_3)	1.5
Sulfide sulfur	2.0
Insoluble residue	1.0
Loss on ignition	4.0

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

(1) Fed Test Method Std No. 158, Method 2101.1.
(2) Maximum.
(3) Fed Test Method Std No. 158, Method 2211.1.

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 12 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 day in moist air, 6 days in water	600	500
1 day in moist air, 27 days in water	1500	1000

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".

SS-C-608 COMPOUND, JOINTING; SULFUR (FOR BELL-AND-SPIGOT CAST-IRON PIPE)

Issue: 8 January 1947 Revision: None Amendment: 1

SCOPE

This jointing compound is intended for making permanent, water-tight joints in cast iron bell and spigot piping.

CLASSIFICATION

The jointing compound is available in two types.

Type I For cold water service
Type II For hot and cold water service

PROPERTIES

CHEMICAL. The jointing compound consists of at least 45% sulfur and the remainder, 90% fine, inert, unspecified mineral aggregate.

PHYSICAL. No physical properties are specified.

PROCESS. The jointing compound is applied by melting, flowed into the assembled joint and allowed to solidify at room temperature under contact pressure.

PERFORMANCE. The jointing compound has a tensile strength of at least 600 psi at room temperature and in addition 350 psi for Type II after 10 cycles of five minutes immersion in 200F water followed by immediate immersion in ice water for five minutes. The jointed pipes can sustain 375 psi for 60 minutes without serious leakage and under 150 psi hydrostatic pressure does not leak more than 100 U S gallons per 24 hours per inch nominal diameter per mile of pipe which contains 440 joints.

FORM

The solid jointing compound is available in 50 and 100 pound containers.

QPL

No.

NOTES

(1) Use Type I for pipe carrying cold water not exceeding 90F in temperature and Type II for pipes carrying hot water not exceeding 200F.

(2) Do not use for oil and gas lines.

(3) Jointing and leakage tests are in accordance with American Water Works Association Standard Specification for laying cast iron pipe, No. 7D.1 – 1938.

SS-P-402 PLASTER; GYPSUM

Issue: 5 May 1945 Revision: None Amendment: None

SCOPE

This gypsum material is intended for plastering of walls.

CLASSIFICATION

The plaster is available in five types.

Type N Neat plaster
Type W Wood fibered plaster
Type B Prepared sanded brown coat plaster
Type S Prepared sanded scratch coat plaster
Type G Calcined gypsum for finishing coat

PROPERTIES

CHEMICAL. The plaster consists of a calcined gypsum base and other materials dependent on type. Type N also contains retarder, and if specified, hair, sisal or other fiber; Type W, retarder and wood fiber; Type B, unspecified materials; Type S, unspecified materials; and Type G may contain retarder. The basic chemical composition is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF SS-P-402 PLASTER

INGREDIENT	TYPE				
	N	W	B	S	G
Gypsum ($CaSO_4 \cdot 1/2\ H_2O$), %, min	60.5	60.5	15.0	20.0	60.5
Wood fiber, %, min	–	1.0	–	–	–
Sand, %, max	–	–	75.0	66.7	–

PHYSICAL. The plaster, Type G only, is sufficiently fine to pass completely through a U S Standard No. 14 mesh sieve and at least 60% through a No. 100 mesh sieve (RR-S-366).

PROCESS. The gypsum is activated by mixing with commercial retarder and sand, if necessary, and sufficient quantities of water (see Note Section) to give a consistency equivalent to between 17 and 23 mm penetration (modified Vicat), applied by trowelling and cured at room temperature under contact pressure. Setting times are given in Table II.

SS-P-402 (Continued)

TABLE II. PROCESS PROPERTIES OF SS-P-402 PLASTER

PROPERTY	TYPE N(1)	W	B	S	G
Time for set, hr					
Retarded					
Min	2	1.5	2	1.5	0.66
Max	32	8	6	7	NR
Unretarded					
Min	NR	NR	NR	NR	0.33
Max	NR	NR	NR	NR	0.66

(1) Mixed with three parts of Standard Ottawa sand prior to activation.
NR = No Requirement

PERFORMANCE. The plaster, Types N, W and S, has a tensile strength of at least 125 psi; Type B, 75 psi; and Type G, 200 psi. Type N uses two parts of standard Ottawa sand prior to activation.

FORM

The powdered plaster is available in commercial packages.

QPL

No.

NOTES

(1) Type N plaster for the scratch coat may be mixed with 2 parts of sand and for the brown coat with 3 parts of sand.

(2) Type W plaster for the scratch or brown coat may be used with or without the addition of sand.

(3) Types B and S plaster are used without the addition of sand.

(4) Type G plaster for the finish coat is used as an addition to lime putty. The user should specify the retarded or unretarded grade is needed.

(5) This specification is similiar to ASTM C28 and ASA A49.3, "Gypsum, Plasters."

SS-S-168 SEALING COMPOUND, SEWER, BITUMINOUS, TWO COMPONENT, MINERAL FILLED, COLD-APPLIED

Issue: 9 April 1962 Revision: None Amendment: 2

SCOPE

This compound is intended for sealing bell and spigot sewer pipe joints.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The compound consists of two components. The liquid component is composed of asphalt blended with unspecified plasticizers and fluxing oils. The solid component is composed of natural asphalt and inert mineral filler. Both components are water free. The resulting composition of the compound after mixing is given in Table I. A separate asphalt base primer containing no filler (not further defined) is supplied with the compound.

TABLE I. CHEMICAL COMPOSITION OF SS-S-168 SEALING COMPOUND

COMPOSITION (1)	PERCENT OF TOTAL WEIGHT
Asphalt (soluble in CS_2)	40–60
Inert mineral matter	30–50
Organic matter (CS_2 insoluble), max	5.0
Volatile matter, max	10

(1) SS-R-406.

PHYSICAL. The physical properties of the compound and primer are given in Table II.

SS-S-168 (Continued)

TABLE II. PHYSICAL PROPERTIES OF SS-S-168 SEALING COMPOUND AND PRIMER

PROPERTY	COMPOUND (1) (2)	PRIMER
Specific gravity, 77 F	1.20–1.40	NR
Weight, lb/gal	NR	6.9
Ductility, 77 F, cm, min	1.00	NR
Softening point, °F, min	160	NR
Penetration, 77 F, 100 gram, 5 sec, mm	5–20	NR
Flash point, C.O.C., °F, min	100	90
Volatile content, %	NR	73
Percent solids	NR	27
Color, one coat	NR	Brown
Toxicity	NR	None
Odor	NR	Sweet

(1) SS-R-406.
(2) Before and after aging 24 hours at 140F except for flash point.
NR = No Requirement

PROCESS. The primer is applied by brushing and dried 24 hours. The compound is activated by mixing the solid and liquid components, applied by pouring, trowelling or brushing, and cured at room temperature under contact pressure. Cure time is given by the supplier. The primer has an initial set of less than 1 hour and a final set of less than 3 hours, whereupon it resists water and water vapor. The sealing compound can be stored indefinitely.

PERFORMANCE. The sealing compound has a flatwise tensile strength of at least 65 psi using Portland Cement (ASTM C190 except ASTM C33 sand) and vitrified clay adherends. It does not discolor, effervesce or become slimy after heating 24 hours at 140 F or after five days immersion in 1% hydrochloric acid, 1% nitric acid, 1% sulfuric acid, 5% potassium hydroxide and saturated hydrogen sulfide.

FORM

The compound and primer are available in commercial packages.

QPL

No.

SS-S-169 SEALER, JOINT, SEWER, MINERAL FILLED, HOT-POUR

Issue: 20 April 1954 Revision: None Amendment: None

SCOPE

This compound is intended for sealing bell and spigot sewer pipe joints.

CLASSIFICATION

The compound is available in three types and two classes.

Type I Asphalt base
Type II Coal tar pitch base
Type III Plastic base
Class 1 Pour in place
Class 2 Die cast, ring-and-collar

PROPERTIES

CHEMICAL. The composition of the compound is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF SS-S-169 SEALING COMPOUND

INGREDIENTS	TYPE I		TYPE II		TYPE III
	Class 1	Class 2	Class 1	Class 2	Class 1
Asphalt (soluble in CS_2)	45–60	40–55	–	–	–
Coal tar pitch (1)	–	–	75–80	70–80	–
Plastic (soluble in CS_2) (2)	–	–	–	–	35–50
Inert mineral matter	40–55	45–60	20–25	20–30	50–65
Organic matter, max	5	5	–	–	5

(1) From coke oven tar by distillation or other processing methods.
(2) Acrylic polymeric hydrocarbon.

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

SS-S-169 (Continued)

TABLE II. PHYSICAL PROPERTIES OF SS-S-169 SEALING COMPOUND

PROPERTY (1)	TYPE I		TYPE II		TYPE III
	Class 1	Class 2	Class 1	Class 2	Class1
Specific gravity, at 77 F	1.40-1.55	1.40-1.60	1.40-1.50	1.35-1.50	1.65-1.75
Ductility, at 77 F, cm, min	1.5	0.5	NR	NR	NR
Settlement ratio, max	1.25	1.25	1.25	1.25	1.25
Softening point, °F	190-250	240-270	180-190	210-225	200-230
Penetration					
At 77 F, 100 gram, '5 sec, mm	5–15	4–8	0–2	4–9	0–1
At 115 F, 50 gram, 5 sec, mm	NR	NR	5–10	12–25	0–3

(1) SS-R-406
NR = No Requirement

PROCESS. The compound, Class I, is heated to temperatures where it is free flowing, applied by pouring and cured (solidified) at least 2 hours at room temperature under contact pressure. The Class 2 compound is applied by laying and processed similiar to Class 1. Primer, if necessary, is specified by the supplier.

PERFORMANCE. The sealing compound has a flatwise tensile strength of at least 75 psi using Portland Cement (ASTM C33 sand) and vitrified clay adherends. No chemical reaction occurs during five days exposure to 1% hydrochloric acid, 1% nitric acid, 1% sulfuric acid, 5% potassium hydroxide or saturated hydrogen sulfide.

FORM

The compound is available in commercial packages.

QPL

No.

NOTES

(1) Use Class 2 when weather and trench conditions are such that in place pouring cannot be effected.

TT-R-58 RADIOACTIVE-LUMINOUS-COMPOUND AND ADHESIVES

Issue: 9 April 1941 Revision: None Amendment: None

SCOPE

This adhesive is intended for adhering powdered radioactive luminous compounds consisting of zinc sulfide and a radioactive substance to various surfaces.

CLASSIFICATION

The adhesive is available in two types.

Type A For exposure to air
Type B For immersion in liquids

PROPERTIES

CHEMICAL. The composition of the adhesive and thinner are not given. The luminous compound consists of zinc sulfide and an unspecified radioactive substance.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive and radioactive luminous compound are mixed, applied by brushing and cured at least one hour at room temperature under contact pressure. Thinner may be added when necessary.

PERFORMANCE. The adhesive, 1 cm thick, has a visual transmission equal to or greater than that of one Lovibond tintometer glass 1.0 standard yellow for light of daylight quality when subjected for 20 hours to the spectral energy equivalent to a carbon arc source, inclosed in Corex glass carrying 13 amperes, at an unobstructed distance of 15 inches. The adhesive after air drying one hour at 75F does not lose adhesion to glass or darken after heating at 160F for 20 hours. Type B after curing two hours at 160F does not darken, change hardness or lose adhesion after 48 hours immersion in compass fluid (refined crude petroleum fraction boiling up to 500F).

FORM

The adhesive and thinner are available in 50 milliliter glass bottles.

QPL

No.

UU-L-49 LABELS; PAPER, GUMMED

Issue: 8 August 1956 Revision: a Amendment: None

SCOPE

These gummed and pressure-sensitive adhesive labels are intended for identification purposes including application to microslides and vials.

CLASSIFICATION

The labels are available in two types, four classes and ten styles.

- Type I Labels with water soluble gum
  - Class A Individual labels
    - Style 1 Rectangular, all white
    - Style 2 Rectangular, white with red border
    - Style 3 Rectangular with clipped corners, all white
    - Style 4 Rectangular with clipped corners, white with red border
    - Style 5 Circular, all white
    - Style 6 Elliptical, all white
    - Style 7 Elliptical, white with red border
  - Class B Labels in books, rectangular, white with colored borders
  - Class C Labels in rolls, rectangular with clipped corners, white with red borders
  - Class D Labels for file folders, rectangular, colored
- Type II Labels with water insoluble gum
    - Style 1 Rectangular with rounded corners, all white
    - Style 2 Circular, all white
    - Style 3 Elliptical, all white

PROPERTIES

CHEMICAL. The labels consist of a paper backing containing not more than 5% unbleached or ground wood pulp, coated on one side with an unspecified gum adhesive. Type II has a glassine or wax paper liner.

PHYSICAL. Type I labels weigh 22 pounds and Type II, 32 pounds on the basis of 500 sheets measuring 17 by 22 inches. Type I gum is light colored, nontoxic, nonblocking and not obnoxious to taste or smell. Type II does not have an objectional odor.

PROCESS. The Type I labels are activated with water, the joint closed and cured at least 2 hours at room temperature under contact pressure. The Type II labels require no moisture, heat or other preparation prior to or subsequent to application except for removal of the liner.

UU-L-49 (Continued)

PERFORMANCE. The labels, capable of being written upon with ink, adhere instantly to paper without breaking and after 2 hours cannot be removed without failing the paper or label.

FORM

The labels are available in the sizes, colors and quantities given in Table I.

TABLE I. AVAILABILITY OF UU-L-49, TYPE I

Class A, Styles 1 and 2 Labels

SIZE, IN.	LABELS PER BOX STYLE 1	STYLE 2	WIDTH OF STYLE 2 BORDER, IN. (1)
15/16 by 9/16	–	90	1/16 to 1/8
1 1/2 by 3/4	1000	75	1/16 to 1/8
2 1/8 by 13/16	1000	45	1/16 to 1/8
2 3/4 by 1	–	60	3/32 to 5/32
3 3/4 by 1	–	60	1/8 to 3/16
2 13/16 by 1 9/16	90	60	1/8 to 3/16
3 3/16 by 1 9/16	–	50	1/8 to 3/16
4 1/16 by 1 3/4	70	35	5/32 to 7/32
4 5/8 by 2	–	30	3/16 to 1/4
4 by 2 1/2	–	30	3/16 to 1/4
5 by 3	–	20	3/16 to 1/4

(1) Color of Style 2 border is red.

Type I, Class A, Styles 3 & 4

SIZE, IN.	LABELS PER BOX STYLE 3	STYLE 4	WIDTH OF STYLE 4 BORDER, IN. (1)
13/16 by 9/16	1000	100	1/16 to 3/32
1 1/4 by 17/32	1000	90	1/16 to 1/8
2 by 17/32	1000	75	1/16 to 1/8
29/32 by 23/32	1000	90	1/16 to 1/8
1 3/16 by 15/16	1000	60	1/16 to 1/8
1 1/2 by 1 1/8	1000	60	3/32 to 5/32
1 11/16 by 1 5/16	1000	45	3/32 to 5/32
2 1/2 by 1 1/2	–	30	3/32 to 5/32
4 5/8 by 2	–	30	3/16 to 1/4
5 by 3	–	20	3/16 to 1/4

(1) Color of Style 4 border is red.

UU-L-49 (Continued)

Type I, Class A, Style 5

SIZE, IN.	LABELS PER BOX
3/8	1000
5/8	1000
7/8	1000
1 1/8	1000

Type I, Class A, Styles 6 & 7

SIZE, IN	LABELS PER BOX STYLE 6	LABELS PER BOX STYLE 7	WIDTH OF STYLE 7 BORDER, IN. (1)
1/2 by 5/16	–	65	1/16 to 3/32
11/16 by 15/32	1000	65	1/16 to 3/32
15/16 by 9/16	1000	65	1/16 to 3/32
1 1/2 by 1 1/8	1000	40	1/16 to 1/8

(1) Color of Style 7 border is red.

Type I, Class B

SIZE, IN.	LABELS PER BOOK	WIDTH OF BORDER, IN. (1)	SHEETS PER BOOK
7/8 by 7/8	500	1/32	20
1 3/4 by 1 3/8	240	1/8 to 5/32	20
2 5/8 by 1 5/8	180	1/8 to 5/32	20

(1) Color of border is red, blue or black.

Type I, Class C

SIZE	LABELS PER ROLL	WIDTH OF BORDER, IN. (1)
15/16 by 3/4	1000	1/16 to 3/32
1 1/4 by 1	1000	1/16 to 1/8
1 1/2 by 1 1/8	1000	3/32 to 5/32
1 3/4 by 1 3/8	1000	3/32 to 5/32
2 5/8 by 1 5/8	1000	3/32 to 5/32

(1) Color of border is red.

UU-L-49 (Continued)

Type I, Class D

FANFOLD STRIPS, NUMBER	ROLL NUMBER	SIZES, IN. (1)
500	250	3-1/4 by 1-1/8 (1/3 cut, std size folders) 3-3/4 by 1-1/8 (1/3 cut, legal size folders)

(1) The labels are available in blue, buff, canary yellow, green, orange, pink, salmon and white.

Type II, Style 1, Style 2 and Style 3 (1)

STYLE 1 SIZES, IN.	STYLE 2 SIZES, DIAMETER, IN.	STYLE 3 SIZES MAJOR & MINOR AXIS, IN.
1/2 by 5/16	5/16	1/2 by 3/8
3/4 by 1/2	1/2	3/4 by 1/2
1 by 3/4	3/4	1 by 3/4
1 1/4 by 7/8	1	
1 1/2 by 1		
1 1/2 by 5/8		
1 3/4 by 1/2		

QPL

No.

NOTES

(1) The availability of UU-L-49 labels is governed by Federal Standard No. 108, "Labels, Paper, Gummed".

UU-R-196 REINFORCEMENTS, GUMMED (CLOTH)

Issue: 20 February 1952 Revision: a Amendment: 1

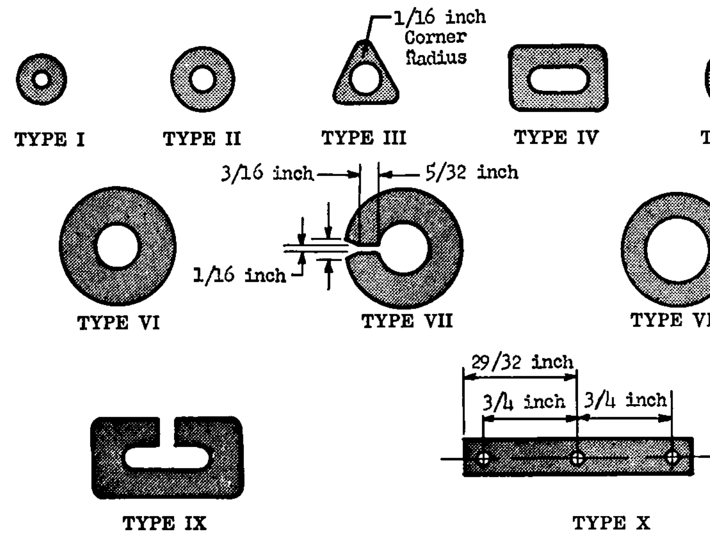
SCOPE

This gummed reinforcement is intended for reinforcing the punched holes of loose leaf sheets.

CLASSIFICATION

The reinforcement is available in 10 types; see Figure 1.

Figure 1. UU-R-196 Reinforcement Types



PROPERTIES

CHEMICAL. The reinforcement consists of a bleached cloth backing coated on one side with an unspecified gum.

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

UU-R-196 (Continued)

TABLE I. PHYSICAL PROPERTIES OF UU-R-196 REINFORCEMENT

INGREDIENT	PROPERTY	VALUE
Base Cloth	Thread count per inch, min	
	Warp	52
	Fill	45
	Tear strength, gr, at 75 F, min	
	Warp	300
	Fill	175
Gummed	Odor, objectionable	None
Reinforcement	Taste, objectionable	None

PROCESS. The reinforcement is activated with water, the joint closed and cured at room temperature under contact pressure.

PERFORMANCE. The reinforcements do not become sticky or adhere to bond paper at high humidity (80% RH) even under a 2 pound load imposed for 24 hours at 70 F. After adhering the reinforcement to paper (UU-P-121, Type II, 50% rag), it cannot be removed without pulling fibers from the paper.

FORM

The white colored reinforcements are available in the sizes and hole diameters given in Table II.

TABLE II. AVAILABILITY OF UU-T-196 REINFORCEMENT

TYPE	SIZE, IN.	PUNCHING	
		NO.	IN.
I	3/8 diameter	1	1/8 diameter
II	1/2 diameter	1	3/16 diameter
III	9/16 height	1	1/4 diameter
IV	3/4 by 1/2	1	7/16 by 3/16
V	9/16 diameter	1	1/4 diameter
VI	15/16 diameter	1	3/8 diameter
VII	15/16 diameter	1	3/8 diameter
VIII	7/8 diameter	1	1/2 diameter
IX	1 3/16 by 5/8	1	11/16 by 3/16 with 1/8 inch wide slot
X	1 13/16 by 5/16	3	1/8 diameter

QPL

No.

UU-S-600 STENCIL, PRESSURE-SENSITIVE, FOR VEHICLE IDENTIFICATION

Issue: 12 August 1958 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape stencil is intended for motor vehicle identification and to protect finished surfaces during application of spray paint used in the identification process.

CLASSIFICATION

The tape is available in four types.

TYPE I Identification for Intra-Agency Pool Vehicles
- U. S. GOVERNMENT 1 inch letters, ¾ inch spacing
- For Official Use Only ¾ inch letters, ¾ inch spacing
- GENERAL SERVICES ADMINISTRATION 1 inch letters

TYPE II Identification for Inter-Agency Pool Vehicles
- U. S. GOVERNMENT 1 inch letters, ¾ inch spacing
- For Official Use Only ¾ inch letters, ¾ inch spacing
- INTER-AGENCY MOTOR POOL 1 inch letters, ¾ inch spacing
- WASHINGTON, D. C. 1 inch letters, ¾ inch spacing
- GENERAL SERVICES ADMINISTRATION ¾ inch letters

TYPE III Identification for Departments or Agencies
- U. S. GOVERNMENT 1 inch letters, ¾ inch spacing
- For Official Use ¾ inch letters, ¾ inch spacing
- DEPARTMENT OF COMMERCE 1 to 1½ inch letters, ¾ inch spacing
- BUREAU OF PUBLIC ROADS ½ inch letters

TYPE IV Identification Stencils as required by using agencies

PROPERTIES

CHEMICAL. The stencil tape consists of a resin impregnated paper backing coated on one side with an unspecified adhesive and a grease resistant, waxed, creped or flat kraft paper liner.

UU-S-600 (Continued)

PHYSICAL. The stencil tape is no more than 0.007 inch thick with adhesive and 0.005 inch without and has a tensile strength of at least 14 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The stencil tape has a peel strength of at least 5 oz/in. of width using a commercial polish ground AISI 302 or 304 stainless steel substrate. It does not lift under 90 pounds spray paint pressure, finishing materials do not penetrate the tape, and after 24 hours contact with dry painted surfaces, does not transfer adhesive, stain or lift the paint when removed.

FORM

The stencil tape is available in die cut combination types (see Classification section) without necessitating the cutting of holding ties which keep letters centered in position.

QPL

No.

UU-T-91 TAPE, PRESSURE-SENSITIVE ADHESIVE, DOUBLE-COATED

Issue: 5 December 1962 Revision: c Amendment: 2

SCOPE

This pressure-sensitive adhesive tape is intended for use where two-sided adhesion is required.

CLASSIFICATION

The tape is available in three types and four classes.

- Type I Transparent film base
  - Class 1 With a liner
  - Class 2 Without a liner
- Type II Opaque paper base
- Type III Translucent paper base
  - Class 1 Liner extended; 1 edge
  - Class 2 Liner extended; 2 edges

PROPERTIES

CHEMICAL. The tape consists of an unspecified transparent film (Type I), an opaque paper (Type II) or a translucent paper tissue (Type III) backing coated on both sides with an unspecified adhesive.

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

TABLE I. PHYSICAL PROPERTIES OF UU-T-91 TAPE

PROPERTY	TYPE I Class 1	TYPE I Class 2	TYPE II	TYPE III Class 1	TYPE III Class 2
Thickness, in., max	0.0045	0.0045	0.007	0.0045	0.0045
Tensile strength, longitudinal, lb/in., at 75 F, min (1)	20	20	25	6	6

(1) UU-P-31, Method 171

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application except for removal of the liner when present. A force no greater than 25 oz/in. of width is necessary for Types I and II, and 8 oz/in. for Type III. After aging 14 hours at 150 F under 80% RH, the rolls require a winding force no greater than 25 oz/in. of width for Type I, 40 oz/in. for Type II, and 10 oz/in. for Type III. There is no separation of backing from adhesive during the unwinding process. The tape should be stored no longer than 6 months between 40 and 50 F.

UU-T-91 (Continued)

PERFORMANCE. The tape has a peel strength of at least 35 lb/in. of width for Type I (Class 1 and 2) and Type II and 75 lb/in. Type III (Class 1 and 2) at 75 F; 40 lb/in. for Type I (Class 1 and 2) after 48 hr accelerated aging by light (RS sunlamp) (no analogous requirements for other Types); and 40 psi for Type I (Class 1 and 2) and Type II and 70 psi for Type III (Class 1 and 2) after aging the tape (prior to application) 14 hr at 150 F and 80% RH using a 302 or 304 stainless steel substrate.

FORM

The tape, unless otherwise specified, is available in the length and widths given in Table III. Type I, Class 1, Type II and Type III tape is wound liner side out. Type III, Class 1, has the liner extended 1/8 inch on one edge only and Type III, Class 2, the liner extended 1/8 inch on both edges to facilitate removal. The liners used with both classes, Type III, are imprinted with instructions concerning the application of the tape to "a clean dry surface" and indicate that the liner is to be removed to expose the second adhesive surface.

TABLE III. AVAILABILITY OF UU-T-91 TAPE

TYPE	CLASS	DISPENSER	CORE DIAM., IN.	WIDTH, IN.	LENGTH, IN.
I	1	No	3	1/2,3/4,1,1½,2	1296
I	2	No	3	1/2,3/4,1,1½,2	1296
I	2	Yes	1	1/2	200
II	–	No	3	1/2,3/4,1,1½,2	1296
III	1	Yes	2	1/4	216
III	1	Yes	3	3/8	1296
III	2	Yes	3	1/2,3/4	1296
III	2	No	3	1, 1½	1296

QPL

No.

NOTES

(1) Use Types I and II for attaching riders, mounting photos, drawings, clippings, holding premiums and samples.

(2) Use Type II where high adhesion and holding power is needed for mounting of plastic, rubber, or metal plates used for identification, decoration or production systems.

(3) Limit procurement to that quantity which will not result in storage greater than 6 months.

UU-T-93 TAPE, PRESSURE-SENSITIVE ADHESIVE, PAPER, DRAFTING

Issue: 14 October 1960 Revision: c Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for securing drawing or tracing paper during drafting operations.

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 thickness no greater than 0.009 inch, a tensile strength of at least 16 lb/in. of width and an elongation of 8%.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and is nonblocking with tracing paper.

PERFORMANCE. The tape has a peel strength of 8 oz/in. of width at room temperature either as received or after aging the tape 12 days at 150 F under 80% RH or after 7 days in 75 F water vapor prior to application using commercial polish ground stainless steel adherends (QQ-S-766).

FORM

The tape is available in the lengths and widths given in Table I.

TABLE I. AVAILABILITY OF UU-T-93 TAPE

LENGTH, YD	CORE DIAMETER IN.	SPLICES NO.	SPLICES OVERLAP, IN.	WIDTH, IN.
60	3	3	1/2	½, ¾, 1, 1¼, 1½, 2, 3
10	3, 1	1	1/2	½, ¾, 1

QPL

No.

UU-T-101 TAPE, GUMMED; MENDING AND REINFORCING (PAPER AND CLOTH)

Issue: 18 June 1959 Revision: e Amendment: None

SCOPE

This gummed tape is intended for mending and reinforcing applications.

CLASSIFICATION

Type I Paper, transparent
Type II See Note Section No. 1
Type III Cloth, transparent
Type IV Cloth, nontransparent

PROPERTIES

CHEMICAL. The tape consists of a glassine paper (Type I) or a woven cotton fabric (Types III and IV) backing coated on one side with an unspecified gum.

PHYSICAL. The tape does not have an objectionable odor or taste. The other physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF UU-T-101 TAPE

PROPERTY	TYPE I	TYPE III	TYPE IV
Construction, threads per inch, min			
Warp	NR	77	52
Fill	NR	65	42
Tensile strength, lb/in., at 75 F, min	16	40	25
Opacity, %, max (1)	25	50	NR

(1) 100% is for opaque material and 0% is for transparent paper.
NR = No Requirement

PROCESS. The tape is activated with water (TAPPI T463m), the joint closed within 15 seconds and cured at least 2 hours at room temperature under contact pressure.

PERFORMANCE. The tape is tacky when peeled from 90 pound kraft paper 5 seconds after application and after 2 hours cannot be removed without paper or tape failure.

FORM

The tape is available in the lengths, widths and colors given in Table II.

UU-T-101 (Continued)

TABLE II. AVAILABILITY OF UU-T-101 TAPE

TYPE	WIDTH, IN.	LENGTH, YD	DISPENSER (1)	COLOR
I	5/8	12	Spool	Colorless
	1	25	Slotted box	Colorless
III	3/4	10	Slotted box	Colorless
	1	10	Slotted box	Colorless
IV	3/4	10	Nonslotted box	White, gray, black
	1-1/2	10	Nonslotted box	White, black
	2	5(2)	Nonslotted box	White, black

(1) Core sizes may be specified.
(2) Unless otherwise specified.

QPL

No.

NOTES

(1) Type II is superseded by Federal Specification L-T-90, Type I, Class A. (see abstract).

UU-T-106 TAPE, PRESSURE-SENSITIVE ADHESIVE, MASKING, PAPER

Issue: 27 July 1959 Revision: c Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for masking surfaces not to be covered by finishes.

CLASSIFICATION

The tape is available in two types.

Type I Creped Type II Flat

PROPERTIES

CHEMICAL. The tape consists of a 100% unbleached sulfate paper backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape is no thicker than 0.009 inch, has a tensile strength of at least 16 lb/in. (Type I) and 25 lb/in. (Type II) of width, an elongation of at least 8% (Type I) and ___ (Type II) and a stiffness of 10-14 oz for both tape types 1 inch and wider.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The tape can be stored 1 year.

PERFORMANCE. The tape applied over painted surfaces does not remove any paint or leave adhesive when stripped from the surface. The tape is sufficiently resistant to conventional finishing materials to prevent penetration during application. The tape has a peel strength of at least 14 oz/in. of width on Type 302 or 304 stainless steel at 75 F even after storing the tape 12 days at 150 F and 80% RH or held over water 7 days at 75 F in closed vessels prior to application.

FORM

The tape is available in 60 yard rolls wound on 3 inch diameter cores and, unless otherwise specified, in 1/4, 3/8, 1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 3 and 6 inch widths. The tape may contain up to 3 splices.

QPL

No.

NOTES

(1) Use Type I for curved line color separation and Type II for straight line color separation.

(2) Limit procurement to prevent storage for periods greater than 6 months.

(3) Do not use for carton sealing or closures.

(4) The supplier must establish suitability for use with explosives.

UU-T-111 TAPE; PAPER, GUMMED (SEALING AND SECURING)

Issue: 14 September 1960 Revision: c Amendment: None

SCOPE

This gummed adhesive tape is intended for packaging applications including sealing, securing and bonding of paper and paper products.

CLASSIFICATION

Class 1 Light weight, for light weight packages
Class 2 Medium weight, for medium weight packages
Class 3 Heavy weight, for heavy, bulky packages

PROPERTIES

CHEMICAL. The tape consists of a 100% unbleached or semi-bleached sulfate paper backing coated on one side with an unspecified adhesive.

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

TABLE I. PHYSICAL PROPERTIES OF UU-T-111 TAPE

PROPERTY	CLASS 1	CLASS 2	CLASS 3
Ream weight of paper backing 24 x 36 – 500, lb, min (1)	35	60	90
Tear strength, gr, at 75 F, min (2)			
Lengthwise	55	113	203
Crosswise	66	134	224
Tensile strength, lb/in., at 75 F, min (3)	26	45	68

(1) UU-P-31, Method 300.
(2) UU-P-31, Method 170, Values do not apply for tapes less than two inches in width.
(3) UU-P-31, Method 171.

PROCESS. The tape is activated with water, the joint closed and cured at least 2 hours at room temperature under contact pressure.

PERFORMANCE. The tape is tacky when peeled from 90 pound kraft paper 5 seconds after application and after two hours cannot be removed without paper or tape failure. The Class 2 tape in 2, 2-1/2 and 3 inch widths only has minimum adhesion values of 25, 32 and 40 points, respectively (TAPPI T463m).

UU-T-111 (Continued)

FORM

The tape, wound on cores containing a hole not less than 7/16 inch in diameter, is available in the lengths and widths given in Table II.

TABLE II. AVAILABILITY OF UU-T-111 TAPE

CLASS	WIDTH ± 1/32 IN.	LENGTH, FEET, MIN
1	¾, 1, 1¼, 1½, 2, 3, 4, and over	500 or 800 (1)
2	1, 1½, 2, 2½, 3, 4, and over	600 or 1000
3	2, 2½, 3, 4, and over	375

(1) 500 feet when wound gum side out and 800 feet, gum side in.

QPL

No.

NOTES

(1) Use tape for sealing closures of fiberboard boxes and other containers, securing wrappers of packages and banding unwrapped bundles of paper and paper products.

UU-T-116 TAPE, PAPER, GUMMED, WATER-RESISTANT

Issue: 7 October 1952 Revision: b Amendment: None

SCOPE

This gummed adhesive tape is intended for packaging applications where resistance to water penetration is necessary.

CLASSIFICATION

One type only.

PROPERTIES

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

PHYSICAL. The tape, two or more inches wide, has a tear strength of at least 150 grams at 75 F (UU-P-31, Method 170 or TAPPI T414m) and all widths a tensile strength of at least 38 lb/in. of width initially and 4 lb/in. of width after activating with solvent and allowing to dry 72 hours (UU-P-31, Methods 171 and 172).

PROCESS. The tape is activated with water, unless otherwise specified by the vendor, the joint closed and cured at least one minute at room temperature under contact pressure.

PERFORMANCE. The tape when peeled from V3s all-kraft fiberboard gives at least 75% fiber failure in the board and retains a peel strength of at least 7 oz/in. of width on 50-pound wet-strength waterleaf kraft paper after 15 minutes immersion in water, the latter using a 72 hour room temperature cure. The tape resists the passage of water for at least 12 hours (UU-P-31, Method 181 or TAPPI T433m) after solvent activating, drying and conditioning two hours at 40 F and 60% RH.

FORM

The tape is available in 375 foot rolls wound on cores in 1, 1½, 2, 2½, 3, 4 and over, if specified, inch widths. The cores contain a hole not less than 7/16 inch in diameter.

QPL

No.

NOTES

(1) This tape is suitable for taping closures of interior water resistant fiberboard boxes or other uses where high resistance to water penetration is necessary.

(2) This specification was canceled 19 October 1960.

UU-T-118 TAPE, PAPER, PRESSURE-SENSITIVE ADHESIVE, HOSPITAL STERILIZER, SEALING

Issue: 3 April 1959 Revision: None Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for (1) sealing or holding surgical pack wrappers and (2) for indicating steel, enamel, porcelain or glass has been subjected to elevated temperatures by steam sterilization in hospital autoclaves.

CLASSIFICATION

The tape is available in two sizes.

Size 1 ½ inch wide
Size 2 1 inch wide

PROPERTIES

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

PHYSICAL. The tape has a thickness no greater than 0.010 inch, a tensile strength of at least 16 lb/in. of width at 75 F and 6 lb/in. at 75 F after 5 minutes immersion in boiling water and an ultimate elongation of at least 6% at 75 F.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape changes color after steam autoclaving 30 minutes at 250 F with all pencil and pen markings remaining legible; however, under identical dry oven heating, no color change occurs. Upon changing color, the tape does not stain white surgical pack wrapper cloth and can be removed without breaking and without transfer or splitting of the adhesive. The tape has a peel strength of at least 22 oz/in. of width at 75 F either as received or after aging the tape 12 days at 150 F under 80% RH or after 7 days in 75 F water vapor prior to application using commercial polish ground AISI 302 or 304 stainless steel adherends.

FORM

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

QPL

No.

UU-T-123 TAPE, PRESSURE-SENSITIVE ADHESIVE, PAPER, PHOTOGRAPHIC

Issue: 11 August 1960 Revision: c Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for edging and blocking out purposes in the development and printing of negatives and for use in sealing photographic film cans.

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 containing no pinholes is colored dull black, has a thickness no greater than 0.012 inch, a tensile strength of 16 lb/in. of width and an ultimate elongation of at least 8%.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored 6 months.

PERFORMANCE. The tape has a peel strength of at least 10 oz/in. of width at room temperature as received and after aging the tape 10 days at 150F under 80% RH or after 7 days in 75F water vapor prior to application using AISI 302 or 304 stainless steel adherends. Further, it does not fog undeveloped photographic film (medium contrast panchromatic film, ASA speed 50-60).

FORM

The tape is available in 60 yard rolls wound on 3 inch diameter cores in ½, ¾, 1, 1¼, 1½, 2 and 3 inch widths. It is also available in 10 yard rolls on 1 or 3 inch diameter cores in ½ and 1 inch widths. Each roll may contain up to three splices.

QPL

No.

ZZ-C-191 CEMENT; RUBBER (ARTISTS' AND PHOTOGRAPHERS' AND COLD-PATCHING)

Issue: 10 December 1959 Revision: a Amendment: 3

SCOPE

This cement is intended for (1) the mounting of paper and photographic prints and (2) cold patching of rubber.

CLASSIFICATION

The cement is available in two types.

Type I Photographers' and artists'
Type II Cold patching

PROPERTIES

CHEMICAL. Type I cement consists of at least 12% pale crepe natural rubber or synthetic rubber in a sulfur-free solvent. Type II consists of at least 6% natural rubber in sulfur-free benzene or naphtha and up to two percent resin.

PHYSICAL. Type I cement is colorless (commercial designation) and dries to a colorless tacky film. Type II cement has no applicable requirements.

PROCESS. The cement is applied by brushing or spatula, air dried 20 minutes, the joint closed and Type I cured 2 hours and Type II overnight at room temperature under contact pressure. Excess Type I cement when dry (tacky) can be removed by wiping with a cloth or finger tips.

PERFORMANCE. Type I does not wrinkle, curl or shrink even thin white paper upon drying, nor does it stain or discolor white paper after being rupped off. Type I has a peel strength of at least 400 grams using 48 pound ledger paper, 15 mm wide and Type II a peel strength greater than 25 pounds using butyl rubber adherends, (ZZ-T-721) one inch wide.

FORM

The liquid cement is available in commercial packages including collapsible tubes.

QPL

No.

NOTES

(1) This specification is governed by Military Standard MS 39501 (CE), "Adhesive, Rubber, Photographers' and Artists'; Colors, Container Sizes and Use Characteristics Thereof".

ZZ-T-416 TIRE REBUILDING AND TIRE AND TUBE REPAIR MATERIALS

Issue: 27 August 1959 Revision: b Amendment: None

SCOPE

These cements are intended for vulcanized reconditioning of natural, SBR and butyl base pneumatic tires and inner tubes used on ground vehicles.

CLASSIFICATION

The repair and treading materials are available in four types, sixteen classes and eight styles.

- Type I Tire repair materials
  - Class A Tread gum, tire repair
  - Class B Cushion rubber gum, tire repair
  - Class C Fabric, tire repair
    - Style 1 Nylon fabric Style 2 Rayon fabric
- Type II Tire capping materials
  - Class A Tread rubber
    - Style 1 Bevel stock Style 2 Wing stock
  - Class B Padding (filling) stock
  - Class C Filler strip stock
  - Class D Stripping stock
- Type III Patches and patch materials
  - Class A Patch, pneumatic tire repair
    - Style 1 Nylon fabric Style 2 Rayon fabric
  - Class B Tube repair gums
    - Style 1 Combination tube repair gum
    - Style 2 Tube repair gum (vulcanizing)
- Type IV Processing materials
  - Class A Cements, vulcanizing, tire and tube repair
  - Class B Cements, rubber, cold process
  - Class C Talc, technical
  - Class D Solvent, rubber
  - Class E Curing bag paint
  - Class F Lubricant, mold
  - Class G Crayon, rubber marking

PROPERTIES

CHEMICAL. The vulcanizing cement and the cold cure cement consist of natural rubber. No reclaimed natural rubber is used in the vulcanizing cement.

PHYSICAL. The vulcanizing cement has a viscosity between 20 and 80 seconds (ASTM D553) and contains 0.5 lb/gal (10% solids, min) of rubber. The cold cure cement contains 0.15 lb/gal rubber.

PROCESS. The vulcanizing cement is applied by brushing or spraying when diluted with solvent, the joint closed and cured in

ZZ-T-416 (Continued)

accordance with the vulcanizing conditions of the adherends usually in 20–40 minutes at 260–280 F contact pressure. The cold cure cement is applied by brushing, the joint closed and cured at room temperature with the combination tube repair gum substrate under contact pressure. Curing bag paint (Type IV, Class E) is applied by brushing on curing bags to prevent sticking between the bag and the section being repaired. All molds are coated with the mold lubricant (Type IV, Class F) prior to repair or retreading operation. Tread rubber and repair materials for pneumatic tires can be stored for 12 months at room temperature when protected against physical change.

PERFORMANCE. Tires containing repair patches show no cracking, flaking, loss of adhesion or failure when subjected for 6 hours to a speed of 30 mph at 100 F under the following load conditions applied radially in accordance with the recommended practice given in the Year Book of the Tire and Rim Association (2001 First National Tower, Akron 8, Ohio): 1 hour at 100% load; 1 hour at 120% load; and 4 hours at 140%. A shear strength of 120 lb/in. of width (40 psi) is obtained with the vulcanizing cement using vulcanized SBR to unvulcanized SBR adherends cured 45 minutes at 280 F.

FORM

The vulcanizing cement is available in 5 and 55 gallon containers and the cold cure cement in 5 gallon containers.

QPL

No.

NOTES

(1) This specification contains extensive data on the tire repair, tire capping, patching and processing materials. They are not reproduced here. See Specification for details.

DDD-B-0035 (GSA-FSS) BANDAGES, ABSORBENT, ADHESIVE

Issue: 15 October 1963 Revision: b Amendment: None

SCOPE

This pressure-sensitive adhesive absorbent bandage is intended for corrective medical procedures.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The bandage consists of a maximum of four components: (1) an absorbent compress material composed of cotton (JJJ-C-561, Grade B), rayon (JJJ-C-561, Grade B), gauze (CCC-G-101, Type I or II), flannel, or absorbent cellulose (L-C-166) (see Form section for construction), (2) a compress cover, when specified, composed of a plastic film, (3) an adhesive plaster backing composed of a plasticized film coated on one side with a new natural or synthetic, but not reclaimed, rubber base adhesive, and (4) a liner composed of an organic or metallic film, laminated with paper, or plain. The bandage is packaged in a white, sterilizable kraft or glassine paper envelope.

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

PROCESS. The bandage requires no moisture, heat or other preparation prior or subsequent to application except removal from the sterile package and stripping of the liners.

PERFORMANCE. The bandage, when touched in the adhesive area after stripping of the liner during application, does not string out in long threads. The bandage when removed does not leave any adhesive mass on the skin. The adhesive is unaffected by 48 hours accelerated aging under 300 psi oxygen pressure at 70 C.

FORM

The bandage, enclosed in a sterilized paper envelope, is available in the sizes given in Table II, each having a compress construction system given in Table III.

DDD-B-0035 (Continued)

TABLE I. PHYSICAL PROPERTIES OF DDD-B-0035 BANDAGE

COMPONENT	INGREDIENT	PROPERTY	VALUE
Compress absorbent material (1)(2)	Flannel	Weight, oz/sq yd, min	6
Compress cover (3)		Perforated	Yes
		Toxicity	None
		Solubility in wound	None
Adhesive Plaster Backing (4)		Color	Flesh
		Toxicity	None
		Perforations, no./sq in., min	12
		Area of perforations, % of perforated area (5)	5–15
		Tensile strength, lb/in., min	4
Adhesive		Weight, oz/sq yd, min	1.7
Envelope	Kraft	Weight, lb/500 sheets, 24x36 in., min	30
		Tensile strength, lb/in., min	
		Machine direction	20
		Cross direction	7
		Porosity, Gurley densitometer, sec/100 CC air/sq in., min	65
	Glassine	Weight, lb/500 sheets, 24x36 in., min	25
		Burst strength, points, min (6)	15

(1) The physical properties of the other absorbent material ingredients are given in the specifications listed in the Chemical section.
(2) The construction options of the compress are given in the Form section. The weight and absorbent capacity of all constructions are approximately the same as, but not less than, the Type A compresses of equal sizes. For 2 x 4½ size bandage it is not less than twice the Type A compress.
(3) The number of perforations or valvule forming slits are not given; however, they are of such size and number that wound exudates are readily transmitted to and absorbed by the compress.
(4) The adhesive plaster backing is perforated in the area containing the compress. These perforations may extend beyond the compress.
(5) Except for 3/8 by 1½ inch size.
(6) UU-P-31, Method 112.

DDD-B-0035 (Continued)

TABLE II. AVAILABILITY OF DDD-B-0035 BANDAGE

Nominal Bandage Size, in.	Width or Diameter in.	Length, in.	Compress Dimensions Width or Diameter, in.	Compress Dimensions Length, in.
3/8 x 1½	11/32	1-7/16	9/32	3/8
3/4 x 3	11/16	2-27/32	9/16	7/8
1 x 3	15/16	2-27/32	13/16	7/8
1½ x 1½	1-7/16	1-7/16	1/2	1/2
2 x 4½ (1)	1-15/16	4-1/4	1-9/16	1-5/8
7/8 (dia.)	13/16(dia.)	—	5/16 (dia.)	—

(1) Adhesive plaster tapered on both ends.

TABLE III. COMPRESS CONSTRUCTION SYSTEMS FOR DDD-B-0035 BANDAGE

TYPE (1)	CONSTRUCTION
a	Four layers Type I gauze
b	Top layer Type I gauze and underlayers Type II gauze
c	Top layer Type I gauze and cotton, rayon and/or absorbent cellulose filler
d	One layer flannel
e	Top layer compress cover and cotton, rayon, gauze, flannel and/or absorbent cellulose filler

(1) The compress does not extend beyond the edges of the adhesive plaster. The adhesive liner fully covers the exposed adhesive plaster and overlaps the compress by at least 30%.

QPL

No.

NOTES

(1) The supplier certifies that the sealed envelope has been sterilized with high pressure steam or other suitable means.

JJJ-A-20 ACACIA, TECHNICAL (GUM ARABIC)

Issue: 24 January 1958 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding wood and paper and for use in photographic and lithographic work.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. This gum consists of the exudate from the stems and branches of *Acacia Senegal (Linne), Willdenow,* or other related African species of Acacia (Fam. *Leguminosae*). The gum contains no starch, dextrin or tannin bearing gums.

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

TABLE I. PHYSICAL PROPERTIES OF JJJ-A-20 GUM ARABIC

PROPERTY	VALUE
Insoluble residue, %, max (1)	1.0
Ash, %, max	4.0
Acid insoluble salt, %, max (2)	0.5
Moisture, %, max	15.0
Acidity, %, max	
Inorganic	None
Organic	0.4
Lead subacetate treatment, white precipitate	Yes
Fehling's solution reduction (Cu_2O)	Trace
Solubility, gr/100 ml water	35

(1) After boiling 15 min. in a solution of 100 ml water and 10 ml of 10% hydrochloric acid.

(2) After boiling the ash 5 min. in 25 ml of 10% hydrochloric acid.

PROCESS. The adhesive is activated by mixing with water, applied by brushing, the joint closed and cured at room temperature under contact pressure. No curing time is given; however, 1 hour is usually sufficient.

PERFORMANCE. No performance properties are given.

FORM

The powdered gum, unless otherwise specified, is available in 1 and 10 pound canisters.

QPL

No.

LLL-R-626 ROSIN, GUM; ROSIN, WOOD; AND ROSIN, TALL OIL

Issue: 21 May 1957 Revision: b Amendment: None

SCOPE

This rosin is intended as a modifier for adhesive formulations and for bonding glass, wood and paper.

CLASSIFICATION

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

Class A Gum rosin
Class B Wood rosin
Class C Tall oil rosin
Type I Lump
Type II Powder
Grade X Lightest color
Grade WW
Grade WG
Grade N
Grade M
Grade K
Grade I
Grade H
Grade G
Grade F
Grade E
Grade D Darkest color
Grade FF Unrefined dark colored wood rosin

PROPERTIES

CHEMICAL. The rosin consists of a natural resin, commonly called colophony, composed chiefly of rosin acids derived from and isomeric with the acidic components of the oleoresin contained within or exuded by living pine trees or obtained by extraction or chemical recovery from the wood or stumpwood of this species. Type II is Type I except in a powdered form and may contain an unspecified filler.

PHYSICAL. The rosin is a clear, transparent material, possessing a tint ranging from yellow-amber to red in color (in accordance with grade designation, the standards for which are issued by the U S Department of Agriculture). Type II rosin, additionally, is sufficiently fine such that it can pass through a U S Standard No. 8 mesh sieve and when kept for 2 hours at 135 F does not congeal or form lumps. The other physical properties of the rosin are given in Table I.

LLL-R-626 (Continued)

TABLE I. PHYSICAL PROPERTIES OF LLL-R-626 ROSIN

PROPERTY	VALUE: ALL GRADES EXCEPT GRADE FF	VALUE: GRADE FF
Softening point, °C, min (1)	70	67
Acid number, min (2)	160	150
Saponification number, min (3)	166	162
Toluene insoluble matter, %, max (4)	0.05	0.05

(1) Ring and Ball Method, ASTM E28.

(2) Milligrams of KOH per 1 gram of sample, ASTM D465.

(3) Milligrams of KOH per 1 gram of sample, ASTM D464.

(4) Insoluble matter consists of sand, dirt, bark or wood chips, ASTM D269. Type II contains no more than 10% inert filler to prevent congealing and solidification during storage.

PROCESS. The rosin with other compounding ingredients, if any, is dissolved in a solvent such as toluene, applied by brushing, the joint closed and cured generally at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The Type I rosin, containing no more than 10% crushed, powdered and small broken pieces, is available in 400 and 600 pound containers. Type II rosin is available in 1 pound containers.

QPL

No.

NOTES

(1) The rosin acids are isomers with the empirical formula $C_{20}H_{30}O_2$ and defined according to method of manufacture.

A. Gum rosin: The residue after the distillation of gum spirits from the exuded oleoresin collected from living pine trees.

B. Wood rosin: Recovered by extraction of the residual oleoresin remaining in the dead wood of pine trees, such as stumpwood, with or without subsequent refining.

C. Tall oil rosin: Manufactured by distilling tall oil, the mixture of rosin and fatty acids recovered by acidification of the saponified oleoresins (skimmings) derived from the alkaline sulfate paper pulping process.

(2) This specification is governed by Military Standard MS 35618 (CE), "Rosin, Powdered, Lithographic; Colors, Container Sizes and Use Characteristics Thereof."

MMM-A-100 ADHESIVE, ANIMAL – GLUE

Issue: 10 December 1963 Revision: b Amendment: 1

SCOPE

This glue is intended for assembly gluing of wood and in the manufacture of ammunition primers and spirally wound fiber containers.

CLASSIFICATION

The glue is available in two types and seven grades.

Type I Dry form
- Grade P1 For ammunition primers
- Grade V1 Veneering and doweling
- Grade V2 Veneering and doweling
- Grade J1 Edge joints in furniture
- Grade J2 Edge joints in furniture
- Grade S1 For short assembly periods or high fabrication temperatures
- Grade S2 For short assembly periods or high fabrication temperatures

Type II Liquid form

PROPERTIES

CHEMICAL. The glue consists of the proteinaceous extract from animal bones and hides. Type I, Grade P1 only, has an ash content of at least 4%, a grease content of no more than 0.4% and contains no alum, zinc oxide, salts, sugars, dextrin, clay fillers, sulfites or sulfides.

PHYSICAL. Type I has a moisture content of 9–15% and a pH of 5.5–7.5. The viscosity and jelly strengths are given in Table I. Type II glue, after being dried at 75–80 F to constant weight, absorbs no more than 15% moisture when left standing 24 hours at 75–80 F and 70–5% RH. The viscosity is at least 1800 centipoises at 85 F and no more than 50,000 centipoises at 70 F. Type II has a pH of 5.5–7.7. Both types do not have any odor of decomposition upon receipt, and Type I even after 48 hours at 38 C.

MMM-A-100 (Continued)

TABLE I. PHYSICAL PROPERTIES OF MMM-A-100 (TYPE I) GLUE

	GRADE						
PROPERTY	P1	V1	V2	J1	J2	S1	S2
Viscosity, millipoise, min (1)	NR	59	72	83	100	111	125
Jelly strength, grams (2)	170-194	150-177	207-236	237-266	290-330	331-362	363-394

(1) For 11% aqueous solution at 60 C.
(2) For an 11% aqueous gel at 10 C using a Bloom Gelometer.
NR = No Requirement

PROCESS. Type I glue is activated by mixing with water, the mixture melted at 62 C, applied hot by brushing on between 18 and 25 gr/sq ft, the joint immediately closed and cured (solidified) at least 16 hours at room temperature under 150 psi bonding pressure. Type II glue is ready to use, applied cold to joints and processed similar to Type I. Both types will foam when agitated.

PERFORMANCE. No shear properties are given for Type I; however, they are generally similar to Type II. The block shear strength of Type II glue is 2800 psi at 70–85 F using maple adherends (Fed Test Method Std No. 175, Method 1031). Failure occurs 50% or more in the wood.

FORM

The flake or ground Type I glue is available in 50 and 100 pound multiwall shipping sacks and 300 pound quantities in barrels. The liquid Type II glue is available in 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) The adhesive must be tested for suitability with explosives at a Government laboratory specified by the purchaser.

(2) Any type and grade of animal glue is suitable for manufacture of spiral wound fiber containers.

(3) This specification includes the requirements of JAN-G-338 and MIL-G-20469 (see abstracts).

MMM-A-115 ADHESIVE, ASPHALT, WATER EMULSION TYPE (FOR ASPHALT AND VINYL ASBESTOS TILE)

Issue: 3 January 1964 Revision: a Amendment: None

SCOPE

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

CLASSIFICATION

The adhesive is available in two classes.

Class 1 Clay type dispersing agent
Class 2 Chemical type dispersing agent

PROPERTIES

CHEMICAL. The adhesive consists of an asphaltic base material dispersed in water containing either a clay or chemical type dispersing agent.

PHYSICAL. The adhesive is homogeneous, free from offensive odors, does not develop mold on standing and has a Brookfield viscosity at 75F between 7,000 and 30,000 centipoises.

PROCESS. The adhesive is applied by trowelling using a standard notched trowel, air dried 1½ hours, the asphalt tile laid and the joint cured at least one hour under contact pressure. The bonding agent has a maximum air drying time of 1½ hours, whereupon it assumes the properties of a pressure-sensitive adhesive. It can be stored 3 months during which time any thickening that occurs can be dispersed by stirring.

PERFORMANCE. Asphalt tile after bonding one hour to steel at 75F under 0.18 psi pressure will not slip more than ½ inch when allowed to stand vertically (approximately 80°) for 1 hour at 75F. The adhesive after air drying 48 hours at 75F does not break down during 18 hours immersion in 5 percent sodium hydroxide resulting in solution turbidity or discoloration. A 0.050 inch thick film of adhesive after air drying one hour at 75F does not bleed or exude and does not sag more than 1/8 inch when allowed to stand vertically for 5 hours at 160F.

FORM

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

QPL

No.

NOTES

(1) This specification is an interim revision of Federal Specification SS-A-00138 (see abstract).

MMM-A-125 (GSA-FSS) ADHESIVE, CASEIN TYPE, WATER AND MOLD RESISTANT

Issue: 17 April 1964 Revision: b Amendment: None

SCOPE

This adhesive is intended for wood bonding where resistance to water and mold is needed.

CLASSIFICATION

The adhesive is available in two types

Type I Water resistant
Type II Water and mold resistant

PROPERTIES

CHEMICAL. The adhesive consists of casein.

PHYSICAL. The adhesive is a dry, uncaked powder.

PROCESS. The adhesive is activated by mixing with water and other ingredients in accordance with the supplier's instructions, applied by brushing, the joint closed and cured at least 4 hours at room temperature under 150-200 psi bonding pressure. The adhesive at room temperature has a working life of at least 5 hours (800 poises viscosity) and in mixing cans sets to a firm jelly in 24 hours (Type I) or 48 hours (Type II).

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

TABLE I. PERFORMANCE PROPERTIES OF MMM-A-00125 ADHESIVE

PROPERTY	TYPE I	TYPE II
Shear, interlaminar, psi, at 75F, min (1)		
Initial	340	340
Wet (2)	140	140
Mold – 14 days (3)	NR	140
Shear, block, psi, at 75F, min (4)	2800	2800

(1) Fed Test Method Std No. 175, Method 1032, using yellow birch adherends.
(2) Conditioned per Fed Test Method Std No. 175, Method 2031.
(3) Casein mold.
(4) Fed Test Method Std No. 175, Method 1031, using maple adherends.
NR = No Requirement

FORM

The powdered adhesive is available in 4 ounce, 1, 5, 100 and 300 pound containers.

QPL

No.

MMM-A-00130 (GSA-FSS) ADHESIVE, CONTACT

Issue: 2 October 1961 Revision: None 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 in an unspecified solvent.

PHYSICAL. The adhesive has a specific gravity between 0.80 and 0.87, 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 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 160F.

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-00137 (GSS-FSS) ADHESIVE, LINOLEUM

Issue: 11 February 1963 Revision: a 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 6 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 1/2, 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.

MMM-A-00150 (GSA-FSS) ADHESIVE FOR ACOUSTICAL MATERIALS

Issue: 3 October 1962   Revision: a   Amendment: None

SCOPE

This adhesive is intended for bonding prefabricated acoustical materials to inside walls and ceilings of rooms.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, it does not contain more than 0.5% benzene or volatile chlorinated hydrocarbon solvents.

PHYSICAL. The adhesive is a nontoxic paste.

PROCESS. The adhesive is applied by troweling, the tile laid and the joint cured at least 24 hours at room temperature under contact pressure. The adhesive between 20 and 30 C wets the surface of plywood and gypsum board. In film thicknesses of 3/8 inch, it does not sag from walls or drop from ceilings. At least 20 square inches of adhesive 1/8 inch thick should be used at or near the corners of the acoustical tile. After drying 30 days at 49 C, no more than 15% volume shrinkage occurs. Storage and other application procedures are given by the supplier; however, the adhesive can be stored in unopened containers for 4 weeks at 50 C or 3 days at -18 C.

PERFORMANCE. The adhesive, in 1/8 inch thickness, cast on glass, does not crack after 7 days at 49 C. The vehicle does not stain paper during drying 28 days at 49 C. The adhesive is capable of withstanding tensile loads without failure as specified in Table I.

MMM-A-00150 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MMM-A-00150 ADHESIVE

Tensile Load, lb	Adhesive Thickness, in.	Temperature, °C	Relative Humidity, %(2)	Duration, hr
2¼	3/16	21–27	45 – 55	72
2¼	3/16	21–27	80 – 85	72
0	3/16	21–27	45 – 55	24
1¾	3/16	49	$<$ 10	72
1¼	3/8	21–27	45 – 55	72
1¼	3/8	21–27	80 – 85	72
0	3/8	21–27	45 – 55	24
¾	3/8	49	$<$ 10	72

(1) There is no failure during the time specified under the indicated load using 2¾ inch diameter, 3/8 inch thick gypsum lathe discs (ASTM C37) cured for 5 minutes.
(2) ASTM E104.

FORM

The paste adhesive is available in 1/2, 1, 5 and 55 gallon containers.

QPL

No.

NOTES

(1) Do not use this adhesive as the means for holding acoustical materials weighing more than 2-1/2 lb/sq ft to ceiling surfaces.

(2) Do not use acoustical adhesives over surfaces that are moist or have an alkaline reaction, or that may later become moist or alkaline. Concrete or plaster should be properly dried and aged before applying the adhesive.

(3) This specification is similar to ASTM D1779, "Adhesive for Acoustical Materials."

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

Issue: 21 January 1964 Revision: a Amendment: 1

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-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: 1 July 1963 Revision: None Amendment: 1

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-00181 (ARMY-MR) ADHESIVE, ROOM-TEMPERATURE AND INTERMEDIATE-TEMPERATURE SETTING RESIN (PHENOL, RESORCINOL, AND MELAMINE RESIN)

Issue: 9 March 1964 Revision: None 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

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 or incorporated hardener may be used.

PHYSICAL. The pH of the set film is between 3.5 and 11.0.

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-00181 (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-00182 (GSA-FSS) ADHESIVE, RUBBER (FOR COLD PATCHING)

Issue: 29 November 1962 Revision: None Amendment: None

SCOPE

This adhesive is intended for cold bonding of natural and synthetic rubber, expecially in tire inner tube repairs.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of at least 6% natural rubber in a benezene or naphtha solvent and not more than 2% unspecified resin.

PHYSICAL. The benzene boils between 75 and 84 C and the naphtha between 40 and 145 C.

PROCESS. The adhesive is applied by brushing or with a spatula, air dried 20 minutes, the joint closed and cured overnight at room temperature under contact pressure.

PERFORMANCE. The adhesive using adherends (ZZ-I-550), composed of 50 percent butyl or 55 percent natural rubber, is sufficiently strong to prevent separation under a shear load of 12.5 psi.

FORM

The adhesive is available in one fluid ounce collapsible tubes and ½ pint, pint, quart and one gallon containers.

QPL

No.

NOTES

(1) This specification is an interim revision in part of Federal Specification ZZ-C-191 (see abstract).

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

Issue: 22 January 1963 Revision: None Amendment: None

SCOPE

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

CLASSIFICATION

The adhesive is available in four classes and three sizes.

Class 1 Collapsible tubes
Size 1 1 oz Size 2 2 oz Size 4 4 oz
Class 2 Glass jars with brushes
Size 2 2 oz Size 4 4 oz
Class 3 Metal Cans – Size 4 4 oz
Class 4 Other containers (half-pints and larger capacities)

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 is colorless and dries to a colorless film. The solvent fraction has a distillation endpoint 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.

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 bond paper adherends, 15 mm wide.

FORM

The adhesive is available in the containers specified in the Classification Section.

QPL

No.

NOTES

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

MMM-A-188 ADHESIVE: UREA-RESIN-TYPE (LIQUID AND POWDER)

Issue: 8 November 1960 Revision: b Amendment: None

SCOPE

This adhesive is intended for assembly gluing of wood and bonding of plastic laminates to wood where moderate water resistance is desired.

CLASSIFICATION

The adhesive is available in three types.

Type I Powder (with separate catalyst)
Type II Powder (with incorporated catalyst)
Type III Liquid (with separate catalyst)

PROPERTIES

CHEMICAL. The adhesive is an unextended urea formaldehyde resin containing no more than 20% insoluble matter, including filler and insoluble partially polymerized resin. The unspecified filler is an inert, insoluble organic or inorganic powder incapable of being dissolved or swelled excessively by water. No amylaceous (flour or starch) or protein base fillers are present.

PHYSICAL. The pH of the cured film is not less than 2.5.

PROCESS. The adhesive is activated by mixing base resin, hardener and filler, if any, applied by brushing, the joint closed and cured in accordance with the supplier's instructions. The activated adhesive has a working life between 2 and 8 hours at 75 F (maximum viscosity of 600 poises) during which time the adhesive can be removed with water. A similar working life at 90 F must be specified by the purchaser. Storage limits are given by the supplier.

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

TABLE I. PERFORMANCE PROPERTIES OF MMM-A-188 ADHESIVE

PROPERTY	VALUE
Shear, interlaminar, psi, at 75 F, min (1)	
Initial	340
Wet (2)	280
Shear, block, psi, at 75 F, min (3)	2800

(1) Fed Test Method Std No. 175, Method 1032, using yellow birch adherends.

(2) Condition per Fed Test Method Std No. 175, Method 2031.

(3) Fed Test Method Std No. 175, Method 1031, using maple adherends.

MMM-A-188 (Continued)

FORM

The adhesive and catalyst are available in the quantities given in Table II.

TABLE II. AVAILABILITY OF MMM-A-188 ADHESIVE

TYPE	FORM	SIZE
I	Powder	100 and 300 pounds
II	Powder	50, 100 and 300 pounds
III	Liquid	1, 5 and 55 gallons
Catalyst	Solid	1, 10, 25 and 100 pounds
(Types I & III)	Liquid	1, 5 and 10 gallons

QPL

No.

MMM-A-193 ADHESIVE, VINYL ACETATE RESIN EMULSION

Issue: 25 August 1959 Revision: b Amendment: None

SCOPE

This adhesive is intended for assembly gluing of wood items such as furniture, small patterns and models which are subjected to normal indoor temperature conditions where relative humidities are not high and do not fluctuate widely.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of polyvinyl acetate emulsion containing at least 50% solids.

PHYSICAL. The viscosity of the adhesive at 23 C is between 1000 and 7000 centipoises (Brookfield) or between 400 and 600 grams (Stormer) and has an ash content of no more than 1%.

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 6 months at room temperature in air tight containers and can be frozen five times down to -20F for periods as long as 18 hours without adverse effect.

PERFORMANCE. The adhesive has a block shear strength of at least 2800 psi at 75 F using maple adherends (Fed Test Method Std No. 175, Method 1031) and an interlaminar shear strength of at least 400 psi at 75 F, 250 psi at 75 F after 30 min. at 160 F and 250 psi at 75 F after 1 week at 75 F and 90% RH using yellow birch adherends (Fed Test Method Std. No. 175, Method 1032).

FORM

The liquid adhesive is available in commercial packages unless otherwise specified.

QPL

No.

NOTES

(1) This adhesive is not suitable for edge gluing and laminating of furniture parts.

(2) This adhesive is intended for dowel, mortise-tenon, lock and finger joints.

MMM-A-00250 (GSA-FSS) ADHESIVE, WATER-RESISTANT (FOR SEALING FIBERBOARD BOXES)

Issue: 15 October 1962 Revision: None 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 adherends (PPP-B-636).

FORM

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

QPL

No.

NOTES

(1) This specification is an interim revision of Federal Specification O-A-161 (now cancelled).

MMM-A-00260 (GSA-FSS) ADHESIVE, WATER-RESISTANT (FOR SEALING WATERPROOF PAPER)

Issue: 15 October 1962 Revision: None 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 (Aspergillus niger USDA TC-215-4247 or ATCC 6275, Aspergillus flavus ATCC 1003 and Pencillium USDA 1336.2). Grades A and B adhesive and Grade B dried film are free from disagreeable odor. Grade A dried film is odorless.

PROCESS. The adhesive is applied by machine (Type I) or by brushing (Type II), the joint closed in 30 seconds and cured 24 hours at room temperature under 0.5 psi bonding pressure. The adhesive, Type II, classes 1 and 2 only, is readily brushable at temperatures between 60 and 100 F and Type II, all classes, in closed containers can be stored as long as two weeks at 120 F 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 12 ounce peel load per inch width of bond area.

MMM-A-00260 (Continued)

FORM

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

QPL

No.

NOTES

(1) This specification is an interim revision of Federal Specification O-A-166 (now cancelled).

(2) The supplier certifies the adhesive is nontoxic.

MMM-B-00350 (ARMY-CE) BINDER, ADHESIVE, EPOXY RESIN, FLEXIBLE

Issue: 22 June 1962 Revision: None 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-tridimethylamiñomethyl phenol alone or in combination with dimethylaminomethyl 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-00350 ADHESIVE

PROPERTY	EPOXY RESIN		POLYSULFIDE RUBBER	
	MIN	MAX	MIN	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

NR = No Requirement

MMM-B-00350 (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-00650 (CE) GROUT, ADHESIVE, EPOXY RESIN, FLEXIBLE, FILLED

Issue: 29 June 1962 Revision: None 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.

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 pavement, 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 and containing no more than 50 percent unspecified nor settling mineral filler. No diluents, wetting agents or volatile solvents are present. The hardner is 2, 4, 6-tridimethylaminomethyl phenol alone or in combination with dimethylaminomethyl phenol.

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

TABLE I. PHYSICAL PROPERTIES OF MMM-G-00650 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	410	NR
Fire point, °F (Cleveland Open Cup)	NR	NR	460	NR
Sulfur, %	NR	NR	36	36

NR = No Requirement

MMM-G-00650 (Continued)

PROCESS. The grout is activated by mixing the epoxy and polysulfide rubber components in accordance with the supplier's instructions, the adhesive applied by brushing, 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 1/2 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.

MMM-M-792 MUCILAGE

Issue: 15 January 1960 Revision: b Amendment: 1

SCOPE

This mucilage is intended for general office bonding work where a moderately quick setting adhesive is required.

CLASSIFICATION

The mucilage is available in three types and three classes.

Type I Bottles with spreaders

Class 1 4 oz unit Class 2 1 oz unit Class 3 2.3 oz unit

Type II Bottles with applicators Type III Other containers

PROPERTIES

CHEMICAL. The mucilage consists of a mixture of unspecified gums or synthetic resins, water and mold inhibitors such as phenol, thymol, beta-naphthol, sodium benzoate, benzoic acid, para-hydroxy benzoic acid, and salicylic acid. An essential oil such as cassia, wintergreen, clove, cinnamon, peppermint or sassafras is included with the phenol preservatives and is optional with other preservatives.

PHYSICAL. The mucilage has a viscosity at 25C between 690 and 1200 centipoises as received and not over 2400 centipoises after 90 days under normal warehouse storage conditions. The wet and dry film of mucilage are free from odor and do not decompose or support mold growth after being innoculated with mold spores from starch and incubated 10 days at 30C.

PROCESS. The mucilage is applied by brushing, the joint closed and cured at room temperature under contact pressure (see Performance Section for curing times).

PERFORMANCE. The mucilage is equivalent to 30% gum acacia (arabic) base mucilage in that it gives the same paper fiber failure by peeling after 2, 5, 10 and 30 minutes and 24 hours using kraft paper adherends (UU-P-268, Grade B, 60 pound).

FORM

The liquid mucilage is available in the containers specified in the Classification Section. Type III containers are specified by the purchaser. The Type I spreader is similar to an eyedropper; Type II is a brush.

QPL

No.

NOTES

(1) The availability of MMM-M-792 mucilage is governed by Fed Std No. 00107, "Mucilage".

PPP-T-45 TAPE, GUMMED, PAPER, REINFORCED

Issue: 15 September 1960 Revision: a Amendment: None

SCOPE

This gummed adhesive is intended for packaging applications.

CLASSIFICATION

The tape is available in two types.

Type I Asphaltic

Type II Nonasphaltic

PROPERTIES

CHEMICAL. The tape consists of two sheets of a 30 pound, 100% sulfate kraft paper backing reinforced with glass, sisal or rayon fiber, combined with a laminate of asphalt (Type I) or other unspecified material (Type II) and coated on one side with an unspecified adhesive.

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

TABLE I. PHYSICAL PROPERTIES OF PPP-T-45 TAPE

PROPERTY	REINFORCEMENT GLASS	SISAL	RAYON
Tensile strength, lb/in., at 75 F, min			
Lengthwise	75	75	57
Crosswise	45	45	27
Elongation, ultimate, %, at 75 F, max	NR	NR	15
Reinforcement spacing, in., min (1)			
Lengthwise	0.5	0.5	0.5
Crosswise	2	2	2

(1) For diamond patterns, spacing is 1 inch maximum between parallel sides of diamond.

NR = No Requirement

PROCESS. The tape is activated with water, the joint closed and cured at least 2 hours at room temperature under contact pressure.

PERFORMANCE. The tape is tacky when peeled from 90 pound kraft paper 5 seconds after application and after 2 hours cannot be removed without paper or tape failure.

FORM

The tape, unless otherwise specified, is available in 300 foot

PPP-T-45 (Continued)

rolls wound on cores in 1, 1-1/2, 2, 2-1/2, 3 and 4 inch widths. The core contains a hole not less than 1/2 inch in diameter.

QPL

No.

NOTES

(1) Use Type I asphaltic tapes for (1) sealing fiberboard boxes for domestic shipment and storage, (2) securing package wrappings including wrappings of textile bolt packages, (3) banding of tubing, wire, pipe, hose, etc. and (4) protecting porcelain enamel against abrasion.

(2) Type I is interchangeable with Type II except where asphalt might have a deleterious effect, such as on food products.

PPP-T-0060 (ARMY-QMC) TAPE; PRESSURE-SENSITIVE ADHESIVE, WATERPROOF-FOR PACKAGING AND SEALING

Issue: 30 November 1961 Revision: a Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for packaging applications and the sealing of inlets, outlets, vents and louvres of equipment subjected to temperatures between 32 and 152 F where waterproofness is required.

CLASSIFICATION

The tape is available in three types and three classes.

Type I Water vaporproof, waterproof
Type II Water vapor resistant, waterproof
Type III Waterproof
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 for Types I and III and 6.5 lb/in. for Type II is required for unrolling the tape, either as received or aged 7 days at 150 F and 80% RH.

PERFORMANCE. The tape does not soften or lift properly applied paint such as cellulose nitrate lacquer (MIL-L-7178) and enamel (MIL-E-15090 and TT-E-529). The other performance proproperties are given in Table II.

PPP-T-0060 (Continued)

TABLE I. PHYSICAL PROPERTIES OF PPP-T-0060 TAPE

PROPERTY	Type I, Class 1	Type I, Class 2 & 3	Type II, Class 1	Type III, Class 1	Type III, Class 2 & 3
Tensile strength, lb/in., at 75 F, min (1)					
Dry	35	25	40	35	25
Wet	30	8	40	30	8
Tear strength, gr, at 75 F, min (2)	NR	NR	450	NR	NR
Bursting strength, psi, at 75 F, min (3)	65	35	65	65	35
Specular gloss (4)	11.0	11.0	11.0	11.0	11.0
Water penetration rate, gr/100 sq in./24 hr					
Under 1 inch water head, max	5.0	5.0	5.0	5.0	5.0
Water vapor transmission rate, gr/100 sq in./24 hr					
After 24 hr at 100 F and 90–5% RH, max	1.0	1.0	5.0	NR	NR
Curling					
Initial					
Curl, in., max (5)	3	3	3	3	3
Twist, degrees, max (6)	360	360	360	360	360
After 7 days at 150 F and 80% RH					
Curl, in., max (5) (7)	3	NR	3	3	NR
Twist, degrees, max (6) (7)	360	NR	360	360	NR

(1) CCC-T-191, Method 5102.
(2) CCC-T-191, Method 5132.
(3) CCC-T-191, Method 5122.
(4) Fed Test Method Std No. 141, Method 6101, on olive drab tapes only.
(5) The difference in unwound length of 36 inches and length when tape is released.
(6) The amount of twisting of an unsupported 36 inch length of tape.
(7) Conditioning refers to rolls of tape prior to performance of test.
NR = No Requirement

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 ½ inch splices.

PPP-T-0060 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF PPP-T-0060 TAPE

	Type				
	I		II	III	
	Class				
PROPERTY	1	2 & 3	1	1	2 & 3
Peel, oz/in., at 75 F, min (1)					
Initial	25	25	25	25	25
After aging roll 7 days at 150 F and 80% RH prior to application	25	25	20	25	25
After accelerated weathering (2)					
24 hours	NR	NR	25	NR	NR
72 hours	25	NR	NR	25	NR
After application at 32 F	20	20	20	20	20
Creep in shear, (1) (3)					
At 75 F, 1000 gr/sq in. load, min., min					
Initial					
Steel	100	30	60	45	960
Backing	100	25	3	20	180
After aging roll 7 days at 150 F and 80% RH prior to application					
Steel	100	30	60	45	480
Backing	100	15	2	15	180
At 150 F, 100 gr/sq in. load, hr, min					
Initial					
Steel	24	4	24	24	24
Backing	24	½	24	24	16
After aging roll 7 days at 150 F and 80% RH prior to application					
Steel	24	2	24	24	8
Backing	24	¼	24	24	8

(1) Tape to A1S1 302 or 304 stainless steel or to tape backing.
(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) The tape does not creep or slip under the indicated load for the time specified.

NR = No Requirement

PPP-T-0060 (Continued)

TABLE III. COLOR AVAILABILITY OF PPP-T-0060 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	–	24087	34087
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.

QPL

Yes.

NOTES

(1) Use Type I for applications where high resistance to water vapor permeability is desired.

(2) Use Type II for waterproofing operations such as sealing ammunition fiber containers and when moderate resistance to water vapor permeability is desired. Only exterior (Class 1) tape is suitable for this application.

(3) Use Type III for waterproofing operations where protection against water penetration is required and moisture vapor penetration characteristics are not important.

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

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

(6) Use Class 3 for sealing and packaging which are overpacked in exterior containers where high strength is desired.

PPP-T-66 TAPE; PRESSURE-SENSITIVE ADHESIVE, VINYL PLASTIC FILM

Issue: 11 December 1963 Revision: c Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for sealing, identification and corrosion prevention applications requiring resistance to sunlight, water, oils, solvents, acids, alkalies and abrasives.

CLASSIFICATION

The tape is available in two types and two classes.

Type I General purpose
- Class A Transparent
- Class B Colored

Type II Printable

PROPERTIES

CHEMICAL. The tape consists of a modified polyvinyl chloride or polyvinyl chloride-vinyl acetate film backing coated on one side with an unspecified adhesive.

PHYSICAL. The Type I, Class A tape is sufficiently transparent to read 10 point type. The colors of Type I, Class B, and Type II are given in Form section. The other physical properties of the tape are given in Table I.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The Type II tape is capable of being printed and this printing, when provided by the supplier, if offset on unwinding, does not affect legibility. The tape, both types, can be stored 6 months preferably at 70 F and 40-5% RH.

PERFORMANCE. The tape has a peel strength at 75 F of at least 15 oz/in. of width and at least 25 oz/in. of width after 96 hours accelerated aging (Fed Test Method Std No. 141, Method 6151) using a commercial polish ground AISI No. 302 or 304 stainless steel substrate. The Type I (black only) tape in indirect contact with undeveloped film for 7 days at 120 F does not cause an increase in fog density greater than 0.02 (ANSCO-Sweet Densitometer).

FORM

The tape is available in 36 yard rolls wound on 3 inch diameter cores in 1/4, 1/2, 3/4, 1, 1-1/2, 2, 3 and 4 inch widths. Each roll may contain up to 2 splices. Type I, Class A, is transparent; Type I, Class B, is black, blue, brown, green, orange, red, white or yellow; and Type II is white or yellow.

PPP-T-66 (Continued)

TABLE I. PHYSICAL PROPERTIES OF PPP-T-66 TAPE

PROPERTY	TYPE I MIN	TYPE I MAX	TYPE II MIN	TYPE II MAX
Thickness, in.	NR	0.0065	NR	0.0075
Tensile strength, lb/in., at 75 F	12	NR	12	NR
Elongation, ultimate, %, at 75 F	100	NR	100	NR
Modulus of elasticity, lb/in., at 75 F (1)	NR	11	NR	11
Tear strength, lb, at 75 F (2)	2	NR	3	NR
Moisture vapor transmission rate, gr/100 sq in./24 hr After 24 hr at 100 F and 90–5% RH	NR	3	NR	3
Shrinkage, %, after 1 hr at 150 F	NR	5	NR	5
Resistance to creep, in. (3)	NR	3/16	NR	3/16
Opacity (4)	3.0	NR	NR	NR
Corrosion	None	NR	None	NR
Resistance to salt water, hr at 158 F (5)	96	NR	96	NR

(1) The amount of tension to produce an elongation of 10% in a ½ inch specimen.
(2) ASTM D1004.
(3) The tape is stretched 25%, adhered to Type 302 stainless steel (No. 4 finish) and allowed to stand 24 hours at 75 F and 50% RH.
(4) On Type I, Class B, black only using an ANSCO–Sweet Densitometer.
(5) Tape coated copper rod shows no signs of corrosion or loss of adhesion after 96 hours exposure to 158 F salt water.

QPL

No.

NOTES

(1) Use 2 or 3 inch wide tape for marking traffic lanes and 3/4 or 1 inch wide tape for sealing screw caps, stoppers or slip cover closures.

(2) Use Type I, Class B, black tape for sealing photographic film cans and magazines.

(3) The tape is useful for color coding of pipes (viz. steam and water lines) and for protecting pipes not buried underground from corrosion by moisture, acids, alkalies and salts.

(4) The tape is also useful for sealing openings such as examination ports in dehydrated containers or openings on mechanical equipment.

PPP-T-0070 (GSA-FSS) TAPE, PRESSURE-SENSITIVE, (PACKAGING GRADE VINYL PLASTIC FILM)

Issue: 17 January 1964 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for (1) closing and sealing interior and exterior domestic containers, (2) protecting labels against moisture and weathering and (3) general purpose holding and sealing applications.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of an unplasticized polyvinyl chloride backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape is sufficiently transparent to permit reading of 10 point type. It has a tensile strength, ultimate elongation and bursting strength of at least 25 lb/in., 60% and 35 psi, respectively, both dry and wet (6 hr immersion in water). The water penetration rate is not greater than 2.0 gm/100 sq in./24 hr (Fed Test Method Std 00147, Method 72).

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape has a peel strength of at least 20 oz/in. at 75 F, 18 oz/in. after 30 hours at 120 F under 80% RH and 30 oz/in. after 96 hours accelerated weathering using a commercial polished ground AISI 302 or 304 stainless steel adherend (Fed Test Method Std 00147, Methods 10, 61 and 63, respectively). Under 3035 gr/sq in. shear load, the tape at room temperature will not creep more than 1/8 inch during 24 hours (Fed Test Method Std 00147, Method 20).

FORM

The tape is available in 72 yard rolls or multiples thereof wound on 3 inch diameter cores in widths specified by the purchaser. Each roll may contain up to 3 splices.

QPL

No.

NOTES

(1) The tape may be used as a packing list enclosure when printed on the adhesive side in an appropriate manner and supplied on a liner.

PPP-T-76 TAPE, PRESSURE-SENSITIVE ADHESIVE PAPER, (FOR CARTON SEALING)

Issue: 16 July 1963 Revision: b Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing fiberboard cartons used in packing and packaging applications which are subjected to temperatures between -65 and 160 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a 100% sulphate kraft paper backing coated on one side with an unspecified adhesive.

PHYSICAL. The 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. An average force of 3 lb/in. of width is necessary to unroll the tape either as received or after 20 days storage at 135 F. No more than 10% of adhesive is transferred to the backing during unwinding of the tape. The tape as received or after aging does not distort more than ½ inch.

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

PPP-T-76 (Continued)

TABLE I. PHYSICAL PROPERTIES OF PPP-T-76 TAPE

PROPERTY	VALUE
Thickness, in., max	0.010
Tensile strength, lb/in., at 75 F, min	
Initial	
Lengthwise	
Dry	45
Wet, 4 hr in 75 F water	20
Crosswise	
Dry	22
Wet, 4 hr in 75 F water	12
After 20 days at 135 F	
Lengthwise, dry	40
Crosswise, dry	20
Tear strength, gr, at 75 F, min (1)	
Initial	100
After 20 days at 135 F	75
After accelerated weathering, 60 hr (2)	75
Curling	
Initial	
Curl, in., max (3)	10
Twist, degrees, max (4)	360
Aged 20 days at 135 F	
Curl, in., max (3)	10
Twist, degrees, max (4)	360
Water solubility, %, max (5)	2.0

(1) UU-P-31, Method 170.
(2) Fed Test Method Std No. 141, Method 6151 or ASTM D822.
(3) The difference in unwound length of 36 inches and length when tape is released.
(4) The amount of twisting of an unsupported 36 inch length of tape.
(5) After 1 hour in 185 F water under ½ inch head.

PPP-T-76 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF PPP-T-76 TAPE

PROPERTY (1)	VALUE
Peel, oz/in., min	
At 50 F	
Tape to stainless steel (2)	
Initial	10
After aging roll 20 days at 135 F prior to application	10
Tape to backing	
Initial	10
After aging roll 20 days at 135 F prior to application	10
At 73 F	
Tape to stainless steel (2)	
Initial	35
After aging roll 20 days at 135 F prior to application	35
After 60 hr accelerated weathering (tape only)	35
Creep in shear, (2) (3)	
At 75 F, 1000 gr/sq in. load, hr, min	
Initial	96
After aging roll 20 days at 135 F prior to application	96
At 160 F, 100 gr/sq in. load, hr, min	
Initial	96
After aging roll 20 days at 135 F prior to application	96

(1) The tape bonded to 60 pound kraft paper (UU-P-268, Grade A) which has been heated 24 hours at 160 F followed by 2 hours at -65 F does not separate after bending 180° on a 1½ inch diameter mandrel at –65 F.
(2) Type 302 stainless steel (ASTM A167, No. 4 finish) substrate.
(3) The tape does not creep or slip under the indicated load for the time specified.

FORM

The tape is available in 120 yard rolls wound on 3 inch diameter cores in 1, 1½, 2 or 3 inch widths. Each roll may contain up to 4 splices. Unless otherwise specified, the color corresponds to unbleached kraft paper.

QPL

No.

PPP-T-97 TAPE; PRESSURE-SENSITIVE ADHESIVE, FILAMENT REINFORCED

Issue: 12 December 1962 Revision: c Amendment: 2

SCOPE

This pressure-sensitive adhesive tape is intended for securing packages and reinforcing bundles and containers.

CLASSIFICATION

The tape is available in four types and two classes.

Type I Low tensile strength
Type II Medium tensile strength
Class A Opaque
Class B Transparent
Type III High tensile strength
Type IV High tensile strength, weather resistant

PROPERTIES

CHEMICAL. The composition of the tape is not given; however, it contains reinforcing filaments.

PHYSICAL. The Type II, Class B tape is sufficiently transparent to allow the reading of 10 point lower case, long primer type. The other physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF PPP-T-97 TAPE

PROPERTY	TYPE I	TYPE II Class A	TYPE II Class B	TYPE III	TYPE IV
Tensile strength, lb/in., at 75 F, min	160	240	300	425	400
Elongation, %, at 75 F					
Min	12	3	3	3	3
Max	20	8	8	8	8
Impact, in.-lb/in., at 75 F, min					
1 impact	60	40	40	80	50
25 impacts	30	20	20	40	30

PPP-T-97 (Continued)

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and is supplied within 6 months of manufacture. Design details using this tape are given in Appendix I of the specification.

PERFORMANCE. The tape, as received or aged 7 days at 150 F and 80% RH, has a peel strength of at least 25 oz/in. of width at 75 F using a stainless steel substrate. The tape does not lose adhesion to 60 pound kraft wrapping paper (UU-P-268, Grade A) when bent 180° over a 11/2 inch diameter mandrel at -65 F after exposure to 160 F for 24 hours followed by -65 F for 2 hours. The tape (Type IV only) adhered to fiberboard (PPP-B-636, Type II, Class I, Grade 2) after 100 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151) does not lift, pull loose, flake, crack, transfer adhesive or become brittle. The tape adhered to AISI 302 or 304 stainless steel (1/2 x 3 inch bond area) can sustain a 10 pound load for 48 hours at room temperature without slipping more than 1/8 inch.

FORM

The tape, unless otherwise specified, is available in 60 yard rolls wound on 3 inch diameter cores in 1/2, 3/4, 1, 11/4, 11/2, 13/4 and 2 inch widths. Each roll may contain up to three 4 inch splices. Type IV is available in black only; Types I, II and III in any color as manufactured except black.

QPL

No.

NOTES

(1) Do not use Type I, II, and III where immersion in water or prolonged exposure to weather is expected. For these applications, use Type IV.

(2) Do not order tape in quantities greater than that which can be used in 6 months.

JAN-G-96 GUM TRAGACANTH (FOR USE IN AMMUNITION)

Issue: 25 October 1944 Revision: None Amendment: None

SCOPE

This gum is intended for manufacturing ammunition primers and as an ingredient in adhesive compositions for bonding paper.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. This gum consists of the exudation from the stems of the Asian and East European species of *Astragalus*, especially *A. gummifer* and is commonly called gum tragacanth.

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

TABLE I. PHYSICAL PROPERTIES OF JAN-G-96 GUM

PROPERTY	VALUE
Color	White to light tan
Form	Leaf or flakelike
Odor	None
Chlorine or chlorides	None
Acidity	
Inorganic	None
Organic, %, max	0.040
Foreign gums	None
Indian gums	None
Ash, %, max	3.5

PROCESS. The gum is dissolved in aqueous solvents, the resulting mucilage applied by brushing, the joint closed and cured at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The gum is available in commercial packages.

QPL

No.

JAN-C-99 CEMENT, PETTMAN

Issue: 30 November 1945 Revision: None Amendment: 1

SCOPE

This cement is intended for the loading and assembly of ammunition where waterproofness is required.

CLASSIFICATION

The cement is available in two types.

Type A Pettman cement
Type B Modified Pettman cement

PROPERTIES

CHEMICAL. The Type A and B cement consists of 18–22 and 17–21% alcohol, 10.5–13.5 and 15–19% pine tar (JJJ-T-121), 16–20 and____% shellac (TT-S-271, Type I, Grade D),____and 28–32% rosin (LLL-R-626, Type I, Grade D),____and 0.5–1.5% commercial ethyl cellulose, and 47–53 and 31–35% iron oxide composed of at least 50% Fe_2O_3 ground sufficiently fine to pass at least 96.5% through a U S Standard No. 325 mesh sieve.

PHYSICAL. The cement has a viscosity at 25 C between 25 and 300 seconds using a 3 19/32 inch head of cement discharging through a 0.15 inch diameter orifice (Fed Test Method Std No. 141, Method 4282).

PROCESS. The Type A cement is activated by mixing the pine tar and alcohol, adding the shellac, left standing 20 hours, the iron oxide added in small quantities with stirring until a uniform consistency is reached, the resulting cement applied by brushing, the joint closed and cured at room temperature under contact pressure. The Type B cement is activated by dissolving the ethyl cellulose in alcohol, the rosin added with stirring followed by the iron oxide added in small quantities, the resulting cement applied by brushing, the joint closed and cured at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The liquid cement, unless otherwise specified, is available in 10 gallon containers.

QPL

No.

MIL-A-101 ADHESIVE, WATER-RESISTANT, FOR SEALING FIBREBOARD BOXES

Issue: 12 March 1952 Revision: A Amendment: None

SCOPE

This adhesive is intended for sealing fiberboard boxes.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, rubber base adhesives may be used.

PHYSICAL. The nontoxic adhesive and its cured film are free from obnoxious or objectionable odors.

PROCESS. The adhesive is applied in accordance with the supplier's instructions, the joint closed within one minute and cured 24 hours at room temperature under 4 psi bonding pressure.

PERFORMANCE. The adhesive has a shear strength of at least 100 psi with not less than 75% fiber failure at 75F, after 24 hours exposure to 140F and to -40F and after 24 hours immersion in 70F distilled water using V1s or V2s and V3s or V4s fiberboard adherends (JAN-P-108).

FORM

The adhesive is available in five gallon containers.

QPL

Yes.

MIL-A-140 ADHESIVE, WATER-RESISTANT, WATERPROOF BARRIER-MATERIAL

Issue: 23 November 1951 Revision: A Amendment: None

SCOPE

This adhesive is intended for the manufacture and closure of waterproof 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, rubber base solvent adhesives may be used for Class 1.

PHYSICAL. The nontoxic adhesive is water resistant such that it prevents passage of water for at least 8 hours and is resistant to fungus (Aspergillus niger USDA TC-215-4247 or ATCC 6275; Aspergillus flavus ATCC 1003 and Penicillium USDA 1336.2). Grades A and B adhesive and Grade B dried film are free from disagreeable odors. Grade A dried film is odorless. The solids content does not vary more than 10% from batch to batch.

PROCESS. The adhesive is applied by machine (Type I) or by brushing (Type II), the joint closed in 30 seconds and cured 24 hours at room temperature under 0.5 psi bonding pressure. The adhesive, Type II, Classes 1 and 2 only, is readily brushable at temperatures between 60 and 100 F and Type II, all classes, in closed containers can be stored as long as two weeks at 120 F and can withstand freezing when cycled three times between O F (16 hours) and 75 F (8 hours) without any deleterious effect.

PERFORMANCE. The adhesive is flexible at OF such that it can be bent 180°, including reverse bending, on a ¾ inch mandrel without separation of the bond using Barrier Material adherends (JAN-P-125, Types H-3 and L-2). With the same adherends it has a shear strength at 75F of at least 10 psi after a four hour water soak and 7.5 psi after 30 days at 120F. No separation or flow of adhesive occurs after 30 days heat aging at 120F. Further, Type II develops sufficient tack such that after 90 seconds bonding time, it can support for 60 seconds a 12 ounce peel load per inch of bond area.

MIL-A-140 (Continued)

FORM

The liquid adhesive is available in 5 and 55 gallon containers. Rubber base solvent adhesive is available only in 5 gallon drums.

QPL

Yes.

NOTE

(1) The supplier certifies the adhesive is nontoxic.

JAN-G-338 GLUE, ANIMAL

Issue: 30 April 1946 Revision: None Amendment: None

SCOPE

This adhesive is intended for the manufacture of primers.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The glue consists of the proteinaceous extract from animal base materials containing no alum, zinc oxide, salts, sugar, glucose, dextrin, clay fillers, sulfides, sulfites, no more than 0.4% grease, and an ash content not greater than 4%.

PHYSICAL. The glue, ground or in the form of chips or flakes not greater than ¼ inch thick, contains between 9 and 15% moisture, a jelly strength between 170 and 194 grams at 10 C (Bloom gelometer) and a pH between 6.5 and 7.5. The glue, as a 10% aqueous solution, does not decompose even after 48 hours at 37-8 C.

PROCESS. The glue is activated by mixing with water, the mixture melted at 62 C, applied hot by brushing, the joint closed and cured (solidified) at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The solid glue is available in containers up to 100 pound capacity.

QPL

No.

NOTES

(1) This specification was cancelled 7 October 1963.

MIL-A-374 ADHESIVE, PASTE, FOR DEMOLITION CHARGES

Issue: 31 January 1953 Revision: A Amendment: None

SCOPE

This adhesive is intended to stick explosive charges to vertical, horizontal, sloping or overhead surfaces at temperatures ranging between 10 F and 125 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The adhesive is a paste which is trowellable between 10 and 125 F.

PROCESS. The adhesive, in a thickness between 1/16 and 1/8 inch, is applied evenly to the largest side of the explosive block, whereupon it is pressed forcibly against the surface, pushing it back and forth to improve the bond. The thickness of explosives is limited to 2 inches against a surface.

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

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-374 ADHESIVE

PROPERTY	VALUE
Shear, gr/sq in. (1)	
At 75F, 30 min., max	225
At 125F	
60 min., min	75
15 min., max	150

(1) The adhesive sustains the shear load for the time indicated without rupture or slippage of the load more than ¼ inch using steel adherends.

FORM

The paste adhesive is available in ½ pound containers.

QPL

No.

MIL-A-388 ADHESIVE AND SEALING COMPOUNDS, CELLULOSE NITRATE BASE

Issue: 9 June 1959 Revision: A Amendment: 1

SCOPE

This adhesive is intended for (1) affixing shipping labels, (2) repairing cloth, wood, paper, china, glass, metal, leather and plastic, (3) anchoring glass, metal and plastic laboratory equipment and (4) manufacturing ammunition.

CLASSIFICATION

The adhesive is available in three types.

Type I Uncolored adhesive
Type II Uncolored sealing compound and adhesive
Type III Uncolored, green and red sealing compound

PROPERTIES

CHEMICAL. The adhesive consists of cellulose nitrate resins and plasticizers dispersed in nontoxic (threshold limits less than 100 parts per million) low boiling solvent mixtures containing no benzene or chlorinated hydrocarbons. Type III contains green or red solvent dyes.

PHYSICAL. The nontoxic adhesive is clear, transparent (Hellige Scale No. 3, maximum), homogeneous and possesses no objectionable odor. Type III colors brass distinctly red or green. The nonvolatile content and viscosity of the adhesive are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-388 ADHESIVE

PROPERTY	TYPE I	TYPE II	TYPE III
Nonvolatiles, %			
After 3 hr at 105 C	19(1)	25(1)	20–26
Viscosity, poises, at 25 C	22–27	69(1)	55–75

(1) Minimum.

PROCESS. The adhesive is applied by brushing, the joint immediately closed and cured at least 15 minutes at room temperature under contact pressure. The adhesive dries tack free in 5 minutes. Thinners can be used to adjust consistency; acetone is suitable for Type III. The adhesive does not gel, separate or change in viscosity during storage. Type III can be refrigerated at -25 C for 16 hours without adverse effect.

MIL-A-388 (Continued)

PERFORMANCE. Type I – The adhesive adheres labels printed with stencil ink (TT-I-599) to soft wood, fiberboard (PPP-B-636) and birch plywood (MIL-P-6070) without blurring or otherwise marring the label text. No loss of adhesion or clarity, softening or tackiness occurs after 24 hours immersion in 75 F water, accelerated weathering (Fed Test Method Std No. 141, Method 6152) or exposure to high temperatures (150 F, 24 hours). It is flexible between room temperature and -25 C in that it does not crack or lose adhesion from 0.014 inch thick steel when bent 180° over a 1/8 inch diameter mandrel. The adhesive sticks tenaciously to brass after baking 24 hours between 100 and 105 C. It has a peel strength at 75F of 3 lb/in. of width using birch plywood (MIL-P-6070) and cotton cloth (MIL-C -5646) as adherends.

Type II – The adhesive does not cause blurring or otherwise mar stencil ink (TT-I-599) printed labels, and it adheres tenaciously to brass after baking 24 hours between 100 and 105C. It has a peel strength both dry and water-wet at 75 F of 8 lb/in. of width using leather (MIL-L-3122) as adherends.

Type III – The sealing compound adheres tenaciously to brass after baking 24 hours between 100 and 105 C and does not corrode copper.

FORM

The liquid adhesive and sealing compounds are available in commercial containers. Type II is also available in 1¾ fluid ounce collapsible lead tubes.

QPL

No.

NOTES

(1) Use Type I (formerly MIL-A-4833) for adhering ahipping labels; Type II (formerly MIL-C-15799) for repairing and anchoring work; and Type III (formerly JAN-C-338) for use as a sealant in the manufacture of ammunition.

MIL-G-413 GLUE, MARINE, AND AVIATION MARINE (WATERPROOF)

Issue: 7 August 1952 Revision: A Amendment: 2

SCOPE

This glue is intended for fastening cotton fabric to wood and paying wood seams.

CLASSIFICATION

The glue is available in two classes.

Class 1 Aviation Marine Glue
Class 2 Marine Glue

PROPERTIES

CHEMICAL. The Class 1 glue consists of pine tar, denatured alcohol, a dryingoil chosen from tung, rosin and linseed, and 50-60% rosin. The Class 2 glue ingredients are not specified except that the siliceous filler content does not exceed 25% and no coal tar derivatives are used.

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

PROCESS. The Class 1 glue is applied by brushing, the joint closed and cured at room temperature under contact pressure. No cure time is specified; however, the glue remains tacky (pressure sensitive) in the joint for at least 3 weeks. The Class 2 glue is melted at 350 F, applied hot (viscosity 8 poises) by pouring into the seams and cured (solidified) at room temperature under contact pressure.

PERFORMANCE. Class 1 glue coated mercerized cotton airplane fabric (MIL-C-5646) prevents migration of water and 3% salt solution under a 14 inch head. This glue, after 3 weeks contact between wood and mercerized cotton, is tacky when the joint is separated. Class 2 glue pays wood seams to a solid mass with a uniform jet black color and glossy finish containing no vapor pockets.

MIL-G-413 (Continued)

TABLE I. PHYSICAL PROPERTIES OF MIL-G-413 GLUE

PROPERTY	CLASS 1	CLASS 2
Consistency	Liquid	Solid
Ash content, %, max	1.5	NR
Boiling Point, °F, max	NR	350
Flexibility, OF, cracking or peeling	NR	None
Flow, at 170 F, 24 hr	NR	None
Odor, objectionable	NR	None
Penetration, cm		
At 77 F (2)	0.2-0.6	NR
At 32 F, 200 gr load, 60 sec, min (3)	NR	0.10
At 68 F, 200 gr load, 60 sec (3)	NR	0.30-0.50
At 115 F, 50 gr load, 5 sec, max (3)	NR	1.15
Plasticity, 360° bend, breaks (4)	None	NR
Specific gravity, at 16 C	1.010-1.040	NR
Viscosity, poises, at 350F, max	NR	8
Volatile Matter, % max		
After 2 hr at 105 C	2.0	NR
After heating at 105 C to constant weight	2.5	NR

(1) Bent 180° over a 3/8 inch diameter mandrel using a thin film of glue on 0.015 inch thick black iron.

(2) New York Penetrometer under 50 gram load applied for 5 seconds to volatile free residue.

(3) SS-R-406, Method 214.

(4) Volatile free residue.

NR = No Requirement

FORM

Unless otherwise specified, the liquid Class 1 glue is available in pint, quart and gallon containers and solid Class 2 glue in 50, 200 and 300 pound containers.

QPL

No.

NOTES

(1) Use Class 1 glue for fastening sheeting to inner and outer wood skins of floats, flying boat hulls and double plank and batten seam construction on wood boats.

(2) Use Class 2 glue for paying wooden deck seams on ships.

MIL-C-897 CEMENT, RUBBER (SYNTHETIC-RUBBER-TO-SYNTHETIC-RUBBER-ADHESION)

Issue: 29 June 1950 Revision: A Amendment: 1

SCOPE

This cement is intended for bonding systhetic rubber except for repairing rubber boats or life saving equipment.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of synthetic or reclaimed rubber in a solution containing no benzol, high freezing point solvents or chlorinated solvents.

PHYSICAL. The viscosity of the cement at 75 F is no more than 2.5 minutes and after 21 days at 160F, no more than 3.75 minutes (Ford cup, ¼-inch orifice).

PROCESS. The cement is applied by brushing on 2 coats, air dried 15 minutes and 1 hour, respectively, after each coat, the joint closed and cured 24 hours at 75 F under 10 psi bonding pressure. The cement can be stored 21 days at 160 F in unopened containers.

PERFORMANCE. The cement has a tensile strength of at least 70 psi at 75 F and the cement either aged (21 days at 160 F) or unaged, has a peel strength of at least 5 lb/in. of width at 75 F using SBR, nitrile and neoprene rubber adherends (HH-G-156).

FORM

The liquid adhesive is available in 33-43 milliliter aluminum tubes, pint, quart and gallon containers.

QPL

No.

NOTES

(1) This specification was canceled 31 December 1963.

MIL-A-927 ADHESIVE: SYNTHETIC RESIN (FOR PHENOLIC LAMINATES)

Issue: 16 September 1952 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding cotton fabric reinforced phenolic laminates.

CLASSIFICATION

The adhesive is available in three types.

Type I Room temperature setting
Type II Intermediate temperature setting
Type III High temperature setting

PROPERTIES

CHEMICAL. The composition of the adhesive is given in Table I. Unspecified accelerators may be either incorporated in the adhesive or supplied separately.

TABLE I. CHEMICAL COMPOSITION OF MIL-A-927 ADHESIVE

TYPE	BASE RESIN
I	Resorcinol or Furane
II	Phenolic, Resorcinol, Melamine or Furane
III	Phenolic, Resorcinol or Melamine

(1) Other resins may be used, if previously approved.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive, if two part, is first activated by mixing base resin with accelerator, the one or premixed two part adhesive applied by brushing or spraying, the joint closed and cured in accordance with the conditions given in Table II. Solvents capable of dissolving the adhesive during its working life are specified by the supplier.

TABLE II. PROCESS PROPERTIES OF MIL-A-927 ADHESIVE

PROPERTY	TYPE		
	I	II	III
Working life, hr, min	2	3	6
Cure			
Temperature, °F	75–90	90–180	180–350
Time, hr, max	8	5	0.5
Pressure, psi, max	200	200	200
Storage, life, months, min	12	6	3

MIL-A-927 (Continued)

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

TABLE III. PERFORMANCE PROPERTIES OF MIL-A-927 ADHESIVE

PROPERTY	TYPE I	TYPE II	TYPE III
Shear, psi, at 75 F, min (1)			
Initial	1000	1800	1800
Wet (2)	1000	1800	1800

(1) Using cotton fabric reinforced phenolic laminate adherends (MIL-P-15035, Type FBM.
(2) After 24 hours immersion in 180 F water, followed by drying 24 hours at 180 F and then 24 additional hours immersion in 180 F water.

FORM

The liquid adhesive is available in 6 to 55 gallon containers. Powdered or jelly type materials are available in 5 gallon pails and 6 to 55 gallon containers. Separate accelerators are packaged in quantities stoichiometrically equivalent to the quantity of adhesive supplied.

QPL

Yes.

NOTES

(1) Type I adhesive is intended for field repair where heat is not available.

(2) Type II and III adhesives are intended for assembly and repair applications where heat is available.

MIL-A-928 ADHESIVE; METAL TO WOOD, STRUCTURAL

Issue: 31 March 1955 Revision: A Amendment: 1

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 three conditions.

Type I Single adhesive system

Type II Two adhesive system

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

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

Condition C Primary adhesive with a high temperature (180-325 F) setting secondary adhesive.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. Unspecified accelerators, hardeners, modifiers and solvents may be used.

PHYSICAL. The adhesive may be liquid, powder, stick or film. The pH of the cured secondary adhesive 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 6 and 7.5 gr/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.

MIL-A-928 (Continued)

TABLE I. PROCESS PROPERTIES OF MIL-A-928 ADHESIVE

PROPERTY	TYPE I	TYPE II					
		CONDITION A		CONDITION B		CONDITION C	
		PRIMARY	SECONDARY	PRIMARY	SECONDARY	PRIMARY	SECONDARY
Cure							
Temperature, °F, max	335(1)	335(1)	75–90	335(1)	90–180	335(1)	180–325
Time, hr, max	1/3(1)	1/3(1)	8	1/3(1)	5	1/3(1)	1/2
Pressure, psi, max	50	50	50	50	50	50	50
Storage, months,							
At 25 C	3	3	12	3	6	3	6
At 5–10 C	6	6	NR	6	NR	6	NR

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

NR = No Requirement

MIL-A-928 (Continued)

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

TABLE II. PERFORMANCE PROPERTIES OF MIL-A-928 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.

FORM

The liquid adhesives and accelerators are available in metal cans or in 6 to 55 gallon drums. Powdered or jelly-type materials are available in cans, 5 gallon pails or in 55 gallon drums.

QPL

Yes.

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 and C adhesives should be used where the fabrication of large items necessitates a curing time in excess of the Condition A adhesive.

(4) This specification is similar to MMM-A-00138 (Navy-Weps) "Adhesive, Metal to Wood, Structural."

MIL-A-1154 ADHESIVE, BONDING, VULCANIZED SYNTHETIC RUBBER TO STEEL

Issue: 4 April 1963 Revision: C Amendment: 1

SCOPE

This adhesive is intended for bonding vulcanized neoprene, SBR and nitrile synthetic rubber to steel.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The viscosity of the cement at 75 F is not greater than 150 seconds using a funnel 2 1/2 inches high containing a 1/4 inch orifice.

PROCESS. The adhesive is applied by brushing, air dried one hour, the joint closed and cured 120 hours at room temperature under 2.5 psi bonding pressure during the first 48 hours and under contact pressure the remainder of the time. The adhesive can be stored one year at 75 F in unopened containers.

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

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-1154 ADHESIVE

PROPERTY	VALUE
Peel, lb/in., min (1)	
At RT	
1 hr cure (2)	1.5
120 hr cure	
Initial	5 (4)
After 48 hr in 5% salt solution (3)	4
At 140 F, 20 min.	1 (5)

(1) Using steel and separately neoprene, SBR and nitrile adherends (see Note 1).
(2) On both unaged and aged adhesive (2 weeks at 120 F in unopened container).
(3) Salt water immersion begins 48 hours after initiation of cure.
(4) For nitrile, the value is at least 4 lb/in. of width.
(5) Specimen does not strip more than 3 inches in 3 minutes.

FORM

The adhesive, unless otherwise specified, is available in 1/2 and 1 pint containers.

QPL

Yes.

MIL-C-1219 CEMENT, IRON AND STEEL

Issue: 14 September 1954 Revision: A Amendment: None

SCOPE

This cement is intended for repairing minor defects in iron and steel castings.

CLASSIFICATION

The cement is available in two classes.

Class A Dry
Class B Hydraulic

PROPERTIES

CHEMICAL. The cement consists of at least 77% metallic iron and an unspecified binder.

PHYSICAL. No physical properties are given.

PROCESS. The cement is activated with water, applied by troweling and cured 24 hours at room temperature under contact pressure. Class A cement is applied only to thoroughly dry castings; Class B can be applied to wet castings.

PERFORMANCE. The cement does not separate from iron or steel castings or disintegrate when cooled rapidly from 1500 F to 60 F by dropping into cold water. A force of at least 200 pounds applied with a 1/8 inch diameter punch is necessary to perforate the cement or separate it from the castings. The cured cement can be filed without breaking.

FORM

The powdered cement, unless otherwise specified, is available in 1, 2, 5, or 10 pound containers.

QPL

No.

NOTES

(1) Use Class B cement for castings which are used under fresh and salt water.

(2) The cement is not to be used to repair or conceal structural defects in castings.

(3) The cement should not be used on interior surfaces of components for pneumatic or hydraulic systems.

(4) Federal Specification QQ-C-100 includes the requirements of this specification (see abstract).

MIL-C-2399 CEMENT, LIQUID, TENT PATCHING

Issue: 28 January 1960 Revision: A Amendment: None

SCOPE

This cement is intended for patching tents.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of a 30% solution of nitrile rubber in an unspecified solvent.

PHYSICAL. The cement is a liquid.

PROCESS. The cement is applied by brushing on two coats, the first to give a wet film thickness of 0.010 inch and the second 0.020 inch, air dried 15 minutes after each coat, the joint closed and cured 72 hours at room temperature under contact pressure. The cement remains brushable as low as 10 F and can be stored 14 days at 160 F in unopened containers.

PERFORMANCE. The adhesive has a shear strength of at least 100 psi at RT, a peel strength of at least 5 lb/in. of width at RT using a 3 hr cure and after 72 hr cure 14 lb/in. at RT, 12 lb/in. at RT after soaking 48 hr in water and 18 lb/in. at RT after 100 hr at 160 F using cotton duck adherends (MIL-D-10860). The adhesive has sufficient flexibility so that no creases or cracks are sustained when bent 180° at RT even after subjecting to 100 hr at 160 F.

FORM

The liquid adhesive is available in pint and gallon containers.

QPL

No.

NOTES

(1) This specification is governed by Military Standard MS 35499 (CE), "Adhesive, Liquid, Tent Patching; Colors, Container Sizes and Use Characteristics Thereof."

MIL-T-2463 TAPE, CENSORSHIP, MILITARY CENSOR – CIVIL MAILS

Issue: 26 September 1950 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing mail opened by military censors.

CLASSIFICATION

One type only.

PROPERTIES

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

PHYSICAL. The tape, containing the imprinted 18 point Franklin Gothic condensed legend "OPENED BY MIL. CEN.–CIVIL MAILS" repeated every ½ inch, is 0.0029 inch thick, has a tensile strength of at least 20.6 lb/in. of width, an opacity of 10% (UU-P-31) and the backing only is insoluble in methyl ethyl ketone or ethylene chloride.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape bonds firmly to writing paper (UU-P-601) such that failure occurs in the fibers of the paper upon peeling the tape even after 30 hours exposure to 150 F and 85% RH. The adhesion of the tape to its backing is between 8 and 20 oz/in. of width. The legibility of the tape legend is not impaired after 30 hours exposure to 150 F and 85% RH.

FORM

The tape, unless otherwise specified, is available in 216 foot rolls wound on 3 inch diameter cores in 1 inch widths. Each roll may contain up to one splice.

QPL

No.

MIL-C-2861 CEMENT, INSULATION, HIGH TEMPERATURE

Issue: 17 September 1963   Revision: C   Amendment: None

SCOPE

This cement is intended for temperature control on irregular surfaces of equipment and piping operating between 100 and 1800 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of a dry mixture of refractory material composed of rock or mineral wool, asbestos fibers and a clay binder; the mixture contains no more than 0.5% sulfur.

PHYSICAL. The cement after molding and drying has a maximum density of 30 lb/cu ft and a thermal conductivity (Btu/in./hr/sq ft/°F) of 0.70, 0.85 and 0.95 at mean temperature differences of 200, 500 and 700F, respectively (ASTM C177).

PROCESS. The cement is activated by mixing with water, applied by trowelling or hand application and cured at room temperature under contact pressure (no time is specified). A wet coverage of at least 50 board feet (sq ft/inch thickness) per 100 pounds of dry material is obtained (ASTM C166).

PERFORMANCE. The cement has a flatwise tensile strength of at least 3.0 psi at 75 F using steel adherends (ASTM C 353), an abrasion resistance of no more than 40% weight loss after 10 min. and 60% after 20 min. (ASTM C 421), a compressive strength of at least 10 psi at 75 F (ASTM C 354), a linear shrinkage not greater than 1.0% after 6 hr at 750 F, 2.0% after 6 hr at 1200 F and 3.0% after 6 hr at 1500 F (ASTM C 356) , a volumetric shrinkage from wet to dry state of no more than 20% (ASTM C 166) and does not corrode quarter hard (Temper No. 3) cold roll steel when in contact for 30 days at RT.

FORM

The cement is available in 50 pound shipping bags.

QPL

Yes.

MIL-C-2908 CEMENTS, FINISHING, INSULATION

Issue: 29 March 1960 Revision: A Amendment: None

SCOPE

This cement is intended as a finish coat on thermal insulation and as a combination insulation and finishing coat on small pipe fittings.

CLASSIFICATION

The cement is available in two types.

Type I Asbestos
Type II Hydraulic setting mineral wool

PROPERTIES

CHEMICAL. The Type I cement consists of a dry mixture of asbestos fibers, unspecified fillers and binders. The Type II cement consists of nodulated rock or mineral wool fibers and an unspecified hydraulic binder.

PHYSICAL. The asbestos fibers in the Type I cement are small enough to pass between 60 and 85% through a Standard No. 100 mesh sieve. The other physical properties of the cement are tabulated in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-C-2908 CEMENT

PROPERTY	TYPE I	TYPE II
Density, molded, lb/cu ft	NR	40.0
Hardness, molded, mm penetration, max (1)	0.40	NR
Thermal conductivity (Btu/hr/sq ft/°F/in.) (2)		
At mean temperature		
200F	NR	0.90
600F	NR	1.10

(1) A 1,000 gram load on a 1/8 inch diameter ball point is used.
(2) ASTM C177.
NR = No Requirement

MIL-C-2908 (Continued)

PROCESS. The cement is activated by mixing with water, applied by trowelling or hand application and cured 24 hours at room temperature under contact pressure. A wet coverage of at least 30 board feet (sq ft/inch thickness) per 100 pounds of dry material is obtained. Type I uses 26.5 mm consistency cement (Fed Test Method Std No. 791, Method 311).

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

TABLE II. PERFORMANCE PROPERTIES OF MIL-C-2908 CEMENT

PROPERTY	TYPE I	TYPE II
Abrasion resistance, weight loss, %, max(1)	NR	20.0
After 10 minutes	NR	20.0
After 20 minutes	NR	40.0
Compression, psi, at 75 F, min (2)	NR	100
Resistance to heat, 6 hr, °F	300	1200
Hardness penetration, mm, max (3)	0.40	NR
Weight loss, %, max	NR	0.10
Linear shrinkage, %, max	NR	2.0
Shrinkage, vol %, max, wet to dry	10	NR
Corrosion (4)	NR	None

(1) Against oak wood, specific gravity 0.65.
(2) ASTM C354, at 5% deformation.
(3) A 1,000 gram load on a 1/8 inch diameter ball point is used.
(4) Cold roll steel, 0.020 inch thick, quarter hard, temper No. 3, weighing 0.85 lb/sq ft is placed in contact with molded cement for 30 days at RT.
NR = No Requirement

FORM

The powdered cement is available in 50 pound paper cartons.

QPL

No.

NOTES

(1) This specification is similiar to ASTM C449, "Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement."

MIL-A-3029 ASPHALT, WATERPROOFING (FOR USE IN MANUFACTURE OF FIBER AMMUNITION CONTAINERS)

Issue: 17 April 1950 Revision: None Amendment: 1

SCOPE

This asphalt is intended for waterproofing fiber containers used in the packing of ammunition.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The compound consists of asphalt prepared from asphaltic petroleum.

PHYSICAL. The asphalt is black and glossy, has a softening point between 80 and 85 C (ball and ring method). a consistency equivalent to a penetration of not less than 25 mm (SS-R-406, Method 214.0), a flash point of not less than 232 C, no more than 0.5% mineral matter, and no more than 1% carbon disulfide, 2% carbon tetrachloride and 2% benzene insoluble matter.

PROCESS. The asphalt is melted at a temperature not exceeding 200 C, applied by brushing and allowed to resolidify at room temperature under contact pressure.

PERFORMANCE. The asphalt after aging 1 week does not show any separation of oil, grease, paraffin scale or similar material.

FORM

The solid asphalt is available in commercial packages.

QPL

No.

MIL-A-3167 ADHESIVES (FOR PLASTIC INHIBITORS)

Issue: 21 August 1951 Revision: None Amendment: 1

SCOPE

This adhesive is intended for bonding web and end ethyl cellulose or cellulose acetate plastic inhibitors to cruciform shape double-base powder grains.

CLASSIFICATION

The adhesive is available in three types and four classes.

- Type I Cellulose nitrate base adhesive
  - Class 1
  - Class 2
- Type II Cellulose acetate base adhesive
  - Class 1
  - Class 2
  - Class 3
  - Class 4
- Type III Solvent base adhesive
  - Class 1

PROPERTIES

CHEMICAL. The composition of the adhesive is given in Table I.

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

PROCESS. The adhesive is applied by brushing, the joint closed and cured 24 hours at room temperature under contact pressure. Type I, Class 2 adhesive may be diluted up to 30% by weight with butyl acetate. Type II, Class 1 may be diluted up to 20% by weight with acetone (O-A-51). No other classes may be diluted.

PERFORMANCE. The adhesive, Types I and III, adheres web and end molded ethyl cellulose inhibitors (MIL-I-3166) to cruciform grains of double-base powder without bubble formation or unbonded edges after heating 72 hours at 130 F. Types II and III perform similarly with cellulose acetate inhibitors (MIL-I-3166). Forcible separation of the web results in the powder grain pulling off with the web.

FORM

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

QPL

No.

NOTES

(1) Use Type I or III for adhering ethyl cellulose inhibitors.
(2) Use Type II or III for adhering cellulose acetate inhibitors.

MIL-A-3167 (Continued)

TABLE I. CHEMICAL COMPOSITION OF MIL-A-3167 ADHESIVE

INGREDIENTS	PERCENT BY WEIGHT						
	TYPE I		TYPE II				TYPE III
	CLASS 1	CLASS 2	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 1
Cellulose Nitrate (1)	2.5	3.3	–	–	–	–	–
Ethyl Lactate (1)	35.0	45.0	–	59.0	–	–	60.0
Butyl Acetate (AN-O-B-841)	62.35	51.0	–	39.0	–	–	40.0
Ethyl Glycollate (1)	0.15	0.2	–	–	–	–	–
Cellulose Acetate (1)	–	–	5.0	2.0	–	–	–
Diacetone Alcohol (O-A-393)	–	–	95.0	–	–	–	–
Acetone (O-A-51)	–	–	–	–	100	–	–
Ethylene glycol monomethyl ether (1)	–	–	–	–	–	60	–
Ethylene glycol monoethyl ether (1)	–	–	–	–	–	40	–

(1) These individual chemicals have specific requirements for purity such as color, water concentration, distillation range, etc. They are not reproduced here (see specification for details).

MIL-A-3167 (Continued)

TABLE II. PHYSICAL PROPERTIES OF MIL-A-3167 ADHESIVE

PROPERTY	TYPE I		TYPE II				TYPE III
	CLASS 1	CLASS 2	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 1
Viscosity, centipoise, at 25 C	220–300	700–1000	400–500	0.9–1.1	NR	NR	0.8–0.9
Specific Gravity, 25/25 C	0.920–0.940	0.945–0.960	0.945–0.955	0.955–0.975	NR	0.947–0.953	0.955–0.975
Nonvolatiles, % After 3 hr at 105 C	2.55–2.75	3.40–3.60	4.90–5.10	1.90–2.10	NR	None	None

(1) The viscosity and specific gravity of Type II, Class III are those of acetone (O-A-51).

NR = No Requirement

MIL-C-3316 ADHESIVES, FIRE-RESISTANT, THERMAL INSULATION

Issue: 19 November 1960 Revision: A Amendment: None

SCOPE

This adhesive is intended for the installation and repair of fibrous glass insulation board on piping, machinery and other metal surfaces.

CLASSIFICATION

The adhesive is available in three types.

Type I For repairing damaged surfaces of faced fibrous glass insulation board and for securing cotton brattice cloth to unfaced fibrous glass insulation board.

Type II For securing glass tape to fibrous glass insulation board joints and securing lagging cloth to thermal insulation on piping and machinery.

Type III For securing bonded fibrous glass insulation to metal surfaces.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The adhesive is nontoxic, nonirritating, fire resistant and flexible in that it does not scale, chip or leave the surface when a 0.002 inch thick film on 0.011 inch thick bright tinplate (baked 75 minutes at 212-221 F after air drying 24 hours) is bent 180° on a ¼ inch diameter mandrel. The other physical properties are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-C-3316 ADHESIVE

PROPERTY	TYPE I	TYPE II	TYPE III
Flash point, °F, min (1)	110	100	80
Viscosity, at 77 F, Krebs (2)	NR	100–110	100–130
Color	White	NR	NR

(1) Fed Test Method Std No. 791, Method 1103.

(2) Fed Test Method Std No. 141, Method 4281.

NR = No Requirement

PROCESS. The adhesive is applied by brushing, air dried 10 minutes at room temperature, the joint closed, an additional coat of adhesive applied for Type II joints only and the assembly cured 48 hours (Type I) and 24 hours (Types II and III) at room temperature under contact pressure. Type I gives a coverage not less than 30 square feet per gallon which air dries to the touch in 4 hours and hard within 48 hours, leaving a finished weight of

MIL-C-3316 (Continued)

5.35 oz/sq ft. The Type I adhesive has sufficient strength to bond vertically or in the overhead position, cotton brattice cloth (MIL-C-788) to fibrous glass insulation board (MIL-I-742) without the need for shoring, pinning or other mechanical devices. The adhesive, all types, is capable of being stored 6 months at room temperature in airtight containers and at temperatures down to 16 F for 16 hours.

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

TABLE II. PERFORMANCE PROPERTIES OF MIL-C-3316 ADHESIVE

PROPERTY	TYPE I	TYPE II	TYPE III
Peel, gr, at 75 F, min			
Initial	1360(1)	2000(2)	2000(2)
After 24 hours at 194 F	NR	2000(2)	2000(2)
Washability (3)	Yes	NR	NR
Paintable (4)	Yes	Yes	NR
Corrosion (5)	NR	NR	None
Puncture resistance in.-oz/in. of tear	800	NR	NR

(1) Fibrous glass insulation board and cotton brattice cloth (MIL-C-788) adherends.
(2) Type II joints do not peel during 10 minutes under indicated load using 2 inch wide glass cloth tape (MIL-C-20079) bonded to the glass cloth face of fibrous glass boards (MIL-I-742). Type III joints sustain identical loading conditions using 1 inch thick, 3 inch wide fibrous glass insulation (MIL-I-22023) and steel adherends.
(3) Washing with a stiff hog bristle brush with cake grit soap and water causes no breakthrough or detachment of adhesive.
(4) No bleeding or discoloration of chlorinated alkyd resin base fire-resistant paint (MIL-P-17970).
(5) The adhesive, after air drying 24 hours, protects steel against corrosion during 72 hours exposure to 4% salt spray.
NR = No Requirement

FORM

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

QPL

Yes.

MIL-B-3469 BALSAM, CANADA

Issue: 5 July 1961 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding optical elements of fire control instruments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of oleoresin exuded from the balsam fir *Abies Balsamea* and contains no Oregon balsam, turpentine, colophony, spruce pitch or similar substances.

PHYSICAL. The adhesive as a 70% solution in xylene has a color of 1½ (ASTM D155) and a viscosity at 100 F between 60 and 100 centipoises. The solid adhesive as supplied has an acid number no greater than 88 and the dry resin balsam base 130.

PROCESS. The solid adhesive is dissolved in a solvent such as xylene, applied by brushing or spraying, allow to air dry a few minutes, the joint closed and cured generally for 24 hours at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The adhesive is available in stick form packaged 6 sticks, 3 inches long by ½ inch diameter, per carton.

QPL

No.

NOTES

(1) This specification is governed by Military Standard MS 35619 (CE), "Canada Balsam, Sealing Compound for Optical Elements; Colors, Container Sizes, and Use Characteristics Thereof".

MIL-P-3542 PRIMER, PRESSURE-SENSITIVE TAPE

Issue: 24 April 1958 Revision: A Amendment: None

SCOPE

This primer is intended for use on painted surfaces to increase the adhesion of pressure-sensitive adhesive tapes.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the primer is not given.

PHYSICAL. No physical properties are given.

PROCESS. The primer is applied by brushing (Fed Test Method Std No. 141, Method 205.1) and the pressure-sensitive adhesive tape installed within 3 to 15 minutes. The primer can be stored for 7 days at 140 F without incurring more than a 30% change in viscosity (Ford Cup No. 4).

PERFORMANCE. The primer is flexible at 20 F (30 minute soak) such that three hours after air drying on 0.040 inch thick aluminum, it can be bent 180° over a 3/8 inch mandrel without cracking or chipping (primer side out). The primer over painted steel (MIL-T-704, Type A) can support a 1.5 psi shear load for 24 hours without failure. The peel strength of the primer on painted steel and aluminum (MIL-T-704, Type A) using pressure-sensitive adhesive tape (PPP-T-60, Type II, Class 1) is 40 oz/in. of width at (1) 75 F, (2) 75 F after 72 hours at 140 F (min ind value can be as low as 25 oz/in.) and (3) 75 F after 14 hours immersion in 75 F water (min ind value can be as low as 36 oz/in.).

FORM

The liquid primer is available in quart containers.

QPL

No.

MIL-I-3825 INSULATION TAPE, ELECTRICAL, SELF-FUSING; FOR USE IN ELECTRONIC, COMMUNICATIONS, AND ALLIED EQUIPMENT

Issue: 27 March 1962 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced wire and cable 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)	2.8
Dissipation factor, at 23 C (3)	0.002

(1) ASTM D 1000.
(2) Fed Test Method Std No. 406, Method 4041.
(3) Fed Test Method Std No. 406, Method 4021.

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.

PERFORMANCE. The tape, spirally wound, after being stretched 150-300% on AWG size 8 wire and conditioned 24 hours between 20 and 30 C, does not delaminate, crack or split (1) under

MIL-I-3825 (Continued)

(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 5½ inch maximum diameter cores in ½, ¾, 1, 1¼, 1½, 2, 2½ and 3 inch widths and in black, white or unpigmented colors.

QPL

Yes.

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-003920 (Ord) ADHESIVE, OPTICAL, THERMOSETTING

Issue: 11 July 1958 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding of glass lenses for use in optical instruments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of styrene monomer and an unsaturated polyester derived from 1,2 propanediol and bicyclo (2,2,1) -5-heptene 2,3 dicarboxylic anhydride containing hydroquinone as a stabilizer .Tertiary butyl perbenzoate packaged separately is used as the catalyst.

PHYSICAL. The physical properties of the adhesive, activator and cured adhesive are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-A-003920 ADHESIVE

PROPERTY	COMPONENT		
	ADHESIVE	ACTIVATOR	CURED CEMENT
Refractive index, at 25 C	1.5290-1.5310	1.489(1)	1.548-1.558
Density, at 25 C, gm/ml	1.085-1.090	1.04(1)	NR
Active oxygen, %	NR	7.8(1)	NR
Viscosity, at 25 C, poises	170-300	NR	NR
Color, platinum-cobalt, max	300	NR	NR
Lint and dust particles, max			
Less than 0.1 mm length	7	3	NR
Less than 1.0 mm length	3	1	NR
Less than 5.0 mm length	1	NR	NR

(1) Minimum.

NR = No Requirement

MIL-A-003920 (Continued)

PROCESS. The adhesive is activated by mixing together 113.5±3 grams of base resin with 1.50±0.01 milliliters of catalyst, applied by brushing, the joint closed and cured 16 hours at 212 F under contact pressure. Addition of cobalt naphthenate will permit lower temperature curing. The activated adhesive is stable 50 days at 20-5 C in the absence of light. The base resin prior to use should be stored between 40 and 75 F.

PERFORMANCE. The adhesive does not separate, feather or show other forms of disintegration such as voids when bonded glass joints are (in the following order and repeated three times) immersed in 100 F water for 22 hours, followed by freezing at -65 F for 22 hours, then heated at 160 F and 100% RH for 22 hours, and finally subjected to accelerated weathering without water spray for 22 hours (Fed Test Method Std No. 601, Method 7311). Additionally, the glass joints are capable of withstanding -80 F for 5 hours under no load.

FORM

The liquid adhesive, unless otherwise specified, is available in 4 ounce amber bottles and the liquid activator in 1/8 ounce amber bottles.

QPL

Yes.

MIL-A-3932 ADHESIVE, STENCIL

Issue: 20 October 1954 Revision: None Amendment: None

SCOPE

This adhesive is intended for cementing stencils in the application of insignia and design.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, it is not a water base cement or dispersion.

PHYSICAL. The adhesive has a viscosity between 15 and 20 seconds when 125 ml of adhesive discharges at 25 C from a 3 7/8 inch high funnel containing a ¾ inch orifice.

PROCESS. The adhesive is applied by brushing or spraying in thicknesses up to 0.003 inch, air dried 15 minutes at 25-30 C, the joint closed and pressure applied with 4 passes of a 1000 gram roller, 2-2½ inches in height.

PERFORMANCE. The adhesive bonds kraft masking paper such that sharp, clean patterns are obtained with stencil paint (TT-P-98, Type I). No more than 4 inches of kraft paper (UU-P-268, Grade B-2), two inches wide, is peeled from enamel coated (TT-E-485, Type IV) low carbon steel panels in 1 minute using an 80 gram load and not less than 4 inches, using a 1000 gram load. The adhesive does not adhere to more than 1% of the enamel coated steel when the paper is removed.

FORM

The liquid adhesive, unless otherwise specified, is available in 5 gallon containers.

QPL

No.

MIL-G-3937 GLUE, VEGETABLE

Issue: 8 December 1954 Revision: None Amendment: None

SCOPE

This glue is intended for use in the manufacture of ammunition.

CLASSIFICATION

One class only.

PROPERTIES

CHEMICAL. The composition of the glue is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-G-3937 GLUE

INGREDIENT	WEIGHT, %
Water	55 – 75
Mineral matter, max	5
Starch	4 – 10
Dextrin and dextrose	13 – 33

PHYSICAL. The opaque glue has a viscosity at 25 C between 450 and 650 centipoises.

PROCESS. The glue is applied by brushing, the joint closed, 6.6 psi applied for 2 minutes and then the assembly cured 2 hours at room temperature under contact pressure.

PERFORMANCE. The glue has a shear strength of 36 psi at room temperature using brass and silk (MIL-C-3761, Class B) adherends and does not corrode copper, brass or tin-plated metal.

FORM

The liquid adhesive is available in 1, 5, 25 and 100 pound containers.

QPL

No.

MIL-A-3941 ADHESIVE, PAPER LABEL, WATER-RESISTANT

Issue: 19 March 1959 Revision: A Amendment: None

SCOPE

This adhesive is intended for adhering paper labels to soft wood, fiberboard, black and galvanized iron, glass, tin, enamel painted metal and rubber surfaces.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The liquid adhesive is nontoxic, and in bulk is light colored, transparent to translucent. The viscosity at 75 F is at least 12.6 seconds (Gardner-Holt) or 9.2 stokes. The dried film is free from obnoxious or objectionable odor and is substantially colorless and transparent. The film is fire resistant (self extinguishing) and fungus resistant (CCC-T-191).

PROCESS. The adhesive is applied by brushing, the joint closed, an additional coat of adhesive applied over the label and cured 24 hours at room temperature under contact pressure. The adhesive dries tack free without blushing in no more than 5 minutes and hard in no more than 16 hours, and can be stored 6 months at room temperature in unopened containers.

PERFORMANCE. The adhesive film does not whiten, dull or show other visible defects after 18 hours immersion in water nor does it change transparency after heating at 212 F for 24 hours or after 60 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151). The adhesive does not cause bleeding, smearing or running of stencil ink (TT-I-559), colored borders of labels or discoloration of paper stock. The adhesive film is flexible and can be bent 180° on a ¼ inch mandrel. The adhesive shows no loss of adhesion, tackiness, nor does the label strip, blister, buckle, curl or crack when bonded to soft wood (PPP-B-595, Type I), fiberboard (PPP-B-636, Type II, Class 2, V3s), black iron, galvanized iron, glass, tin, enamel (TT-E-485, Types I, II, III) painted metal and compounded GRS-1500 rubber after being subjected separately to (1) 24 hours at 140 F, (2) 24 hours at -25 F, (3) 24 hours immersion in ASTM No. 2 oil, (4) 18 hours immersion in water, (5) 60 hours accelerated weathering (Fed Test Method Std 141, Method 6151) and (6) being coated 3 times with 4% sodium chloride.

MIL-A-3941 (Continued)

FORM

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

QPL

No.

MIL-C-4003 (USAF) CEMENT; GENERAL PURPOSE, SYNTHETIC BASE

Issue: 19 March 1954 Revision: None Amendment: 1

SCOPE

This cement is intended for general purpose bonding applications subjected to air, water and oil environments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the cement is not given.

PHYSICAL. No physical properties are given.

PROCESS. The cement is applied by brushing, air dried between 40 and 60 minutes, the joint closed and cured 96 hours at room temperature under contact pressure. It can be stored 4 weeks at 120 F in the original closed container without gelling or otherwise deteriorating.

PERFORMANCE. The cement after 1 hr and 96 hr cures has a peel strength of at least 3 and 15 lb/in. of width using cotton duck (CCC-C-419) to 2024 Alclad aluminum (QQ-A-00250/5A); ____ and 8 lb/in. using neoprene to aluminum; and ____ and 6 lb/in. using vinyl chloride to aluminum. The adhesive aged 4 weeks at 120 F gives 12.75 lb/in. of width, instead of 15 lb/in.

FORM

The liquid cement is available in pint, quart and gallon containers.

QPL

Yes.

NOTES

(1) Do not use this cement for life rafts, de-icers or other applications where highest obtainable adhesion is necessary.

(2) This specification was cancelled 30 December 1963; use MIL-A-5092 (see abstract).

MIL-T-4053 TAPE; PRESSURE-SENSITIVE, ADHESIVE (CORROSION RESISTANT)

Issue: 20 August 1962 Revision: B Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for binding joints of low pressure, hot air ducts where the temperature does not exceed 350F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a plain weave glass cloth backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape is between 0.0045 and 0.0085 inches thick and has a tensile strength of at least 120 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape has a peel strength of at least 15 oz/in. of width at 75 F and at 75 F after 2 hours at 350 F using a 18-8 steel (MIL-T-8504) substrate (UU-P-31, Method 100). The tape does not corrode copper (WW-T-799, Condition N), 2024 aluminum (QQ-A-267 or QQ-A-268, Condition T), and 18-8 steel (MIL-T-8504) during 144 hours exposure to 325 F steam.

FORM

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

QPL

No.

MIL-T-4239 TAPE, PRESSURE-SENSITIVE ADHESIVE, VINYL-PLASTIC, OPAQUE, PHOTOGRAPHIC

Issue: 30 October 1951 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing photographic film cans and magazines.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a modified vinyl acetate-chloride film coated on one side with an unspecified adhesive. Natural or synthetic, but not reclaimed, rubber base adhesives free of sulfur may be used.

PHYSICAL. The black tape has a thickness between 0.004 and 0.006 inch, a tensile strength and elongation of at least 15 lb/in. and 100%, a moisture vapor transmission rate after 48 hr at 100 F and 88-92% RH not greater than 3 gr/100 sq in./24 hr and an opacity density of at least 3.0 (ANSCO-Sweet Densitometer).

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored 6 months. The tape is delivered within 90 days of manufacture.

PERFORMANCE. The tape when stretched 25% and adhered to glass does not creep more than 0.25 inch after 24 hours at 75 F. It has a peel strength of at least 15 oz/in. of width initially and 30 oz/in. after 96 hours exposure to ultraviolet light (Corex D filter) using commercial ground stainless steel (QQ-S-766) adherends (UU-P-31, Method 100). After indirect contact with undeveloped film for seven days at 120 F, it does not cause an increase in fog density greater than 0.02 (ANSCO-Sweet Densitometer). Further, it does not corrode copper during 96 hours exposure to 70 C saturated salt solution.

FORM

The tape is available in 36 yard rolls wound on 1 inch diameter cores and, unless otherwise specified, in ½, ¾, 1½, and 2 inch widths.

QPL

No.

MIL-T-4403 TAPE, PRESSURE-SENSITIVE ADHESIVE, CLOTH, AERIAL FILM SPLICING

Issue: 2 January 1953 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for splicing photographic aerial film and paper during processing.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a one-up and one-down plain weave, continuous filament, acetate-type rayon yarn backing containing on one side a hard, black pigmented surface of cellulose nitrate and on the other side a black pigmented, unspecified adhesive. Natural or synthetic, but not reclaimed, rubber base adhesive free from sulfur may be used.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-T-4403 TAPE

INGREDIENT	PROPERTY	VALUE MINIMUM	VALUE MAXIMUM
Rayon	Thread count per inch		
Base Cloth	Warp	100	NR
	Fill	100	NR
	Weight, oz/sq yd	NR	0.89
	Tensile strength, lb/in., at 75 F		
	Warp	45	NR
	Fill	45	NR
	Tear strength, lb, at 75 F		
	Warp	2.5	NR
	Fill	2.0	NR
Adhesive	Thickness, in.	0.004	0.006
Coated	Tensile strength, warp, lb/in.,		
Tape	at 75 F	100	NR
	Optical density (ANSCO-Sweet densitometer)	5.0	NR
	Moisture vapor transmission, gr/100 sq in./24 hr		
	After 48 hr at 100 F and 88-92 % RH	NR	8.5

NR = No Requirement

MIL-T-4403 (Continued)

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored for 1 Year.

PERFORMANCE. The tape has a peel strength of at least 15oz/in. of width at 75 F and also at 75 F after 96 hours exposure to ultraviolet light (CCC-T-191, Method 5804) using a commercial polish ground stainless steel (QQ-S-766) substrate (UU-P-31, Method 100). In indirect contact with undeveloped film for 7 days at 120 F, it does not cause an increase in fog density greater than 0.02 (ANSCO-Sweet densitometer). Further, it does not corrode copper during 96 hours exposure in 70 C saturated salt solution. The tape has a splice strength of at least 20 lb/in. of width when (1) water wet 10 minutes and (2) after drying 1 hour at 150 F under 10 pound load and then subjected to three 5 ft-lb shock loadings prior to test using approximately 9-1/2 inch wide aerial roll film (AN-F-30, Class A, L, N), photographic film (MIL-P-4064) and acetate leader adherends.

FORM

The tape is available in the lengths and widths given in Table II. Each roll may contain up to 2 splices.

TABLE II. AVAILABILITY OF MIL-T-4403 TAPE

LENGTH, YD	CORE DIAMETER, IN.	WIDTH, IN.
36	1½	1, 1-1/8
72	1½	1, 1-1/8, 1-1/2, 2(1)

(1) Unless other specified

QPL

No.

MIL-T-4601 TAPE; FILAMENT REINFORCED, GUMMED

Issue: 1 March 1954 Revision: A Amendment: None

SCOPE

This gummed adhesive tape is intended for reinforcing fiberboard or fiberboard surfaced containers not subject to immersion in water or prolonged exposure to weather.

CLASSIFICATION

The tape is available in two types and four classes.

Type A Low elongation
Type B High elongation
Class I Low tensile strength
Class II Medium tensile strength
Class III Medium high tensile strength
Class IV High tensile strength

PROPERTIES

CHEMICAL. The composition of the tape is not given; however, it contains reinforcing filaments.

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

PROCESS. The tape is activated in less than 5 seconds contact with water, the joint immediately closed and cured at least 2 hours at room temperature under contact pressure. The tape is nonblocking even after 24 hours exposure at 75 F to 85% RH and can be stored 6 months at room temperature.

PERFORMANCE. The tape does not split or separate from its own backing or from 90 pound kraft paper at -65 F when bent 180° over a 1-1/2 inch diameter mandrel after cycling 24 hours at 160 F followed by 2 hours at -65 F. Removal of the tape by peeling results in at least 75% fiber failure in the kraft paper.

FORM

The tape, unless other specified, is available in 60 yard rolls wound on cores containing a hole not less than 7/16 inch diameter in the widths specified by the user. Each roll may contain up to 3 splices; the overlap of the splice for Class I is 5 inches, Class II 7 inches, Class III 9 inches and Class IV 9 inches plus 2 inches for each additional 150 pounds of tensile strength over 500 pounds per unit width.

QPL

No.

MIL-T-4601 (Continued)

NOTES

(1) Limit procurement of tape to that quantity which can be used within 6 months since the tape loses some of its initial quality after 6 months storage.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-4601 TAPE

PROPERTY	TYPE A CLASS I	TYPE A CLASS II	TYPE A CLASS III	TYPE A CLASS IV	TYPE B CLASS I	TYPE B CLASS II	TYPE B CLASS III	TYPE B CLASS IV
Tensile strength, lb/in., at 75 F	150–200	201–350	351–500	Over 500	150–200	201–350	351–500	Over 500
Elongation, ultimate, %, at 75 F	0–8	0–8	0–8	0–8	8–16	8–16	8–16	8–16

MIL-A-005090 (Wep) ADHESIVES, HEAT RESISTANT, AIRFRAME STRUCTURAL, METAL TO METAL

Issue: 22 April 1963 Revision: E 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 peel and tensile strength
- Class 2 Normal peel and tensile strength

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 MIL-A-005090 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.

MIL-A-005090 (Continued)

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) MIL-A-5090, revision D, is still in effect. This D revision does not contain requirements for peel and blister detection properties.

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 90% of maximum stress.

NR = No Requirement

MIL-A-005090 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-A-005090 ADHESIVE

PROPERTY	TYPE I Class 1	TYPE I Class 2	TYPE II	TYPE III	TYPE IV
Shear, psi, min (1)					
At –67 F, 10 min.	4900	2500	2250	2250	2250
At 75 F					
Initial	4500	2500	2250	2250	2250
After 30 days salt spray (2)	3600	2250	2100	2100	2100
After 30 days at 120 F and 95-100% RH	3600	2250	2100	2100	2100
After 30 days in water	3600	2250	2100	2100	2100
After 7 days immersion in Anti-icing Fluid (MIL-F-5566)	3600	2250	2100	2100	2100
Hydraulic Oil (MIL-H-5606)	3600	2250	2100	2100	2100
JP-4 (MIL-J-5624)	3600	2250	2100	2100	2100
Aromatic Hydrocarbon (MIL-S-3136, Type III)	3600	2250	2100	2100	2100
Blister detection (3)	3600	2250	NR	NR	NR
At 180 F, 10 min.	2500	1250	NR	NR	NR
At 300 F					
After 10 min.	NR	NR	2000	2000	2000
After 192 hr	NR	NR	2000	2000	2000
At 500 F					
After 10 min.	NR	NR	NR	1850	1850
After 192 hr	NR	NR	NR	NR	1000
Creep Rupture, psi, max (1) (4)					
At 75 F, 192 hr	1600	1600	1600	1600	1600
At 180 F, 192 hr	800	800	NR	NR	NR
At 300 F, 192 hr	NR	NR	800	800	NR
At 500 F, 192 hr	NR	NR	NR	NR	800
Fatigue, psi, at 75 F, max (1) (5)					
10^6 cycles	750	750	750	750	750
10^7 cycles	600	600	600	600	600
Peel, lb/in., at 75 F, min	50	40	NR	NR	NR

(1) Types I and II use 0.063 inch thick Alclad 2024-T3 aluminum (QQ-A-362) 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.

MIL-A-5092 ADHESIVE, RUBBER (SYNTHETIC AND RECLAIMED RUBBER BASE)

Issue: 27 August 1952 Revision: A Amendment: None

SCOPE

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

CLASSIFICATION

The adhesive is available in three types.

Type I General purpose
Type II Oil resistant
Type III Aromatic fuel resistant

PROPERTIES

CHEMICAL. This adhesive consists of 20% solvent dispersed rubber; Type I is reclaimed rubber; Type II, neoprene; and Type III, Buna N.

PHYSICAL. The adhesive has a viscosity at 70 F between 10 and 80 seconds using a 100 ml sample discharging from a 17/69 inch orifice under an initial head of 4-5/8 inch. Type I has a maximum ash content of 20%, and Types II and III, 10%.

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 20 days at 120 F without gelling or otherwise deteriorating.

PERFORMANCE. The performance properties of the adhesive 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 similiar materials to themselves, combinations and to aluminum alloy, steel, laminates and wood. Type III adhesive, however, will not bond vinyl plastics.

MIL-A-5092 (Continued)

3. Type I adhesive will not resist oil or gasoline; Type II will not resist gasoline. In general, the water resistance is poorest with Type I, but excellent with Types II and III.

4. Type II has the poorest storage properties. It will last about 6 to 9 months under normal storage conditions.

5. Types I and III can be thinned with solvent in accordance with the supplier's directions when brushable viscosity is exceeded. Type II cannot generally be diluted.

6. When bonding rubber, use Type I for natural rubber, Type II for neoprene, and Type III for Buna-N.

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

PROPERTY	TYPE I	TYPE II	TYPE III
Shear, lb, min (1)			
At 75 F			
Initial	200	225	225
After 24 hr immersion in			
75 F water	120	225	250
158 F lubricating oil (MIL-L-6082, Grade 1100)	NR	225	225
75 F Aromatic hydrocarbon (MIL-S-3136, Type II)	NR	NR	125
At 140 F, 30 min.	75	75	75
Peel, lb/in, min (2)			
At 75 F			
Initial	12	15	15
After aging			
At 120 F, 20 days (3)	12	15	15
At 120 F, 30 days (4)	12	15	15

(1) 2 inch wide, ¾ inch overlap cotton duck adherends (CCC-D-741).

(2) Cotton duck (CCC-D-741) and Alclad 2024 Aluminum (QQ-A-362) adherends.

(3) The adhesive is aged prior to bonding.

(4) The joint is aged.

MIL-A-5534 ADHESIVE; HIGH-TEMPERATURE SETTING RESIN (PHENOL, MELAMINE, AND RESORCINOL BASE)

Issue: 15 June 1951 Revision: A Amendment: None

SCOPE

This adhesive is intended for laminating aircraft structural wood parts.

CLASSIFICATION

The adhesive is available in three conditions.

Cond. A Liquid Cond. B Powder Cond. C Impregnated film

PROPERTIES

CHEMICAL. The adhesive consists of a phenolic, resorcinol or melamine resin containing no more than 35% insoluble material. Any fillers, either separate or incorporated in the resin, are water insoluble and inert and contain no amylaceous (flour or starch) and protein materials. Plasticizers and separate hardners may be used. Separate, unspecified solvents may be used with Conditions A and B adhesives.

PHYSICAL. The pH of cured Condition A, B and C films is between 3.5 and 11.0. Condition C adhesive contains 7 pounds of dry adhesive per 1,000 square feet of film.

PROCESS. Conditions A and B adhesives are activated by mixing with hardener, solvent and filler, if any, applied by brushing, the joint closed and curedno longer than 15 minutes at temperatures no higher than 300 F under 150-200 psi bonding pressure. The Condition C film is laid directly in the joint and cured similar to Conditions A and B adhesive. Conditions A and B adhesive have a working life of at least 3 hours at room temperature. Condition A can be stored 30 days and Condition B and C, 90 days all at room temperature.

PERFORMANCE. The adhesive has an interlaminar shear strength of atleast 360 psi at 75 F and at 75 F after 3 hours immersion in boiling water or 48 hours immersion in RT water using birch adherends.

FORM

The liquid adhesive is available in commercial packages. Two component adhesives are available in separate containers containing the proper stoichiometric equivalents of each component.

QPL

No.

NOTES

(1) This specification was cancelled 6 November 1963.

MIL-C-5539 CEMENT; NATURAL RUBBER

Issue: 9 January 1950 Revision: None Amendment: None

SCOPE

This cement is intended for the bonding of fabrics, including rubber and neoprene coated fabrics.

CLASSIFICATION

The cement is available in three types.

Type A Self curing (for manfacturing operations)
Type B Air curing (for emergency repairs)
Type C Self curing (for permanent repairs)

PROPERTIES

CHEMICAL. The cement consists of hard Para rubber and additives in clear, water-free benzol, naphtha or a combination of both. Other solvents may be substituted if specified. Catalyst is incorporated or supplied as a separate entity in Type A, incorporated in Type B and separate in Type C.

PHYSICAL. The solids content of Types A and C is at least 7% and Type B at least 5%. The benzol boils between 77 and 89 C and the naphtha between 40 and 145 C.

PROCESS. The Type A and C cement is activated by mixing the base resin and catalyst, all 3 types are applied by brushing, to give 0.6 oz/sq in. on one side of the adherend and 0.55 oz/sq in. on the other side, air dried in accordance with the supplier's instructions, the joint closed and cured in accordance with the time specified in Table I under contact pressure. Working life and stability of the cement is also given in Table I.

TABLE I. PROCESS PROPERTIES OF MIL-C-5539 CEMENT

PROPERTY	TYPE A	TYPE B	TYPE C
Curing time, at 75 F, days, max	30	10	5
Working life, 75 F, hr, min	6–8	NR	6–8
Stability, 10 days at 120 F	No Gel	NR	No Gel

NR = No Requirement

PERFORMANCE. The performance properties are given in Table II.

MIL-C-5539 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-C-5539 CEMENT

PROPERTY	TYPE A	TYPE B	TYPE C
Shear, lb, min (1), (2), (3)			
At 75 F	350	250	350
At 140 F, 30 min.	80	60	80

(1) Also known as seam strength.
(2) Adherends are crude rubber – reclaimed rubber coated cotton fabric using a ¾ inch overlap, 2 inches wide.
(3) These are also the lap shear properties of Type A after storing cement and catalyst (if any) 4 months at 75 F, Type B 6 months at 75 F, and Type C (cement and catalyst) 6 weeks at 75 F.

FORM

The liquid cement is available in pint, quart and gallon containers. The catalyst is available in dark glass bottles or metal cans. Type B cement for life raft repair kits is available in 1, 2 and 4 ounce Boston round glass bottles.

QPL

Yes.

NOTES

(1) Type A should be used for the manufacture of airships, balloons, pneumatic life rafts, and life jackets. Type B is intended for emergency repairs and Type C for permanent repairs to the above products.

(2) Type A should be substituted whenever practical for either Type B or Type C in repair work.

(3) Type B can be stored for 2 years in unopened containers.

(4) Type C is not intended for use beyond the continental limits of the United States and should not be ordered beyond what is necessary for 3 month supply.

(5) For neoprene fabrics, the use of a neoprene base cement (e.g. see abstract MIL-A-5540) will give superior bond strength.

(6) Both Types A and C cements can be cured in 24 hours at 140 F.

(7) Whenever the viscosity increases to the point where thinning is necessary, naphtha, benzol, toluene or xylene may be used.

MIL-A-5540 ADHESIVE, POLYCHLOROPRENE

Issue: 20 February 1963 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding of neoprene 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 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 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 nylon cloth adherends (MIL-C-19002). It has sufficient strength to sustain a 50 psi shear load (75 lb on a 2 in. by ¾ in. joint) for 24 hours at 140 F without separation or 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-V-6093 VARNISH, DECALCOMANIA ADHESIVE

Issue: 4 April 1961 Revision: A Amendment: None

SCOPE

This adhesive is intended for application of "varnish-applied" decalcomanias.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. The adhesive is a clear, transparent, homogeneous liquid having a viscosity of no more than one poise at 25 C, a flash point of not less than 27 C, and a nonvolatile content between 35 and 45% by weight.

PROCESS. The adhesive is applied by brushing to decalcomanias (MIL-P-8635), allowed to air dry until tacky, the paper backing removed with water, then applied to the part by rolling and the joint cured 24 hours at room temperature under contact pressure. The adhesive dries tacky between 10 and 20 minutes and within 4 hours is sufficiently hard to prevent damage by handling. The adhesive, dried up to 30 minutes, is removable with petroleum naphtha. It is capable of being stored 1 year between 70 and 90 F in unopened containers, and will not skin during one week in partially filled, closed containers.

PERFORMANCE. The decalcomanias do not separate, even by prying with a knife, from bare metal, cellulose nitrate lacquered metal (MIL-L-7178) and camouflaged enameled metal (MIL-E-5556). The panels can be bent 180° over a ¼ inch mandrel after baking 24 hours at 180 F. No loss of adhesion occurs after 48 hours immersion in water or naphtha (TT-N-95).

FORM

The liquid adhesive is available in commercial packages.

QPL

Yes.

MIL-T-6841 TAPE, ADHESIVE, RUBBER AND CORK COMPOSITION

Issue: 12 August 1957 Revision: A Amendment: 2

SCOPE

This pressure-sensitive adhesive tape is intended as a seal and packing for the installation of glass or acrylic plastic windsheilds, panels and windows suitable for cabins and cockpits of aircraft.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape backing consists of a mixture of granulated cork and a vulcanized sponged synthetic rubber binder calendered on print cloth. The print cloth backing is coated with a synthetic or natural, but not reclaimed, rubber base adhesive over which is applied a sized Holland cloth or polyethylene sheeting (MIL-P-3803, Grade 1) liner.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-T-6841 TAPE

		VALUE	
INGREDIENTS	PROPERTY	INITIAL	AFTER 70 HR AT 212 F
Cork	Sieve analysis, %	100	
	20 mesh sieve	All	NR
	40 mesh sieve	10	NR
	Weight, %	20-25	NR
Backing (cloth)	Weight, oz/sq yd	3	NR
	Thread count	60x60	NR
Finished tape	Weight, ± %	(2)	10
	Compressibility, % After 5 min. under 100 psi	20-35	15-40
	Recovery, %, min After 5 min.	90	80
	Low temperature resistance, %, min (1)	40	NR

(1) Value shown is defined as percent compression at -40 F under load which produces 25% compression at 70 F x 100 divided by 25.

(2) See Table II.

NR = No Requirement

MIL-T-6841 (Continued)

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

PERFORMANCE. The tape, after aging 7 days at 160 F and then bonded to aluminum, supports a shear load of 3 lb/in. of width for at least 1 minute. Further, the tape does not craze or crack acrylic plastic sheet (MIL-P-6886) which is under a 1500 psi bending stress during 24 hours exposure.

FORM

The tape, unless otherwise specified, is available in 100 foot rolls in the widths, thicknesses, and weights shown in Table II.

TABLE II. AVAILABILITY OF MIL-T-6841 TAPE

THICKNESS, INCHES	WIDTH, INCHES	WEIGHT, LB/SQ YD
1/32	1½	1½
1/16	1, 1½, 2½	2½
3/32	1½	3½
1/8	2½	4¼

QPL

Yes.

NOTES

(1) The tape is not more than 8 months old from date of manufacture to date of delivery.

MIL-R-7725 (ASG) REPAIR AND TREADING MATERIALS, AIRCRAFT PNEUMATIC TIRE

Issue: 12 April 1957 Revision: A Amendment: None

SCOPE

These cements are intended for vulcanized repairing and retreading of aircraft pneumatic (natural) rubber tires and inner tubes.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The vulcanizing cement consists of natural rubber containing no reclaim or synthetic rubber. The composition of the cold cure cement is not given.

PHYSICAL. No physical properties are given.

PROCESS. The vulcanizing cement used for capping, retreading and vulcanized repairs of casings and inner tubes is applied by brushing or spraying, the joint closed and cured during vulcanization of the camelback, camelback with cushion, and tread repair stock at 280 F for 45 minutes and with the cushion repair stock and padding at 260 F for 45 minutes. The cold cure cement used for repairing tubes using combination tube gum, is applied by brushing, the joint closed and cured at room temperature (no time given) under contact pressure. The combination repair tube stock can also be cured by vulcanization (see Note Section No. 1).

PERFORMANCE. No performance properties are given.

FORM

The liquid cements are available in commercial packages.

QPL

No.

NOTES

(1) This specification contains extensive data on the tire repair stock (camelback, camelback with cushion, repair cushion, tread repair stock and padding stock), inner tube (combination tube repair gum and balancing patches), solvent and soapstone. These are not reproduced here. See specifications for details.

(2) Use the tread repair stock for building up treads when making sectional repairs and to fill out edges of camelback.

(3) Use padding stock for filling in worn spots under camelback.

(4) Use combination tube repair stock for inside tube reinforcement repair and for cold cure or vulcanized inner tube repairs.

MIL-I-7798 INSULATION TAPE, ELECTRICAL PRESSURE-SENSITIVE ADHESIVE, PLASTIC

Issue: 25 September 1958 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating electrical conductors and spliced wires where high electrical resistance is required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a polyvinyl chloride (or its copolymers) plastic backing coated on one side with an unspecified adhesive (see Note Section No. 3).

PHYSICAL. The opaque yellow tape (see Form Section) obliterates underlying printed matter and the transparent yellow tape permits easy reading of 10 point type. The other physical properties of the tape are given in Table I.

PROCESS. The tape requires no moisture, heat or other preparation prior or subsequent to application. It can be wrapped and immediately unwrapped at temperatures as low as -40 F without any cracking. The tape can be stored for 2 years below 95 F.

PERFORMANCE. The tape does not blister or unwind off glass after 48 hours exposure to 120 F No. 3 High Swelling Oil (ASTM D471). It has a peel strength at 75 F of 16 oz/in. of width using a cold rolled commercial polish ground, corrosion resistant steel substrate (ASTM A167, Grades 1 and 2). The peel strength of the tape to succeeding layers of backing decreases no more than 50% after aging 168 hours at 150 F and 90% RH.

FORM

The tape, unless otherwise specified, is available in 36 yard rolls wound on 1 inch diameter cores in ½, ¾, 1, 1¼, 1½ and 2 inch widths, and in black (Fed Std 595, Shade No. 17038), yellow-transparent (Shade No. 13655) and yellow-opaque (Shade No. 13655) colors.

QPL

Yes.

NOTES

(1) Limit procurement to quantities which are used within 6 months.

(2) This specification supersedes MIL-I-15126, Type VF (see abstract).

MIL-I-7798 (Continued)

(3) Elastomeric film backing material other than polyvinyl chloride or its copolymers may be used.

TABLE I. PHYSICAL PROPERTIES OF MIL-I-7798 TAPE

PROPERTY	THICKNESS, IN. 0.007	0.010
Thickness tolerance, ± in.	0.001	0.001
Tensile strength, lb/in., at 75 F, min	17	26
Elongation, ultimate, %, at 75 F		
Initial		
Black	125-300	125-300
Yellow – transparent	110-300	110-300
Yellow – opaque	125-300	125-300
After 250 hr accelerated weathering (1)	85	85
Dielectric strength, volts/mil, at 75 F, min (2)		
Initial		
Average	1000	900
Min individual value	950	850
After 96 hours at 75 F and 96% RH	900	810
After 4 hours at 160 F		
Average	700	650
Min individual value	650	600
After 100 hr accelerated weathering (1)		
Average	1000	900
Min individual value	950	850
After 24 hr immersion in water	900	810
Conductance, micromicromhos/in. (3)		
After 18 hr at 75 F and 96% RH		
Maximum	500	500
Maximum median	50	50
Penetration resistance, °C, min (4)	55	60
Abrasion resistance, in., max (5)	0.005	0.005

(1) CCC-T-191, Method 5804.

(2) Fed Test Method Std L-P-406, Method 4031 or ASTM D295-52T.

(3) At 100-130 DC impressed voltage. This property is also called Indirect Electrolytic Corrosion.

(4) The temperature at which a 1/16 inch ball bearing under a 1000 gram load bursts the tape.

(5) CCC-T-191, Method 5304 using an 8 ounce load for 2000 rubs.

MIL-A-8576 ADHESIVE, ACRYLIC MONOMER BASE, FOR ACRYLIC PLASTIC

Issue: 4 October 1956 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding acrylic plastics (MIL-P-5425).

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of methyl methacrylate, methylene chloride (MIL-M-6998) and hydroquinone (O-H-886) or equivalent. The catalyst is not specified and is supplied separately.

PHYSICAL. The adhesive, prior to addition of catalyst, is a colorless, transparent liquid. It has at 75 F, an index of refraction between 1.413 and 1.419, a specific gravity between 1.165 and 1.185 and a viscosity at 25 C not greater than 1.0 poise.

PROCESS. The adhesive is activated by mixing base resin and catalyst, applied by brushing, left standing 15 minutes, the joint closed and cured for at least 12 hours at room temperature under bonding pressures defined by the supplier. The adhesive is preperably stored below 40 F and under no circumstances above 110 F for protracted periods. Storage at 122 F for 1 week will alter the uncatalyzed adhesive such that its specific gravity is between 1.160 and 1.180 and its viscosity is no higher than 4 poises.

PERFORMANCE. The adhesive has a minimum and average flatwise tensile strength of 1500 and 1800 psi at 75 F; 4000 and 5000 psi at 75 F after 24 hr at 160 F; and 2000 and 2400 psi at 160 F after 48 hr at 160 F using acrylic plastic adherends (MIL-P-5425).

FORM

The liquid adhesive, unless otherwise specified, is available in pint, quart and gallon containers. The catalyst package in the required stoichiometric proportions is securely joined to the adhesive package.

QPL

No.

NOTE

(1) This adhesive is not suitable for bonding MIL-P-8184 acrylic plastic, use MIL-A-25055 (see abstract).

MIL-A-8623 ADHESIVE, EPOXY RESIN, METAL TO METAL STRUCTURAL BONDING

Issue: 23 September 1960 Revision: A Amendment: 1

SCOPE

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

CLASSIFICATION

The adhesive is available in three types.

Type I	Room temperature setting (68-86 F or 1 hour at 160 F)
Type II	Intermediate temperature setting (87-210 F)
Type III	High temperature setting (above 210 F)

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin base. Amine activators, unspecified fillers and solvents may be used.

PHYSICAL. Type I and II adhesives are two part systems and Type III is a one part system containing an incorporated activator, if necessary. The adhesive is a film, liquid, powder, stick or jelly material. The accelerator, when required, is either a powder or liquid.

PROCESS. Types I and II adhesives are activated by mixing together both parts, Type III is applied directly, the joint closed and cured no longer than 168 hr at 86 F or 1 hr at 160 F (Type I), 2 hr at 210 F followed by 7 days at 65 F (Type II) and 7 hr at 350 F (Type III), all under no more than 10 psi bonding pressure. The adhesive has a working life of ½ hr for Type I, 2.5 hr for Type II and 8760 hr for Type III; end of working life is considered at 160,000 centipoises viscosity at 65 F. The adhesive can be stored 1 year at room temperature in unopened containers.

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

FORM

The adhesive is available in commercial packages (see Physical section).

QPL

Yes.

MIL-A-8623 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-8623 ADHESIVE

PROPERTY	VALUE		
	TYPE I	TYPE II	TYPE III
Shear, psi, min (1)			
At -67 F			
After 30 min.	1300	2500	2500
After 1 hr at 160 F followed by 30 min. at -67 F	1800	2000	2500
At 75 F			
Initial	2500	2500	2500
After 1 hr at 160 F	2500	2500	2500
After 250 hr salt spray (2)	2250	2250	2250
After 168 hr accelerated weathering (3)	2000	2000	2000
After 7 days immersion in			
Water	2400	2500	2500
Anti-Icing Fluid (MIL-F-5566)	2400	2500	2500
Hydraulic Oil (MIL-H-5606)	2400	2500	2500
JP-4 (MIL-J-5624)	2400	2500	2500
Aromatic Hydrocarbon (MIL-S-3136, Type III)	2400	2500	2500
At 180 F, 30 min.	1250	1250	1500
Creep Rupture, psi (4)			
At 75 F	1600	1600	1600
At 180 F	300	300	300
Fatigue, 10^7 cycles, psi, at 75 F, min (5)	650	600	600
Cleavage, pounds, at 75 F, min (6)	1000	1000	1500

(1) Fed Test Method Std No. 175, Method 1033, using 0.064 inch thick Alclad 2024 aluminum (QQ-A-362) adherends.

(2) Fed Test Method Std No. 141, Method 6061.

(3) Fed Test Method Std No. 141, Method 6152 or ASTM D822.

(4) Maintain shear load for 200 hours without failure and no more than 0.025 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 90% of maximum stress using adherends given in (1).

(6) ASTM D 1062 using adherends given in (1).

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

Issue: 10 August 1962 Revision: B 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 without thinning, 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 MIL-S-3136, 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

Yes.

MIL-T-9906 TAPE, AIRCRAFT TUBING IDENTIFICATION MARKER: NONCORROSIVE, HEAT AND SOLVENT RESISTANT

Issue: 27 March 1961 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for identifying fluid lines where a noncorrosive, 325F heat and solvent resistant tape is required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a printed plastic film backing coated on one side with an unspecified adhesive, and the other side with a pressure-sensitive adhesive tape or coating overlay (to insure fluid resistance of printing). The base materials contain no halogenated compounds.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-T-9906 TAPE

PROPERTY	VALUE
Thickness, in., max	0.0065
Tensile strength, lb/in., at 75 F, min	17
Elongation, ultimate, %, at 75 F, min	70
Flexibility, 180° bend on 1/8 inch mandrel at RT	No cracks
Impact strength, at -20 F, (5 hr), 10 foot-lb (1)	No cracks
Heat resistance, °F for 100 hr (2)	325

(1) Tape is adhered to a one inch steel plate prior to test.

(2) No cracking, wrinkling or other defects; slight discoloration is permissible.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The tape can be unwound at speeds between 15 and 20 inches per second without separation or loosening of the overlayed transparent film and can be stored between 70 and 90 F for 1 year.

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

MIL-T-9906 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-T-9906 TAPE

PROPERTY	VALUE
Peel, oz/in., at 75 F, min (1)	
Initial	50
After accelerated weathering	
Bonded specimens (2)	50
Adhesive before bonding (3)	15
After immersion in	
Water, 24 hr	30
JP-4 fuel (MIL-F-5624), 72 hr	30
Hydraulic oil (MIL-O-5606), 72 hr	30
Hydraulic oil (MIL-H-8446), 72 hr	30
Lubricating oil (MIL-L-7808), at 200 F, 24 hr	30
Corrosion (4)	None

(1) UU-P-31, Method 100, using 2024 Alclad aluminum (QQ-A-362).
(2) Fed Test Method Std No. 141, Method 6151, for 96 hours.
(3) Same as (2) except 20 hours.
(4) Stainless steel tubing (MIL-T-8504) bent into U-shape and tape joint maintained in 325 F steam for 144 hours.

FORM

The tape, unless otherwise specified, is available in 50 yard rolls wound on 3 inch diameter cores. Widths, design and color are in accordance with Air Force – Navy Aeronautical Design Standard AND 10375, "Colors – Fluid Line Designation". The color of the background behind the geometric symbols may be white or silver.

QPL

No.

MIL-C-10523 (Ord) CEMENT, GASKET, FOR AUTOMOTIVE APPLICATIONS

Issue: 23 December 1952 Revision: None Amendment: 2

SCOPE

This cement is intended for (1) bonding uncoated gaskets between the cylinder block and cylinder head of large engines and (2) in assembling fuel lines, particularly the pipe ells at the fuel pump.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the cement is not given.

PHYSICAL. The nontoxic cement has no more than 20% volatiles after 24 hours at 50 C and a viscosity between 6 and 14 minutes at 77 F using a 50 ml specimen discharging from a 3 19/32 inch high funnel containing a 0.25 inch diameter orifice.

PROCESS. The cement is applied by brushing, the joint closed and cured at least one hour at 50 C under contact pressure. The cement can be stored 6 months in closed containers up to 90 F.

PERFORMANCE. The cement shows no blisters, cracks, checks, or visual defects after being immersed consecutively in the following solutions at 80 C for 2 hours and drying after each immersion: boiling water (100 C), ethylene glycol, methyl alcohol, ethyl alcohol, followed by aromatic hydrocarbon (MIL-S-3136, Type II). The adhesive after immersion shows no more than 75% weight loss, no chipping or cracking even after scraping with a knife and in 0.002 inch thickness no cracking when bent 180° after 16 hours at 40 C.

FORM

The cement is available in 8 ounce collapsible tubes, pint, quart and gallon containers.

QPL

No.

MIL-C-10668 (QMC) CEMENT, LIQUID AND CEMENTED TAPE, FOR TENT CONSTRUCTION

Issue: 29 April 1953 Revision: A Amendment: None

SCOPE

This adhesive is intended for making seams, reinforcing panels and stress distribution patches in the manufacture of tents.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of nitrile rubber in an unspecified low boiling solvent containing no mineral acids. The cemented tape consists of cotton duck (CCC-C-419) coated with the above nitrile rubber.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-C-10668 CEMENT

PROPERTY	LIQUID CEMENT	CEMENTED TAPE
Solvent boiling point, °F	70–85	NR
Fabric		
Weight, oz (no cement)	NR	12–29
Color (TT-C-595, No. 3412)	NR	Lustreless green
Thickness, mils	NR	8–12
Percent solids	28–32	NR

NR = No Requirement

PROCESS. The liquid cement is applied by brushing on 2 coats, the first to give a film thickness of 0.001 inch and the second 0.002 inch, air dried 15 minutes after each coat, the joint closed and cured 72 hours at room temperature under contact pressure. The cemented tape is activated by wetting the surface with a solvent specified by the supplier, laid in the joint and cured similar to the liquid cement above. The liquid cement remains brushable as low as -10 F and can be stored 28 days at 120 F in unopened containers.

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

MIL-C-10668 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-C-10668 CEMENT

PROPERTY (1)	VALUE
Shear, psi, at RT, min	100
Peel, lb/in., at RT, min	
Initial	7
After 100 hr at 160 F	7
After 48 hr in water	6
Creep, psi, max (2)	10
Flexibility, 180° bend (3)	
At RT	No crease
At –20 F, 6 hr	Flexible

(1) Cotton duck adherends (CCC-C-419) are used for liquid cement.
(2) Maintain shear load without failure and no more than 1/16 inch deformation while at 160 F for 8 hours.
(3) 3/8 inch diameter mandrel.

FORM

The liquid cement is available in 1 and 5 gallon containers. The cemented tape is available in 150 foot rolls and, unless otherwise specified, in 2 inch widths.

QPL

No.

NOTES

(1) Do not use the liquid cement or cemented tape for field repair of tents; in these cases use MIL-C-2399 (see abstract).

(2) This specification was cancelled 22 October 1963.

MIL-B-10854 (CmlC) BINDER, CELLULOSE NITRATE-CAMPHOR (FOR PYROTECHNIC MIXTURES)

Issue: 22 January 1951 Revision: None Amendment: None

SCOPE

This binder is intended for manufacturing pyrotechnic mixtures.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the binder is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-B-10854 BINDER

INGREDIENT	VALUE	
	MINIMUM	MAXIMUM
Cellulose nitrate, wt %	77.5	82.5
Camphor, wt %	17.5	22.5
Nitrogen content (cellulose nitrate), wt %	10.8	11.1
Ash, wt %	NR	0.2
Residual solvent, %	NR	0.8
Acetone insoluble material, at 21 – 27 C, %	NR	0.2

NR = No Requirement

PHYSICAL. The binder is available in flake, granular, strip or sheet form.

PROCESS. The binder is mixed with other compounding ingredients including the explosive charge and cured at low temperatures under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The strip or sheet binder is available in 25 or 50 pound containers and the flake or granular binder, in 50 or 100 pound containers.

QPL

No.

MIL-S-11030 SEALING COMPOUND, NONCURING, POLYSULFIDE BASE

Issue: 28 July 1954 Revision: B Amendment: None

SCOPE

This adhesive is intended for sealing metal to metal, glass to metal, and acrylic to metal components in optical instruments.

CLASSIFICATION

The adhesive is available in two types and two classes.

- Type I Static sealing of metal, glass or acrylic plastic.
  - Class 1 High viscosity – cone penetration approximately 50.
  - Class 2 Low viscosity – cone penetration approximately 150.
- Type II Rotary sealing of metal to metal – cone penetration 200.

PROPERTIES

CHEMICAL. The adhesive consists of a polysulfide base. Type II consists of 5.5 parts Type 1, Class 2 sealing compound and 1 part grease (MIL-G-3278).

PHYSICAL. The Type I adhesive, both classes, has no more than 1.5% volatiles after 20 hours exposure to 150 F, and no more than 0.4% solubility after 4 hours in 150 F water. Type II adhesive has no applicable requirements.

PROCESS. The adhesive is applied to joints by injection. The filled joint is serviceable immediately.

PERFORMANCE. The adhesive, after 48 hours exposure in 100 F, 30% aromatic hydrocarbon solvent (MIL-H-3136, Type III) does not crack or lose adhesion to 2024 Alclad aluminum (QQ-A-362) after bending 120° on a 4 inch diameter mandrel at -65 F. Further, the compound produces no volatile constituents during 3 hours exposure to 160 F which craze or etch methyl methacrylate. Type I, Class 1, sealing compound additionally does not craze or crack acrylic plastic (MIL-P-6886) under stress. The other performance properties are given in Table I.

MIL-S-11030 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MIL-S-11030 ADHESIVE

PROPERTY	TYPE I CLASS 1	TYPE I CLASS 2	TYPE II
Cone penetration (0.1 mm) (1)			
Initial	40–80	100–200	150–250
After 24 hr at 150 F, max	20	40	40
Water vapor permeability, gr/hr/sq in., max After 48 hr at 160 F	0.010	0.015	0.012
Tensile, flatwise, psi, at 75 F, min (2)	25	10	NR
Heat resistance (3)			
Hardens or blisters	No	No	NR
Oil resistance (4)			
Blisters, softens or loses adhesion	No	No	NR

(1) Fed Test Method Std No. 791, Method 3114, using the 150 gram weight load.
(2) Fed Test Method Std No. 175, Method 1011, using glass, steel and acrylic plastic adherends.
(3) Exposure consists of 48 hours in aromatic hydrocarbon (MIL-H-3136, Type III), 24 hr air dry, followed by baking at 180 F for 72 hours.
(4) Exposure consists of 4 days in mineral oil (MIL-L-15016, symbol 3050).
NR = No Requirement

FORM

The adhesive is available in cellophane lined pint and quart containers.

QPL

Yes.

NOTES

(1) This material should not be used as an integral fuel tank or pressure cabin sealant.

MIL-S-11031 SEALING COMPOUND, ADHESIVE: CURING (POLYSULFIDE BASE)

Issue: 7 September 1951 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding metal to metal or glass to metal components in optical instruments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a polysulfide base and an unspecified accelerator.

PHYSICAL. The adhesive does not have more than 3% volatiles after 2 hours exposure to 200 F and no more than 6% solubility after 4 hours immersion in 160 F water.

PROCESS. The adhesive, unless otherwise specified, is activated by mixing 8.5 parts base resin and 8 parts accelerator, applied by trowel or injection and the joint cured 72 hours at room temperature under contact pressure. The activated adhesive has a working life equivalent to a core penetration of not less than 200 after 3 hours at 75 F and the change in penetration during the three hours at 75 F is not greater than 75% (Fed Test Method Std No. 791, Method 3114).

PERFORMANCE. The cured adhesive does not crack or lose adhesion to 0.040 inch thick aluminum after bending 90° on a 1 inch diameter mandrel at -40 F, does not blister or lose adhesion to aluminum after 4 days exposure in mineral oil (MIL-L-15016, symbol 3050), has a Durometer A hardness of 35-45, a water vapor permeability no greater than 0.025 gr/hr/sq in., and a tensile bond strength of at least 200 psi using steel adherends after curing 72 hours at 80 F. The adhesive produces no volatile constituents during 3 hours exposure to 160 F which craze or etch methyl methacrylate.

FORM

The black paste adhesive is available in pint and quart containers. The accelerator is supplied in the required stoichometric proportions for the adhesive package.

QPL

Yes.

MIL-A-11238 (Ord) ADHESIVE, CELLULOSE NITRATE (FOR ORDNANCE USE)

Issue: 18 September 1962 Revision: A Amendment: None

SCOPE

This adhesive is intended for assembly of ammunition and general purpose bonding applications.

CLASSIFICATION

The adhesive is available in two types.

Type I High solids content
Type II Low solids content

PROPERTIES

CHEMICAL. The composition of the adhesive is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-A-11238 ADHESIVE

INGREDIENT	PERCENT TYPE I	PERCENT TYPE II
Cellulose nitrate (1)	25 – 27	12 – 14
Methyl abietate (2)	13 – 15	6 – 8
Ethyl alcohol (3)	25 – 27	33 – 35
Acetone (4)	16 – 18	22 – 24
Butyl acetate (5)	16 – 18	22 – 24

(1) Commercial ½ second, containing 11.8 to 12.2% nitrogen.
(2) Commercial 90%
(3) MIL-E-463, Grade 2
(4) JAN-A-489
(5) TT-B-838

PHYSICAL. The adhesive is sufficiently flexible such that 24 hours after drying on steel panels it will not chip or crack when bent 180° (Fed Test Method Std No. 141, Method 6222); Type I is 0.004 inch thick and Type II 0.002 inch thick. The other physical properties are given in Table II.

TABLE II. PHYSICAL PROPERTIES OF MIL-A-11238 ADHESIVE

PROPERTY	TYPE I	TYPE II
Nonvolatiles, %, min		
After 3 hr at 100-5 C	38	18
Viscosity, poises (1)		
Maximum	120	1.0
Minimum	63	0.6

(1) Fed Test Method Std No. 141, Method 4271.

MIL-A-11238 (Continued)

PROCESS. The adhesive is applied by brushing, the joint closed and cured 48 hours at 50 C under 50 psi bonding pressure. The adhesive air dries at room temperature in no longer than 60 minutes for Type I and 30 minutes for Type II, and only slight blushing occurs when both types are dried in 100% RH and 35 C. When necessary, the adhesive can be thinned with a solvent whose composition is given in Table III.

TABLE III. CHEMICAL COMPOSITION OF THINNER FOR MIL-A-11238 ADHESIVE

INGREDIENT	PERCENT
Ethyl alcohol	40 – 44
Acetone	27 – 31
Butyl acetate	27 – 31

PERFORMANCE. The adhesive has a shear strength of at least 200 psi for Type I and 150 psi for Type II at 75 F using cold rolled, low carbon steel adherends and a 32 substance white sulfite bond paper adhesive carrier.

FORM

The liquid adhesive is available in five gallon containers.

QPL

No.

NOTES

(1) This adhesive provides good bonds for glass, leather, metals, textiles and some thermoplastics. This adhesive is not recommended for concrete, rubber, wood, ceramics or paper.

MIL-T-11291 (Ord) TAPE, ADHESIVE, ALUMINUM-BACKED (FOR USE WITH AMMUNITION)

Issue: 24 July 1951   Revision: None   Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for use with ammunition.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of pinhole-free aluminum foil coated on one side with an unspecified adhesive.

PHYSICAL. The tape is between 0.0025 and 0.0035 inch thick and has a tensile strength of at least 30 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The tape should be stored in a cool place.

PERFORMANCE. The tape as received has a peel strength between 30 and 75 oz/in. of width (immediately after application) and between 25 and 70 oz/in. of width after aging the roll 12 days at 150 F and 85% RH using 1020 steel adherends. The tape, after accelerated aging, does not transfer more than 25% adhesive to its own backing during unwinding.

FORM

The tape, unless otherwise specified, is available in 60 to 72 yard rolls wound on 3 inch diameter cores in the widths specified by the purchaser.

QPL

No.

NOTES

(1) Suitability of the tape with explosives must be established by the Picatinny Arsenal, Dover, New Jersey, if specified on purchase orders.

MIL-C-12769 BINDER COMPOUND, FOUNDRY CORE

Issue: 21 November 1961 Revision: A Amendment: None

SCOPE

This binder is intended for joining foundry core sections.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the binder is not given.

PHYSICAL. The binder is sufficiently fine to pass at least 95.0% through a U S Standard No. 70 mesh sieve and at least 75.0% through a U S Standard No. 200 mesh sieve. It contains no more than 6.0% moisture and is compatible with core oil (not further defined).

PROCESS. The binder is activated with water, applied by spraying, brushing or dipping, the joint closed and cured at room temperature or elevated temperature under contact pressure.

PERFORMANCE. The binder does not boil or swell out of the joint, withstands metal temperatures up to 3100 F, and joints have strengths equal to or greater than the solid core.

FORM

The powdered binder is available in 300 to 400 pound packages.

QPL

No.

MIL-C-12850 (CmlC) CEMENT, RUBBER

Issue: 30 June 1953 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding natural rubber.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of smoked, pale crepe or para rubber, sulfur and oil free petroleum naphtha and not more than 2% water-white pine resin.

PHYSICAL. The liquid cement consists of 12-14% solids, is non curing, contains no more than 2.40% acetone extractables (ASTM D297) and the naphtha boils between 100 and 285 F.

PROCESS. The cement is applied by brushing on two coats, air dried 15 minutes after each coat, the joint closed and cured 24 hours at room temperature under contact pressure.

PERFORMANCE. The peel strength of the adhesive at 75 F is 5 pounds per inch before and after aging 16 hours at 100 C using natural rubber adherends (MIL-F-10135).

FORM

The liquid adhesive, unless otherwise specified, is available in 5 gallon conatiners.

QPL

No.

NOTES

(1) This adhesive is used primarily for bonding natural rubber components and is suitable for gas mask manufacture.

MIL-T-13020 (SigC) TAPE, RUBBER UNVULCANIZED SPLICING AND MOLDING (TAPES TL-317/U and TL-318/U)

Issue: 28 June 1956 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating splices and for restoring external insulation on communication cables jacketed with rubber or rubber substitutes.

CLASSIFICATION

The tape is available in two types.

Type TL-317/U Gray for restoring interior electrical insulation of communication cables.

Type TL-318/U Black for restoring outside electrical insulation of jackets of communication cables.

PROPERTIES

CHEMICAL. The composition of the tape is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-T-13020 TAPE

	TYPE			
	TL-317/U		TL-318/U	
INGREDIENT, %	MIN	MAX	MIN	MAX
Crude rubber	38	70 (3)	40	70 (3)
Sulfur				
Elemental	NR	0.2	NR	0.75
Total	NR	1.25	NR	1.25

(1) Unspecified small quantities of curing agents, antioxidants and waxy hydrocarbons are added to the rubber. The remainder consists of inorganic mineral fillers. Tape TL-318/U also contains small quantities of carbon black.

(2) A linen or glazed sheeting liner is used.

(3) Percent by volume, all others percent by weight.

NR = No Requirement

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

MIL-T-13020 (Continued)

TABLE II. PHYSICAL PROPERTIES OF MIL-T-13020 TAPE

PROPERTY	TAPE TL-317/U	TAPE TL-318/U
Thickness, in.	0.031	0.031
Thickness tolerance, ± in.	0.003	0.003
Tensile strength, psi, at 75 F, min (1)		
Before cure	125	200
After 15 min. cure (3)	1200	1500
Elongation, ultimate, %, at 75 F, max (2)		
Before cure	400	300
After 15 min. cure (3)		
Initial	300	300
After 118 hr at 70 C, % difference from initial	20	20
After 30 min. cure (2), % difference from 15 min. cure and initial value	15	15
Dielectric strength, volts/mil. at 75 F, min		
Before cure	350	100
After 15 min. cure (3)	350	150
Brittlepoint, °C (4)	-40	-40

(1) Fed Test Method Std No. 601, Method 13021.
(2) Fed Test Method Std No. 601, Method 13031.
(3) Cured at 300 F under 500 psi molding pressure for time specified.
(4) ASTM D746, procedure B.

PROCESS. The tape is molded under elevated temperature and pressure. A typical cure cycle is 300 F for 30 minutes under 500 psi bonding pressure.

PERFORMANCE. The tape meets the fusion test per ASTM D119 using a 2 pound weight and the tackiness test per ASTM D119.

FORM

The tape is available in 55 foot rolls in 1 inch widths. Tape TL-317/U is gray and TL-318/U black.

QPL

No.

MIL-T-13222 TAPE, ADHESIVE, BIAS

Issue: 26 October 1954 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing M1 smoke pots.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a cotton cloth backing (JAN-C-299, Type I, Class E or F) coated on one side with natural, reclaimed or synthetic rubber containing resins, waxes and fillers. A Holland cloth liner is used.

PHYSICAL. The tape is cut on a 45° bias, has a tensile strength of at least 20 lb/in. of width and the coating of adhesive is present in quantities between 4½ and 6½ oz/sq yd.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application except for removal of liner.

PERFORMANCE. The tape has a peel strength of 2 lb/in. of width at 75 F, at 75 F after 48 hours at 160 F, and at -40 F after 48 hours at -40 F.

FORM

The tape is available in 60 yard rolls wound on 1½ inch diameter cores in 1½ inch widths.

QPL

No.

NOTES

(1) Nineteen inch long tape strips are used to seal the smoke pots. If the tape is made up of short bias cuts, integral multiples of 19-20 inch bias cuts should be used.

MIL-P-13298 (Ord) POLYISOBUTYLENE

Issue: 11 March 1958 Revision: None Amendment: None

SCOPE

This binder is intended for manufacturing explosive compositions.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The binder consists of polyisobutylene stabilized against depolymerization with unspecified ingredients and containing no more than 0.10% chlorine.

PHYSICAL. The binder is in the form of consolidated white crumbs, having an acidity, xylene insoluble matter, and iodine number no greater than 0.01% (as HCl), 0.10% and 1.3, respectively, and a viscosity at 37.8 C between 30 and 50 centipoises using 2 grams per 100 ml of xylene (Fed Test Method Std No. 791, Method 305, A procedure).

PROCESS. The binder is mixed with other compounding ingredients including the explosive charge and cured at low temperatures under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The consolidated crumb binder is available in commercial packages.

QPL

No.

MIL-A-13374 ADHESIVE, DEXTRIN (SPIRAL TUBE WINDING FOR AMMUNITION CONTAINERS)

Issue: 20 December 1956 Revision: A 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.

MIL-A-13554 (Ord) ADHESIVE FOR CELLULOSE NITRATE FILM ON METALS

Issue: 26 July 1954 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding cellulose nitrate film to metals such as aluminum, steel, cadmium-plated steel, brass, zinc-plated steel, cronak-treated, zinc-plated steel, etc.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of reclaimed rubber in petroleum naphtha.

PHYSICAL. The adhesive has a specific gravity of 0.7-0.9, a viscosity of 2.0-10.0 poises at 25 C, a solids content after 24 hours at 105 C of 35.0-45.0% and the solvent an initial boiling point of 48.0-64.0 C and an end point of 85.0-101.0 C.

PROCESS. The adhesive is applied by brushing on two coats, air drying 10 minutes at room temperature after each coat, the joint closed and cured 24 hours at temperatures up to 70 C under contact pressure. The adhesive is removable from metals even after baking by immersion 1 hour in 25-30 C petroleum ether (O-E-651, Grade A).

PERFORMANCE. The adhesive cured 24 hours at 25 C and 24 hours at 70 C has a peel strength of at least 4.5 lb/in. and 14.0 lb/in. of width at 25 C and____, 2.5 lb/in. at 60 C using 0.003 inch thick cellulose nitrate and 1/16 inch thick metal (not further defined) adherends.

FORM

The liquid adhesive, unless otherwise specified, is available in cans up to 10 gallon capacity and in drums up to 55 gallon capacity.

QPL

No.

MIL-C-13704 (Ord) CEMENT, SEALING AND PLUGGING

Issue: 7 November 1955 Revision: None Amendment: 1

SCOPE

This cement is intended for sealing and plugging set screws in optical instruments.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the cement is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-C-10854 BINDER

INGREDIENT (1)	COLOR			
	RED	YELLOW	BLACK	OLIVE DRAB
Ethyl cellulose	20	20	18	20
Toluene	40	40	50	40
Alcohol (2)	10	10	13	10
Tricresyl phosphate	5	5	5	5
Indian red	17	NR	NR	1.5
Ochre	8	25	NR	5.5
Iron oxide, black	NR	NR	5	NR
Lamp black	NR	NR	9	8

(1) Composition by weight.
(2) Grade 2 ethyl alcohol per JAN-A-463.
NR = No Requirement

PHYSICAL. The color of the cement approximates the color number of Federal Specification TT-C-595 as specified below.

Red	1020
Yellow	1310
Black	1775
Olive Drab	1405

PROCESS. The cement is applied by brushing or injection, dries tack free in 4 hours and hard in 24 hours.

PERFORMANCE. No performance properties are given.

FORM

The paste cement is available in ¼ pound screw top containers.

QPL

No.

MIL-C-13792 (Ord) CEMENT, VINYL ACETATE BASE SOLVENT TYPE

Issue: 17 November 1954 Revision: None Amendment: None

SCOPE

This cement is intended for general purpose bonding of metals.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The cement consists of 26 to 29% polyvinyl acetate in an unspecified solvent.

PHYSICAL. The cement, weighing 8.16-8.36 lb/gal, has a flash point not less than 20 F (VV-L-791, Method 1103.5), a color no darker than No. 300 (Platinum – Cobalt color standard, American Public Health Association "Standard Methods of Water Analysis", 1936 Edition), and a cloud point between 16 and 19 (will not turn cloudy when added to mixtures of acetone and water; 16 is 210 ml water and 190 ml acetone and 19 is 228 ml water and 172 ml acetone).

PROCESS. The cement is applied by brushing, air dried 0.5 hour, precured 1 hour at 170 F, the joint closed and cured between 3 and 5 minutes at 285 F under 2000 psi bonding pressure.

PERFORMANCE. The cement has a shear strength of at least 1400 psi with no individual value below 1000 psi at 75 F using No. 20 gauge SAE 1008 steel adherends (Fed Test Method Std No. 175, Method 1033).

FORM

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

QPL

No.

MIL-A-13883 ADHESIVE, SYNTHETIC-RUBBER (HOT OR COLD BONDING)

Issue: 7 November 1960 Revision: B 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.

MIL-A-13883 (Continued)

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-13883 ADHESIVE

PROPERTY	TYPE I AVERAGE	TYPE I INDIVIDUAL	TYPE II AVERAGE	TYPE II 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 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 1020 steel (QQ-S-633), 2024 aluminum (QQ-A-267 or QQ-A-268) and brass (QQ-B-626, composition 22).

FORM

The liquid adhesive is available in 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.

MIL-A-14042 ADHESIVE, EPOXY

Issue: 17 July 1959 Revision: A 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.

MIL-A-14042 (Continued)

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

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 (MIL-S-3136, 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-355) and 1022, No. 4 soft steel (QQ-S-00640) 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 the supplier.

(2) The suitability of the adhesive with explosives must be substantiated.

MIL-C-14064 CEMENT: GRINDING DISK

Issue: 22 June 1962 Revision: A Amendment: None

SCOPE

This cement is intended for bonding abrasive discs to metals.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the cement is not given.

PHYSICAL. The cement has a solids content between 34 and 40%, a viscosity at 23 C between 600 and 800 centipoises and the dried film does not have an objectionable odor.

PROCESS. The cement is applied by brushing, the joint closed and cured in accordance with the supplier's instructions.

PERFORMANCE. The cement has a peel strength of at least 12 lb/in. of width at 75 F, 11 lb/in. of width at 75 F after 7 days at 50 C and 7 lb/in. of width at 150 F using 1020 steel (QQ-S-633) and No. 20 abrasive cloth adherends (Fed Test Method Std No. 175, Method 1041).

FORM

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

QPL

No.

MIL-S-14195 (Ord) STYRENE MONOMER

Issue: 22 November 1955 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding glass lenses and for the preparation of cements used in joining optical materials.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of styrene containing 10-20 ppm para-tertiary butylcatechol.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-S-14195 ADHESIVE

PROPERTY	VALUE
Specific gravity 25/25C	0.9035-0.9050
Refractive index, 25C, min	1.5434
Color, platinum-cobalt, max	15
Viscosity, 25C, centipoise, max	0.80
Peroxides, % as H_2O_2, max	0.01
Polymer content, %, max	0.20

PROCESS. The adhesive is activated by mixing the styrene monomer with catalyst, applied by brushing, the joint closed and cured at elevated temperatures under contact pressure. Addition of cobalt naphthenate permits lower temperature curing.

PERFORMANCE. No performance properties are given.

FORM

The liquid styrene monomer, unless otherwise specified, is available in 5 and 55 gallon containers.

QPL

No.

NOTES

(1) The adhesive is not supplied with catalyst. Separate procurement is necessary. Organic peroxides are generally used as catalysts.

(2) The adhesive undergoes shrinkage upon curing, making it subject to shrinkage strains.

MIL-T-14379 (Ord) TAPE, PRESSURE-SENSITIVE ADHESIVE; ELECTRICAL CIRCUIT MARKER, AUTOMOTIVE

Issue: 25 May 1959 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for identification marking of electrical circuits.

CLASSIFICATION

The tape is available in three types.

Type I Printed tape
Type II Unprinted tape
Type III Transparent tape

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The Type I and II tapes have a tensile strength of at least 20 lb/in. of width and the Type III 25 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape (all types) has on a commercial polish ground stainless steel substrate (QQ-S-766) a peel strength of at least 15 lb/in. of width at 75 F and at 75 F after (separately) (1) 24 hr at -65 F, (2) 12 hr at -80 F (prior to application), (3) 120 hr at 180 F, (4) 72 hr accelerated weathering (Fed Test Method Std No. 141, Method 6151) and (5) after fungus innoculation (MIL-F-13927); storage of the tape 20 days at 135-140 F gives 17 lb/in. (Types I and II) and 21 lb/in. (Type III). The printing on Type I remains legible during (1), (3) and (5) exposure conditions.

FORM

The Type I tape has a white opaque background with 3/16 in. high black printed numbers spaced at ½ in. intervals with numbers 6 and 9 underlined. Type II has a white opaque background capable of accepting writing. Type III is colorless. All types are available in 72 yard rolls in 3/8 (Type II) and 3/4 in. widths (Types I and III).

QPL

Yes.

NOTES

(1) Use Type I during manufacturing and assembling operations.

(2) Use Type II during field servicing operations.

(3) Use Type III for laminating over Type II after circuit numbers have been marked on the tape.

MIL-A-14443 (Ord) ADHESIVES: GLASS TO METAL (FOR BONDING OF LENSES)

Issue: 17 October 1961 Revision: A 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 five classes.

- Type I Liquid adhesive
  - Class 1 Neoprene modified thermosetting base
  - Class 2 Modified thermosetting base
- Type II Dry film adhesive
  - Class 1 Fiberglass carrier
  - Class 2 Polyamide carrier
  - Class 3 Unsupported

PROPERTIES

CHEMICAL. The adhesive, consisting of two parts (see process section), is composed of a phenolic-neoprene-nitrile base. Type II is Type I adhesive, except as a dry film and is supplied with or without carrier.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-A-14443 ADHESIVE

PROPERTY	TYPE I	TYPE II
Viscosity, seconds, at 25 C, max (1)		
Class 1	8	NR
Class 2	195	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

MIL-A-14443 (Continued)

PROCESS. The Type I, Class I adhesive is applied to metal surfaces by spraying to give a coating thickness of 6 mils, air dried 30 minutes, oven dried 1 hour at 180 F, the Type I, Class 2 adhesive is then applied by spraying to give a coating thickness of 2 mils, air dried 30 minutes and oven dried 30 minutes at 210 F. The glass adherend is coated and treated with Type I, Class 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 adhesives, the metal surfaces are coated with Type I, Class 1 adhesive as above except to a coating thickness of 1 mil. 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 MIL-A-14443 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 (JAN-G-174, Type 541-599), 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.

MIL-P-14536 (Ord) POLYISOBUTYLENE BINDER

Issue: 12 June 1957 Revision: None Amendment: None

SCOPE

This binder is intended for fabricating explosive compositions.

CLASSIFICATION

The binder is available in two types.

Type I Containing di-(2-ethylhexyl) sebacate
Type II Containing di-(2-ethylhexyl) adipate

PROPERTIES

CHEMICAL. The binder consists of 24.5–25.5% polyisobutylene in the 100,000 to 120,000 molecular weight range (MIL-P-13298), 14.5–17.5% Grade 10 lubricating oil (MIL-L-2104) and 58.0–60.0% di-(2-ethylhexyl) sebacate (MIL-D-10692) for Type I or 58.0–60.0% di-(2-ethylhexyl) adipate (MIL-D-13383) for Type II, all on a volatile free basis.

PHYSICAL. The binder loses no more than 0.6% volatile matter after 6 hr at 100–105 C, has no more than 0.5% foreign matter, a max acid number of 3.0, a penetration of 19–25 mm (Fed Test Method Std No. 791, Method 311), an RDX reagent reactivity of not greater than 1 ml gas at 100 C (MIL-R-398), has the odor of lube oil, contains no unincorporated lumps and leaves 5 grit particles per 50 gr of binder on a U S Standard No. 60 mesh sieve and 0 particles on a U S Standard No. 40 mesh sieve.

PROCESS. The binder is mixed with the other compounding ingredients including the explosive charge and cured at low temperatures under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The jelly binder is available in 55 gallon containers.

QPL

No.

MIL-I-15126 INSULATION TAPE, ELECTRICAL, PRESSURE-SENSITIVE ADHESIVE AND PRESSURE-SENSITIVE THERMOSETTING ADHESIVE

Issue: 15 January 1964 Revision: F Amendment: 2

SCOPE

This pressure-sensitive adhesive tape is intended for use in the construction and repair of electrical and electronic equipment.

CLASSIFICATION

The tape is available in twelve types.

Pressure Sensitive Thermosetting Heat Curing Adhesive

Type AFT	Acetate film backing
Type ACT	Acetate cloth backing
Type CFT	Cotton fabric backing
Type GFT	Glass fabric backing
Type PCT	Paper backing – crepe
Type PFT	Paper backing – flat
Type MFT-2.5	Polyethylene terephthalate film backing 2.5 mils nominal thickness
Type MFT-3.5	Polyethylene terephthalate film backing 3.5 mils nominal thickness

Pressure Sensitive Adhesive

Type EF-7	Polyethylene backing – 7 mils nominal thickness
Type EF-9	Polyethylene backing – 9 mils nominal thickness
Type EF-20	Polyethylene backing – 20 mils nominal thickness
Type MF-2.5	Polyethylene terephthalate backing – 2.5 mils nominal thickness

PROPERTIES

CHEMICAL. The tape consists of a backing (composition is given in Classification Section) coated on one side with an unspecified adhesive.

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

PROCESS. Types EF-7, EF-9, EF-20 and MF-2.5 do not require moisture, heat or other preparation prior to or subsequent to application. Types AFT, ACT, CFT, GFT, PCT, PFT, MFT-2.5 and MFT-3.5 require heat after application of the tape. A typical cure cycle is 130 C for 2 hours under contact pressure.

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

MIL-I-15126 (Continued)

TABLE I. PHYSICAL PROPERTIES OF MIL-I-15126 TAPE

Type	Thickness In. (1)	Thickness Tolerance, ± In. (1)	Tensile Strength Lb/In., at 23 C Min (1)	Dielectric Breakdown (3) Volts, min (1)	Dielectric Breakdown (3) Volts, min (2)	Conductance MicromicroOhms, max (4) (5)	Penetration Resistance °C (1) (6)
AFT	0.0035	0.0005	15	4,500	3,500	15	150
ACT	0.0080	0.0010	30	1,500	1,000	200	NR
CFT	0.0105	0.0015	40	1,000	500	2.0×10^5	NR
GFT	0.0070	0.0010	120	1,000	500	2.0×10^4	NR
PCT	0.0105	0.0010	15	1,000	500	2.0×10^5	NR
PFT	0.0060	0.0010	30	1,000	500	2.5×10^5	NR
EF-7	0.0070	0.0010	12	9,500	9,500	15	45
EF-9	0.0090	0.0015	15	12,000	11,000	15	45
EF-20	0.0200	0.0020	25	15,000	12,000	15	50
MFT-2.5	0.0025	0.0005	20	4,500	4,500	2	180
MF-2.5	0.0025	0.0005	20	4,500	4,500	2	200
MFT-3.5	0.0035	0.0005	30	6,000	6,000	2	200

(1) After conditioning 96 hours at 23 C and 50% RH.
(2) After conditioning 96 hours at 23 C and 96% RH.
(3) ASTM D295 and to convert to volts/mil divide value by thickness of film shown in table.
(4) After conditioning 18 hours at 23 C and 96% RH.
(5) At 100–130 D.C. impressed voltage. This property is also called Indirect Electrolytic Corrosion.
(6) The temperature at which a 1/16 inch ball bearing under a 1000 gram load bursts the tape.
NR = No Requirement

MIL-I-15126 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-I-15126 TAPE

Type	Peel Strength, oz/in., min (1) (4)	Adhesion to Backing, Peel oz/in. (2)	Adhesion to Backing, Peel oz/in. (3)	Bond Separation After Cure minutes (5)
AFT	35	15	40	30
ACT	25	NR	NR	NR
CFT	35	NR	NR	NR
GFT	16	40	100	30
PCT	20	NR	NR	NR
PFT	35	NR	NR	NR
EF-7	12	NR	NR	NR
EF-9	18	NR	NR	NR
EF-20	12	NR	NR	NR
MFT-2.5	20	8	25	30
MF-2.5	20	NR	NR	NR
MFT-3.5	35	NR	NR	NR

(1) After conditioning 96 hours at 23 C and 50% RH.
(2) After conditioning 2 hours at 23 C and 50% RH.
(3) After conditioning 2 hours at 130 C followed by 4 hours at 23 C and 50% RH.
(4) Corrosion resistant steel substrate (ASTM A167, Type 302 or 304) having a surface roughness between 10 and 20 microinches and tested per Fed Test Method Std No. 175, Method 1041.
(5) One half inch wide, one half inch long adhesive tape to backing lap joint sustains a 500 gram weight (Types AFT and MFT-2.5) and a 1000 gram weight (Type GFT) for the period shown at 130 C after curing 2 hours at 130 C under no load.
NR = No Requirement

FORM

The tape, unless otherwise specified, is available in the lengths shown in Table III.

MIL-I-15126 (Continued)

TABLE III. LENGTH OF MIL-I-15126 TAPE ROLLS

Type	Length per Roll, yd (1)	Core Diameter, in. Machine Application	Core Diameter, in. Hand Application
AFT	72	1, 1½, 3	3
ACT	72	1, 1½, 3	3
CFT	60	1, 1½, 3	3
GFT	60	1, 1½, 3	3
PCT	60	1, 1½, 3	3
PFT	60	1, 1½, 3	3
EF-7	22	1, 1½, 3	1
EF-9	18	1, 1½, 3	1
EF-20	18	1, 1½, 3	1
MFT-2.5	72	1, 1½, 3	3
MF-2.5	72	1, 1½, 3	3
MFT-3.5	72	1, 1½, 3	3

(1) Widths available are 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1-1/8, 1-1/4, 1-3/8 and 1-1/2 inches.

QPL

No.

NOTES

(1) Use Type AFT for internal coils and applications requiring high dielectric strength and good insulation and moisture resistance.

(2) Use Type ACT for all types of fine wire coils and transformers where good strength characteristics, fine electrical properties and noncorrosiveness are desired.

(3) Use Type CFT for small motors, dynameter armatures, generators and transformer coils where good varnish penetration and high tensile strength are desired.

(4) Use Type GFT in high heat locations where other adhesives tapes cannot be used.

(5) Use Type PCT and PFT for motor insulating, coil winding, repair of electric motors and reinforcing slot insulation.

(6) Use Types EF-7, EF-9 and EF-20 where high dielectric strength and good resistance to electrolytic corrosion are needed.

(7) Use Types MFT-2.5, MF-2.5 and MFT-3.5 for internal coil and other applications requiring high dielectric strength and good insulation and moisture resistance. These tapes are higher temperature resistant than Type AFT.

MIL-A-15199 (SHIPS) ADHESIVE, ASBESTOS CLOTH TO PIPE, INSULATION

Issue: 21 May 1959 Revision: B Amendment: None

SCOPE

This adhesive is intended for securing woven asbestos cloth to insulating material employed on piping or other such installations.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of sodium silicate and short asbestos fibers.

PHYSICAL. The adhesive is a paste.

PROCESS. The adhesive is applied to dried insulation by brushing, the asbestos cloth laid and the joint cured 72 hours at room temperature under contact pressure. The adhesive can be stored 1 year in air tight containers.

PERFORMANCE. The adhesive is sufficiently strong such that peeling the asbestos cloth (SS-C-466) from the insulation material (MIL-C-2861) will result in rupture of the insulation material and not the adhesive. No irritating or objectionable odors are given off when bonded composites are heated 2 hours at 200 F.

FORM

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

QPL

No.

NOTES

(1) This adhesive should not be used over painted metal surfaces or over fiberglass lagging since it adversely affects these materials.

MIL-S-15204 (SHIPS) SEALING COMPOUND, JOINT AND THREAD, HIGH TEMPERATURE

Issue: 17 September 1962 Revision: B Amendment: None

SCOPE

This compound is intended for sealing threaded and fixed mechanical joints in steam or gas powered equipment operating up to 950 F and 1200 psi pressure.

CLASSIFICATION

The compound is available in two types.

Type A Liquid form
Type B Paste or cement form

PROPERTIES

CHEMICAL. The compound, Type A, consists of a phenolic or cresylic resin base. Type B consists of a phenolic or cresylic resin base and an unspecified inert filler.

PHYSICAL. The compound has a solids content of not less than 85%, a flash point not less than 120 F, the Type A, a viscosity no greater than 100,000 centipoises at 75F and the Type B, a viscosity such that it will not sag or flow during 1 hour at room temperature from vertical surfaces when in 1/8 inch thicknesses. The compound has a heat resistance equivalent to a weight loss of 30% (Type A) and 15% (Type B) after 1 hour exposure to 800 F.

PROCESS. The compound is applied by brushing or injection, a torque of approximately 135 in.-lb applied and the joint cured 24 hours with superheated steam at practically no pressure.

PERFORMANCE. The compound adequately seals turbine casing joints such that no steam leakage occurs after 24 cycles of 4 hours duration, each between room temperature and 950 F under 1200 psi pressure. A torque not greater than 500 in.-lb is needed to undo sealed threaded joints.

FORM

The liquid and paste compound is available in 5 ounce collapsible tubes and 2½ pound containers.

QPL

Yes.

NOTES

(1) This specification is governed by Military Standard MS 35514 (CE), "Gasket Forming Compound, Pipe Joint, High Temperature; Colors, Container Sizes and Use Characteristics Thereof."

MIL-P-15384 (SHIPS) PLASTIC MIX, REFRACTORY (WATER-WALL, BOILER, CHROME ORE PLASTIC)

Issue: 15 December 1959 Revision: C Amendment: None

SCOPE

This plastic mix is intended as a thermally protective covering suitable up to 2800 F for boiler water-wall stud tubes, headers and as a combination gas seal where stud tubes form a water-wall such as in divided furnace boilers.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. This mix consists of refractory chrome ore containing at least 27% chromium oxide, unspecified binders and water.

PHYSICAL. The mix is sufficiently fine to pass at least 99% through a U S Standard No. 3 mesh sieve and at least 90% through a No. 4 mesh sieve.

PROCESS. The mix is applied by trowelling followed by tamping, air dried 48 hours at room temperature and the joint cured 5 hours at 2552 F under contact pressure. The cement has a workability factor between 15 and 40% deformation using a conventional sand rammer and a slump resistance of not more than 10% after heating 5 hours at 2552 F.

PERFORMANCE. The mix after cure has a linear shrinkage of not more than 3% and a modulus of rupture of at least 300 psi at room temperature after heating 5 hours at 1500 F.

FORM

The plastic mix is available in 200 pound containers.

QPL

No.

MIL-P-15731 (SHIPS) PLASTIC MIX, REFRACTORY (SUPERDUTY, FIRE CLAY)

Issue: 2 November 1960 Revision: B Amendment: 1

SCOPE

This plastic mix is intended for (1) boiler repairs, (2) installation around burner openings, (3) for corbels and (4) other boiler applications where a standard molded brick (9x4½x2½ inches) cannot be used.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The mix consists of grog (calcined clay), raw plastic clay and water.

PHYSICAL. The mix has a stiff mud consistency, a pyrometric cone equivalent of at least 32½ (3135 F) and is sufficiently fine to pass at least 95% through a U S Standard No. 4 mesh sieve.

PROCESS. The mix is applied by trowelling followed by tamping, air dried 24 hours at room temperature, oven dried 24 hours between 220 and 230 F and the joint cured 5 hours between 1500 and 2550 F. The mix has a workability index between 15 and 35% deformation using a conventional sand rammer, will not fuse, retains its volumetric configuration even after 2 cycles of 24 hours each at 3000 and 2900 F respectively, and can be stored 1 year in unopened containers.

PERFORMANCE. The mix after oven drying or after 5 hours cure at 1500, 2000 and 2550 has a linear shrinkage of not more than 2% and no more than 0.75% difference exists between cures at 2000 and 2550 F. No more than 5% spalling occurs after 10 cycles of alternate heating at 2650 F for 20 minutes and cooling 20 minutes in high velocity room temperature air. The mix has a modulus of rupture of at least 100 psi after 5 hours cure at 1500 F, 200 psi after 5 hours cure at 2000 F and 300 psi after 5 hours cure at 2550 F.

FORM

The paste mix is available in 100 and 200 pound containers.

QPL

Yes.

MIL-C-17069 CLAY, FIRE (BINDER FOR FOUNDRY MOLDING SANDS)

Issue: 27 August 1952 Revision: A Amendment: None

SCOPE

This clay is intended as a binder for foundry molding sands.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The binder consists of fire clay containing no grit.

PHYSICAL. The clay is sufficiently fine to pass at least 75% through a U S Standard No. 100 mesh sieve and has a pyrometric cone equivalent to not less than 3,002F (No. 30).

PROCESS. The binder is activated by mulling 200 grams of clay and 2000 grams of sand (fineness No. 50), 70 cc water added, the mixture cast into the required geometric configuration and cured at room temperature under contact pressure.

PERFORMANCE. The binder(see Process Section) has a compression strength of 7 psi green and 45 psi cured.

FORM

The powdered clay is available in commercial containers up to 100 pounds net weight.

QPL

No.

MIL-D-17260 DEXTRIN (FOUNDRY USE)

Issue: 20 July 1953 Revision: A Amendment: None

SCOPE

This adhesive is intended as a binder for foundry molding and core sand.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The binder consists of yellow corn dextrin containing no grit, sand or similar foreign substances.

PHYSICAL. The binder contains no more than 5% uncombined moisture, 0.3% ash and 3.0% water insoluble residue.

PROCESS. The dextrin is mixed with sand, activated with water, the mixture cast into the required geometric shape and cured at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The powdered dextrin is available in commercial multiwall kraft paper bags.

QPL

No.

MIL-S-17377 (SHIPS) SEALING COMPOUND, BOILER-CASING

Issue: 2 August 1960 Revision: C Amendment: 1

SCOPE

This compound is intended for sealing boiler casing joints against air leakage.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the compound is not given.

PHYSICAL. The compound is fire resistant such that after 15 seconds ignition time, it will not burn or smolder longer than 5 seconds nor will the flame propagate once the ignition source is removed.

PROCESS. The compound is applied below 86 F with a putty knife and cured at least 24 hours at room temperature under contact pressure.

PERFORMANCE. The compound does not leak more than 500 cubic centimeters per minute at 500 F under an air pressure equivalent to 100 inches water, and retains sufficient adhesiveness after 1 hour successive exposures to 200, 300, 400 and 500 F such that joints are difficult to break.

FORM

The paste sealing compound is available in 5 pound containers.

QPL

Yes.

MIL-A-17682 ADHESIVE, STARCH

Issue: 6 May 1963 Revision: B Amendment: None

SCOPE

This adhesive is intended for bonding paper and cloth.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of wheat starch containing an unspecified preservative.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-A-17682 ADHESIVE

PROPERTY	VALUE	
pH	3.5–7.0	
Odor, musty	None	
	Individual	Average
Spores, no./10 grams, max		
Aerobic thermophilic	150	125
Flat sour	75	50
Anaerobic thermophilic		
Non-Hydrogen sulfide producing	(1)	(1)
Hydrogen sulfide producing	5	(2)

(1) This spore is present in not more than three of five samples tested and in any one sample in not more than four of the six culture tubes used for testing.

(2) This spore is present in not more than two of five samples tested.

PROCESS. The adhesive is activated by mixing with water, applied by brushing, the joint closed and cured 4 hours at room temperature under contact pressure.

PERFORMANCE. The adhesive has sufficient adhesive strength such that in peel, failure occurs in the paper adherends (MIL-P-10831, Type I) and not in the adhesive.

FORM

The solid adhesive is available in 1 pound containers.

QPL

No.

MIL-I-17695 INSULATION TAPE, ELECTRICAL, FILLER TYPE, FLAMEPROOF, SYNTHETIC

Issue: 9 November 1960 Revision: A Amendment: None

SCOPE

This self-fusing tape is intended for reinsulating electrical cables.

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 self-fusing tape are tabulated in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-I-17695 TAPE

PROPERTY (1)	VALUE
Thickness, in., max	0.125
Tensile strength, lbs/in. width, min	8
Elongation, %, min	1000
Dielectric strength, volts/mil, min (1)	200
Insulation resistance, megohms, min (1), (2)	10^5
Electrolytic corrosion factor, min (1)	1.00
Flameproofness, self-extinguishing	Yes

(1) MIL-S-16524 (see Note Section No. 1).

(2) After 23 hours at 96% RH.

PROCESS. The tape, after removal of liner, is applied to the cable and molded by hand or winding machines and sets in 6 hours at room temperature.

PERFORMANCE. No performance properties are given.

FORM

The tape is available in 5 foot roll lengths in 1½ inch widths.

QPL

No.

NOTES

(1) MIL-S-16529, "Splicing, Electric, Cable (Method of)" defines the procedures and tests for insulating electric cables, specifically Types THFA and TSGA.

MIL-T-17991 (Aer) TAPE; WING SLOT, WATERPROOF, NON-CORROSIVE, PRESSURE-SENSITIVE

Issue: 16 April 1954 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended to cover small openings in airplanes, such as wing slots, to prevent entrance of dirt and moisture.

CLASSIFICATION

The tape is available in two forms.

Form A Sheet, with liner
Form B Roll, without liner

PROPERTIES

CHEMICAL. The tape consists of a backing composed of an untreated, long fibered hemp base paper laminated with a thin, transparent cellulose acetate nonfibrous film. The paper side is coated with an unspecified adhesive. Form A has a crepe paper liner.

PHYSICAL. The tape has a tensile strength of at least 8 lb/in. of width and a water penetration rate of no more than 35.0 gr/24 hr/100 sq in. under a one inch water head. The tape does not break or tear while being applied, but breaks under the impact of a ¾ inch steel ball falling 33 inches on tape held taut on a 4 by 3 inch frame.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. It can be stored as high as 160 F for 7 days without the adhesive deteriorating or transferring to liners nor the rolls distorting more than ½ inch.

PERFORMANCE. The tape has a peel strength of at least 15 oz/in. of width using a stainless steel adherend (UU-P-31, Method 100). After 24 hours contact with copper in a weatherometer (CCC-T-191, Method 5804) there is no corrosion or any blistering, curling or shrinkage greater than 1/16 inch in the tape. When stripped from the copper no more than 25% of the adhesive sticks to the metal and this can be removed with aromatic gasoline.

FORM

The width and length of Form A is specified by the end use. The Form B tape is available in 72 yard rolls wound on 3 inch diameter cores and, unless otherwise specified, in 4 inch widths. The rolls may contain up to three ½ inch splices.

QPL

No.

MIL-A-18065 ADHESIVE, HIGH INITIAL BOND

Issue: 17 December 1959 Revision: None Amendment: 1

SCOPE

This adhesive is intended for securing corkboard insulation to metal surfaces.

CLASSIFICATION

The adhesive is available in two classes.

Class 1 Fast setting
Class 2 Slow setting

PROPERTIES

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

PHYSICAL. The adhesive has a consistency between 25 and 35 mm at 77 F using a 150 gram weight cone (Fed Test Method Std No. 791, Method 31.1) and does not chip, scale, crack or otherwise fail when bent 180° on a ¼ inch diameter mandrel. Class 2 adhesive has a flash point not less than 120 F.

PROCESS. The adhesive is applied by trowelling to the cork insulation, air dried 5 minutes, the joint closed and cured 72 hours at room temperature under contact pressure. The adhesive can be stored 1 year in air tight containers.

PERFORMANCE. The adhesive immediately after 5 minutes air dry supports a 1 pound shear load using corkboard (HH-C-561) and mill scale surfaced steel adherends. The adhesive after 24 hour air dry protects steel against corrosion when subjected to 4% salt solution for 72 hours at 100 F. Additionally, Class 1 and 2 adhesives have a flatwise tensile strength of at least 1000 and 750 psf at 20 F, 60 and 60 psf at 75 F after 5 min. cure at 75 F, 1500 and 1500 psf at 75 F after 72 hr cure which does not change after 24 hr in water, and 1000 and 250 psf at 158 F (2 hr) using compressed cork (HH-C-561) and steel adherends; for 5 min. cure steel is substituted for aluminum.

FORM

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

QPL

Yes.

NOTES

(1) Use Class 1 in areas where fire and personnel hazards can be eliminated by ventilation and Class 2 in dead air spaces. These adhesives are suitable for use in submarines.

MIL-I-18622 (SHIPS) INSULATION TAPE, ELECTRICAL, PRESSURE-SENSITIVE ADHESIVE, SILICONE RUBBER TREATED GLASS, ELECTRICAL CABLE SPLICING, NAVAL SHIPBOARD

Issue: 8 June 1960 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced power and control cables where splice breakout is simple and high temperature resistance and mechanical strength are needed.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a woven glass fabric backing coated on one side with a silicone adhesive.

PHYSICAL. The tape has a thickness of 0.010 inch, a dielectric strength of at least 600 volts/mil after 96 hr at 23 C and 96% RH (prior to application of tape), a tensile strength of at least 90 lb/in. of width, and adhesion to backing of at least 9 oz/in. of width; backing consists of ECD 450 1/2 glass yarns woven square using 60 warp and fill threads per inch.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored 2 years.

PERFORMANCE. The dielectric strength, insulation resistance, flame resistance, cold bend and heat resistance do not vary from unspliced TSGA-150 cable when spliced with tape [see MIL-C-915, "Cable, Cord and Wire, Electrical (shipboard Use)" and MIL-C-2194, "Cables, Power, Electrical, Reduced Diameter Type, Naval Shipboard"].

FORM

The tape, unless otherwise specified, is available in 18 to 36 yard rolls wound on 1 inch diameter cores in ½, ¾, 1 and 1½ inch widths.

QPL

Yes.

MIL-C-18726 CEMENT, VINYL ALCOHOL-ACETATE

Issue: 11 June 1956 Revision: None Amendment: 1

SCOPE

This adhesive is intended for general purpose bonding of impervious surfaces.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of 22 to 26% polyvinyl alcohol-acetate in toluene. The polyvinyl alcohol component is between 8.0 and 9.5% of the composite resin.

PHYSICAL. The dry film is flexible and thermoplastic. The softening point may be raised a few degrees by repeated bakings between 400 and 500 F.

PROCESS. The cement is applied by brushing, dried (air evaporation and/or baking up to 500 F for a few seconds or 300 F for a few minutes), the joint closed and cured under heat and pressure in accordance with the supplier's instructions. Cellosolve or the lower alcohols can be used to thin the adhesive. Esters can be added to retard the rate of evaporation of the solvent.

PERFORMANCE. The cement produces strong, impact resistant bonds between impervious surfaces. No specific values are given.

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

NOTES

(1) The adhesive is suitable for bonding metals, phenolics, ureas, pyroxylin and cellulose acetate sheets. It is also effective with wood, paper and cloth.

MIL-I-19166 INSULATION TAPE, ELECTRICAL, HIGH TEMPERATURE, GLASS FIBER, PRESSURE-SENSITIVE

Issue: 19 July 1963 Revision: C Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for construction including securing coils and windings and repair of electrical equipment operating at high temperatures.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a continuous filament glass fabric backing coated on one side with a silicone adhesive.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-I-19166 TAPE

PROPERTY	THICKNESS, IN. 0.007	THICKNESS, IN. 0.010
Thickness tolerance, ± in.	0.001	0.001
Tensile strength, lb/in., at 23 C, min	150	150
Dielectric strength, volts, at 23 C, min (1) (2)		
After 96 hr at 23 C and 0% RH	2000	4000
After 96 hr at 23 C and 96% RH	1500	3000
Conductance, micromicromhos/in., max (3)		
After 18 hr at 75 F and 96% RH		
Average	4.0×10^4	4.0×10^4
Individual value	8.0×10^4	8.0×10^4

(1) ASTM D295.

(2) The dielectric strength after 168 hours at 250 C is equal to or greater than that obtained after conditioning 168 hours at 23 C and 50% RH.

(3) At 100–130 DC impressed voltage. This property is also called Indirect Electrolytic Corrosion.

MIL-I-19166 (Continued)

PROCESS. The tape does not require moisture, heat or other preparation prior to or subsequent to application. A maximum unwinding force of 80 ounces is necessary to unwind the 7 and 10 mil tapes at a rate of 20 ft/min.

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

TABLE II. PERFORMANCE PROPERTIES OF MIL-I-19166 TAPE

PROPERTY	THICKNESS, 0.007	THICKNESS, 0.010
Peel oz/in., at 23 C, min (1)		
To steel (2)	20	16
To backing	12	12
Creep, in/hr, under 1000 gr/sq in. load, max		
To steel (2)	0.050	0.050
To backing	0.050	0.050
Flagging, in., max (3)	0.125	0.125

(1) The peel strength, after 168 hours at 250 C, is equal to or greater than the peel strength after 168 hours at 23 C and 50% RH on both steel and backing; however, no values are given.
(2) Cold rolled, corrosion resistant steel substrate (ASTM A167, Type 302)
(3) The amount of unwinding on a brass rod after resting under no load 14 days at 23 C and 50% RH.

FORM

The natural colored tape, unless otherwise specified, is available in 36 yard rolls wound on 1 inch diameter cores in ½, ¾ and 1 inch widths.

QPL

Yes.

NOTES

(1) The supplier will state the number of fill and warp threads per inch making up the glass fabric backing.

MIL-P-19834 PLATE, IDENTIFICATION, METAL FOIL, ADHESIVE BACKED

Issue: 30 September 1960 Revision: A Amendment: 1

SCOPE

This adhesive-backed metal foil is intended for internal and external equipment identification.

CLASSIFICATION

The adhesive-backed metal foils are available in two types.

Type I Aluminum foil, pressure-sensitive, water-removable cellophane backing

Type II Aluminum foil, adhesive-backed, solvent-activated film

PROPERTIES

CHEMICAL. The identification plates consist of an anodized (MIL-A-8625, Types I or II) aluminum foil (MIL-A-148) coated on one side with an unspecified adhesive and protected with an unspecified film material liner.

PHYSICAL. The identification plates, 3 mils thick without adhesive, are available in the sizes given in Table I and contain markings, colors and gloss specified by the purchaser. Gothic capitals are used. Colors are limited to black, orange, red, blue or combinations thereof, per Fed Std No. 595.

PROCESS. The identification plate, Type I, is activated by immersion in water for no longer than 3 minutes, and Type II with solvent in accordance with the supplier's instructions, the plate applied and cured 96 hours at room temperature under contact pressure. The anodized aluminum plate identification surfaces are treated with one coat of Formula No. 117 coating (MIL-C-15328), one coat of zinc chromate primer (MIL-P-8565), dried 30 minutes, two coats of sea blue lacquer (MIL-L-7178) applied 30 minutes apart and allowed to dry at least 18 hours before applying the plates (for test).

PERFORMANCE. The identification plate characters are clearly visible after 500 cycles of abrasion, using a 1000 gram load (CCC-T-191, Method 5306). Additionally, these characters show no signs of cracking, flowing or softening after 8 cycles consisting of 16 hours at 105 C, 6 hours in 20% salt spray at room temperature followed by 2 hours at -40 C. The plates after the 8th cycle are not nicked, torn, or peeled when subjected to the cutting action of a knife under a 430 gram load. Further, no loss of characters or colors is observed after (1) accelerated oxygen aging consisting of 96 hours exposure to 300 psi oxygen at 70 C (CCC-T-191, Method 5852),

MIL-P-19834 (Continued)

(2) 200 hours accelerated weathering (CCC-T-191, Method 5804) and (3) 200 hours exposure to 20% salt spray at 95 F (Fed Test Method Std No. 141, Method 6061). The plates are not loosened, warped, cracked, corroded, illegible or discolored after (1) 12 hours immersion in tap water, (2) 1 hour exposure to hydrocarbon fluid (MIL-S-3136, Type III) or jet fuel (MIL-F-5161), (3) 1 minute exposure to cleaning agents (P-S-751 and MIL-C-25769) and (4) 3 hours exposure to -55 F followed by 3 hours to 105 C.

FORM

The adhesive-backed identification plates, unless otherwise specified, are available in packages of 10.

QPL

Yes.

TABLE I. PHYSICAL PROPERTIES OF MIL-P-19834 IDENTIFICATION PLATES

SIZE NO.	LENGTH, IN.	WIDTH, IN.
1	2	¾
2	2	1
3	2	2
4	3	1
5	3	2
6	3	3
7	4	1½
8	4	2
9	4	3
10	4	4
11	5	2
12	5	3
13	5	4
14	5	5
15	6	2
16	6	3
17	6	4
18	6	5
19	6	6
20	7	2
21	7	3
22	7	4
23	7	5
24	7	6
25	7	7

MIL-C-20299 COMPOUND, ADHESIVE, WATERPROOF

Issue: 21 November 1951 Revision: None Amendment: None

SCOPE

This adhesive is intended for waterproofing tape for ammunition components.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of equal parts of commercial gutta percha and pine tar pitch.

PHYSICAL. The adhesive has a melting point of 90-110 C, a specific gravity of 0.95-1.05, an ash content not greater than 2%, chloroform-insoluble matter not greater than 1%, acetone-insoluble matter of at least 15% and an acidity not greater than 0.1%.

PROCESS. The adhesive is melted, applied by brushing and cured (solidified) at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The solid adhesive, unless otherwise specified, is available in commercial packages.

QPL

No.

MIL-G-20469 GLUE (FOR USE IN LOADING AMMUNITION)

Issue: 27 November 1951 Revision: None Amendment: None

SCOPE

This glue is intended for the manufacture of ammunition fuzes and fiber cartons especially for ammunition.

CLASSIFICATION

The glue is available in two grades.

Grade I For fuze manufacture
Grade II For ammunition fiber containers

PROPERTIES

CHEMICAL. The Grade I glue consists of the proteinaceous extract from animal hides and contains no alum, zinc oxide or other inorganic preservatives. The Grade II glue consists of the proteinaceous extract from animal hides and bones and contains no more than 0.35% zinc and aluminum base preservatives. Both grades do not contain more than 0.4% grease and an ash content not greater than 4%.

PHYSICAL. The glue has a non objectionable odor, a moisture content between 9 and 15%, a viscosity of 48 millipoises at 60 C (11% aqueous solution), a pH between 5.5 and 7.5, and a jelly strength of at least 135 grams at 10 C (Bloom Gelometer).

PROCESS. The glue is activated by mixing with water, the mixture melted at 62 C, applied hot by brushing, the joint closed and cured (solidified) at room temperature under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The solid adhesive is available in commercial packages.

QPL

No.

NOTES

(1) This specification was cancelled 11 October 1963.

MIL-A-21016 ADHESIVE, LINOLEUM AND PLASTIC TILE

Issue: 28 November 1962 Revision: D Amendment: None

SCOPE

This adhesive is intended for installation of fire-resistant linoleum and plastic tiles to steel flooring.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a water base latex.

PHYSICAL. The adhesive has a viscosity at 70 F of at least 20,000 centipoises.

PROCESS. The adhesive is applied by trowelling in thicknesses of 1/16 inch, air dried 12 minutes, the tile laid and the joint cured at room temperature under contact pressure (no time specified). The adhesive can be stored 1 year in unopened containers.

PERFORMANCE. The adhesive does not corrode mild steel and is fire resistant. The adhesive strength in cleavage for different curring times is given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-21016 ADHESIVE

PROPERTY	CURING TIME, HR 1	96
Cleavage, lb, RT, min (1)		
Linoleum tile – steel (2)		
Initial	3.0	10.0
After 48 hr in water	NR	8.0
Plastic tile – steel (2)		
Initial	1.5	7.5
After 48 hr in water	NR	6.0

(1) Pounds of force necessary to separate the joint (3 inches wide and 3½ inches long) adherends at least 1/8 inch thick.

(2) Linoleum tile (MIL-T-2904), plastic tile (MIL-T-18830) and mild steel adherends.

NR = No Requirement

FORM

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

QPL

Yes.

MIL-A-21366 (SHIPS) ADHESIVE, PLASTIC TABLE TOP MATERIAL TO ALUMINUM BONDING

Issue: 11 May 1960 Revision: None Amendment: 1

SCOPE

This adhesive is intended for bonding decorative plastic laminates to aluminum.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of a neoprene-phenolic resin mixture. Separate, unspecified solvents and extenders to modify the consistency may be added by the supplier.

PHYSICAL. The adhesive is a liquid or paste.

PROCESS. The adhesive is applied by brushing in accordance with the supplier's instructions and the joint cured 10 days at 70 F under contact pressure. The adhesive requires stirring, remains brushable for at least four hours after stirring, and can be stored in air tight containers for 6 months at 70 F.

PERFORMANCE. The adhesive has sufficient cleavage strength to sustain for 24 hours a ten pound load without more than 25% of the bonded specimens failing, and no more than 1/16 inch separation under a 20-pound load, both loads applied to a 1 inch by 5 inch joint consisting of decorative laminate (MIL-T-17171) and 6061 T6 Aluminum (QQ-A-327) adherends.

FORM

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

QPL

No.

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

Issue: 6 July 1959 Revision: None Amendment: 1

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 160 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 cellulose nitrate (MIL-L-7178) and 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 160 F and 85% RH prior to application. Areas of white cellulose nitrate lacquer and white acrylic-nitrocellulose lacquer 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 and, unless otherwise specified, in 1, 2 and 3 inch widths without liners. 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-22010 (SHIPS) ADHESIVE, SOLVENT TYPE POLYVINYL CHLORIDE

Issue: 9 June 1961 Revision: A Amendment: 1

SCOPE

This adhesive is intended for assembling rigid high impact polyvinyl chloride pipe and high impact socket type fittings.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of polyvinyl chloride, stabilizers, additives and colors (light gray approximating Color No. 36270 of Fed Std 595, unless otherwise specified).

PHYSICAL. The adhesive is nontoxic, has a solids content of 12% of which 75% is polyvinyl chloride and a viscosity at 75 F between 700 and 1500 centipoises.

PROCESS. The adhesive is applied by brushing on two coats, the joint closed within 60 seconds after application of adhesive (open assembly time) and cured 48 hours at room temperature under contact pressure. The adhesive can be stored 6 months. Any gelation or separation occurring during storage can be eliminated by stirring.

PERFORMANCE. The adhesive has a shear strength at room temperature of at least 1000 and 600 psi, respectively, using ¼ inch thick rigidhigh impact grade polyvinyl chloride (MIL-P-17638) bonded at 0 and 60 seconds open assembly time. Bonded joints of one inch schedule 120 rigid high impact polyvinyl chloride pipe (MIL-P-19119) and one inch rigidhigh impact socket type polyvinyl chloride couplings are capable of withstanding 500 psi hydrostatic pressure without leakage for 8 hours.

FORM

The liquid adhesive is available in 1 pint containers.

QPL

No.

NOTES

(1) The adhesive is suitable for drinking water plumbing systems.

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

Issue: 1 June 1961 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for exterior preservation and sealing at temperatures varying between -65 F and 140 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	8.5
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 500 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.

MIL-T-22085 (Continued)

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 500 hours accelerated 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 140 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 oil having an aniline point between 160 and 180 F and a saybolt viscosity between 30 and 40 SSU at 160 F under a 1/16 inch head.

FORM

The black or natural colored tape is available in 36 and 60 yard rolls wound 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-22397 ADHESIVE, PHENOL AND RESORCINOL RESIN BASE (FOR MARINE SERVICE USE)

Issue: 8 September 1960 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding wood including the fabrication of wood laminates for ship and boat use and other severe exterior service where high strength, salt water resistance, resistance to shrinking and swelling and long time durability is required.

CLASSIFICATION

The adhesive is available in two grades.

Grade A One year storage life
Grade B Two months storage life (immediate use)

PROPERTIES

CHEMICAL. The adhesive consists of a phenolic, resorcinol or a combination of both resins containing not more than 20% insoluble material based on nonvolatile constituents. Any fillers, either separate or incorporated in the resin, are water insoluble and nonswelling and contain no amylaceous (flour or starch) or protein materials. A separate or incorporated hardener may be used.

PHYSICAL. The pH of the set film is between 3.5 and 11.

PROCESS. The adhesive is applied by brush or squeegee techniques requiring a double spread no greater than 70 pounds per 1000 square feet, the joint closed and cured no longer than 7 hours at 150F under no more than 225 psi bonding pressure. The working life is not less than 2.5 hours at 75 F. The uncured, catalyzed adhesive is removable with water, 0.5% sodium hydroxide, alcohol, or any combination of these materials. The minimum closed assembly period prior to cure is 15 minutes and the range between maximum and minimum closed assembly periods is not less than 40 minutes. Alternate cure cycles are given by the supplier, but in no case is it higher than 215 F. Grade A adhesive can be stored 1 year and Grade B, for 2 months, both at room temperature in tightly closed containers.

PERFORMANCE. The adhesive, using white oak adherends, has an ultimate block shear strength of 2000 psi at 75 F with no less than 80% average wood failure (Fed Test Method Std No. 175, Method 1031). No more than 5% delamination occurs after three cycles of soaking in water and drying 88 hours at 80-85 F. The soaking consists of submerging bonded white oak in 65-80 F water, cycling twice between a vacuum of 20-25 inches for two hours and than a pressure of 80 psi for two hours.

MIL-A-22397 (Continued)

FORM

The liquid adhesive is available in one pint, 1, 5, 30 or 55 gallon containers. The hardeners are furnished in containers of such capacity to provide the correct stoichiometric quantity for an individual container of adhesive.

QPL

Yes.

NOTES

(1) This specification supersedes. cancelled specification MIL-A-397, Type II, Class 2.

MIL-A-22434 (Wep) ADHESIVE, POLYESTER, THIXOTROPIC

Issue: 7 March 1961 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding glass fabric reinforced epoxy laminates to metal where voids up to 0.020 inches must be bridged when applied to vertical and horizontal surfaces.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of 75.0 ± 3.75 parts (by weight) Class 1 resin (Paraplex P43, Rohm & Haas Co.), 25.0 ± 1.25 parts Class 2 resin (Paraplex P13, Rohm & Haas Co.), 0.8 ± 0.04 methyl ethyl ketone peroxide (Lupersol DDM, Wallace & Tiernan, Inc.), 1.5 ± 0.075 parts cobalt naphthenate (TT-D-643, Type II) and 6.0 ± 1.0 thixotropic agent (Cab-O-Sil, Godfrey L. Cabot, Inc.).

PHYSICAL. The thixotropic adhesive, 15 minutes after addition of catalyst, maintains an irregular surface forming peaks when extruded through a 0.051 inch diameter orifice.

PROCESS. The adhesive is activated by mixing Class 1 and 2 resins, adding methyl ketone peroxide, followed by cobalt naphthenate, and ultimately the dry thixotropic agent in the proportions given in the Chemical section. The activated adhesive is applied by brushing, the joint closed and cured either seven days at room temperature or 2 hours at 160 F followed by 72 hours at room temperature, both under 4 psi bonding pressure.

PERFORMANCE. The adhesive has a tensile strength at 75 F of at least 3000 psi when cured seven days at room temperature using glass reinforced epoxy laminate (MIL-G-21729) and 18–8, Type 303 stainless steel adherends. Curing at 160 F (see Process section) reduces the tensile strength to not less than 2500 psi.

FORM

The ingredients are available in commercial packages.

QPL

No.

NOTES

(1) Mixing the peroxide and cobalt naphthenate together directly may result in an explosion.

MIL-I-22444 (SHIPS) INSULATION TAPE, ELECTRICAL, SELF BONDING, SILICONE RUBBER TREATED BIAS WEAVE GLASS, CABLE SPLICING, NAVAL SHIPBOARD

Issue: 1 April 1962 Revision: None Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for insulating spliced power and control cables where splice breakout is complex and high temperature resistance and mechanical strength are needed.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a bias woven glass fabric backing coated on both sides with a silicone adhesive and an unspecified separator.

PHYSICAL. The tape is 0.015–0.020 inch thick, has a dielectric strength of at least 850 volts/mil after 96 hr at 23 C and 96% RH (ASTM D295), a tensile strength and elongation of at least 75 lb/in. of width and 10%. The tensile strength for spliced tape is at least 80% of the unspliced tape with no more than 0.002 inch thickness buildup in spliced area.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application except for removal of the liner. A force of 1 lb/in. of width is necessary to unwind the tape. It can be stored one year at room temperature.

PERFORMANCE. The dielectric strength, insulation resistance, cold bend, and heat resistance do not vary from unspliced TSGA-150 cable when spliced with tape [see MIL-C-915, "Cable, Cord and Wire Electrical (Shipboard Use)" and MIL-C-2194, "Cables Power, Electrical Reduced Diameter Type, Naval Shipboard"].

FORM

The tape, unless otherwise specified, is available in 20 yard rolls wound on 1 inch diameter cores in ½, ¾, 1 and 1½ inch widths.

QPL

No.

MIL-C-22608 (Wep) COMPOUND, INSULATING, HIGH TEMPERATURE

Issue: 8 August 1960 Revision: None Amendment: None

SCOPE

This compound is intended for thermally insulating rocket engines.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the compound is not given; however, it is a water base material.

PHYSICAL. The grey to tan colored compound is sufficiently fine to pass completely through a U S Standard No. 20 mesh sieve, has a solids content between 52 and 58% after drying 16 hours between 70 and 75 C and a specific gravity between 2.01 and 2.09.

PROCESS. The compound is applied by trowelling or spraying when suitably diluted with water, air dried 16 to 18 hours at room temperature and cured at least 2 hours between 91 and 96 C under contact pressure.

PERFORMANCE. The compound has sufficient strength such that impact loads of 7000 gram feet will not cause it to flake, chip or separate from cold roll steel adherends (QQ-S-692). Further, it will not lump or blister when subjected to a blow torch for 3 seconds giving a temperature rise greater than 220 F.

FORM

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

QPL

No.

MIL-A-22611 (Wep) ADHESIVES, FOR POLYVINYL CHLORIDE-COATED CLOTH

Issue: 18 August 1960 Revision: None Amendment: None

SCOPE

This adhesive is intended for repairing polyvinyl chloride coated nylon cloth protective covers.

CLASSIFICATION

The adhesive is available in two types.

Type I Vinyl chloride polymer base
Type II Synthetic rubber base

PROPERTIES

CHEMICAL. The Type I adhesive consists of at least a 20% solution of vinyl chloride polymer and Type II 23.0% synthetic rubber. The solvent is not specified.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is applied by brushing, the joint closed and cured at room temperature under contact pressure. No cure time is given; however, 24 hours is usually satisfactory. The adhesive in air tight containers can be stored 6 months at room temperature.

PERFORMANCE. The adhesive has a shear strength of 360 psi, Type I, and 240 psi, Type II, (Fed Test Method Std No. 175, Method 1033) using polyvinyl chloride coated nylon fabric adherends (MIL-C-20696, Type II, Class 4). The shear strength does not drop more than 5% after 100 hours immersion in 20% salt spray (Fed Test Method Std No. 151, Method 811).

FORM

The liquid adhesive is available in pint and quart containers.

QPL

No.

MIL-T-22755 TAPE, REPAIR; MAGNETIC MINESWEEPING CABLE SHEATH

Issue 11 December 1962   Revision: None   Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended for insulating splices and for making watertight repairs.

CLASSIFICATION

The tape is available in two types.

Type I Synthetic or natural rubber

Type II Synthetic or natural rubber coated cotton fabric

PROPERTIES

CHEMICAL. The Type I is an unsupported tape consisting of unvulcanized or partially vulcanized natural or synthetic rubber containing no reclaim. A parchment paper or glazed sheeting liner is used. The Type II supported tape consists of a clean cotton fabric backing, known commercially as "clean Osnaberg" weighing approximately 4.5 oz/sq yd and coated on one side by the frictioning process with wholly unvulcanized natural or synthetic rubber. No solvents or diluents are used.

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

PROCESS. The tape is applied by winding and cured 30 minutes at 310 F under 500 psi bonding pressure; a tie cement (see Note Section No. 1) is used between the tape and conductor.

PERFORMANCE. The tape, as received or after aging the roll 28 days at 140 F, is sufficiently tacky such that it will adhere to itself (Fed Test Method Std No. 601, Method 13151) and fuses under a winding force of 4 lb/in. of width (Fed Test Method Std No. 601, Method 13131). It has also a peel strength at 75 F of 15 lb/in. of width after vulcanization to both vulcanized SBR and neoprene adherends using the tie cement given in Note Section No. 1. The composition of the SBR and neoprene adhesives are given in Note Section No. 2.

FORM

The tape is available in 21 foot (Type I) and 60 foot rolls in 2 inch widths.

QPL

Yes.

NOTES

(1) The tie cement consists of the composition given in Table

MIL-T-22755 (Continued)

II. After milling, it is dissolved in 833 parts by weight of toluene to make a 15% solids content cement.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-22755 TAPE

PROPERTY	TYPE I	TYPE II
Thickness, in.	0.030	0.015
Thickness tolerance, ± in.	0.003	0.0015
Tensile strength, psi, at 75 F, min (1)		
Initial	250	250
After 28 days at 140 F	250	250
Vulcanized 30 min at 310 F	2000	2000
Elongation, ultimate, %, at 75 F, min (2)		
Initial	300	300
After 28 days at 140 F	300	300
Vulcanized 30 min. at 310 F	400	400
Dielectric strength, volts/mil, at 75 F, min (3)		
Initial	350	350
Immersion in 75 F water		
48 hours	300	300
160 hours	250	250
Breaking strength, lb/in., at 75 F, min (4)	NR	40

(1) Fed Test Method Std 601, Method 13021.
(2) Fed Test Method Std 601, Method 13031.
(3) Fed Test Method Std 601, Method 13321.
(4) Fed Test Method Std 601, Method 13011.

TABLE II. CHEMICAL COMPOSITION OF TIE CEMENT FOR MIL-T-22755 TAPE

INGREDIENTS	PARTS BY WEIGHT
Smoked sheet	100
Zinc oxide treated with proprionic acid (Protox 166)	5
Medium processing channel black (Micronex)	20
Semireinforcing furnace black (Pelletex)	20
Stearic acid	2
Pine tar	2
RPA No. 2	0.2
Phenyl beta naphthylamine (Neozone D)	1.5
2-Mercaptobenzothiazole (Captax)	1
Sulfur with small percentage of magnesium carbonate (Spider Sulfur)	5

MIL-A-22895 (SHIPS) ADHESIVE, METAL IDENTIFICATION PLATE

Issue: 25 June 1962   Revision: None   Amendment: 1

SCOPE

This adhesive is intended for bonding metal identification plates to painted or unpainted surfaces.

CLASSIFICATION

The adhesive is available in two classes.

- Class A Polysulfide adhesive for knife application to metal identification plates
- Class B Rubber adhesive for brush application to metal identification plates not exceeding 0.030 inch thickness

PROPERTIES

CHEMICAL. The Class A adhesive consists of a liquid polysulfide base rubber and a separate, unspecified curing agent. Class B consists of a neoprene or nitrile rubber base in no more than 65% of an unspecified solvent.

PHYSICAL. The Class A adhesive base is light in color while the curing agent is of contrasting color. Class B adhesive is also light in color.

PROCESS. The Class A adhesive is activated by mixing rubber base and curing agent, applied with a 1/8 inch notched putty knife, the joint closed and cured 7 days at room temperature under contact pressure. The Class B adhesive is applied by brushing and the cure can be accelerated by heating at least 12 hours at 45 C. The Class A adhesive has a working life of 2 hours. Both classes have sufficient tack to hold identification plates in a vertical position without slipping or separation and both can be stored 1 year at temperatures between -30 and 100 F.

PERFORMANCE. The adhesive can sustain (1) vibration for 24 hours at 120 F through the resonant point (MIL STD 167, Type I, vertical mode only), (2) shock at room temperature (MIL-S-901, back blows only), and (3) impact imposed by bending 90° with 12 approximately equal blows using a 1¾ pound ball peen hammer; all use anodized, hydrated, annealed 1100-0 aluminum alloy identification plate and zinc chromate primed (MIL-P-735, Formula 84 or MIL-P-17545, Formula 11C) alkyd enameled (MIL-E-15130, Formula 5H-27) steel adherends.

MIL-A-22895 (Continued)

FORM

The liquid adhesive is available in ½ pint, pint, quart and gallon containers. The proper stoichiometric quantity of curing agent is available in glass containers for the amount of Class A adhesive supplied.

QPL

No.

NOTES

(1) The adhesive is intended for both interior and exterior exposures.

(2) Class A is limited to identification plates up to 0.098 inch thickness and can sustain short time exposures up to 400 F.

(3) Class B is limited to identification plates up to 0.030 inch thickness and has a maximum service temperature up to 200 F.

MIL-C-23092 (SHIPS) CEMENT, NATURAL RUBBER

Issue: 4 December 1961 Revision: None Amendment: None

SCOPE

This cement is intended for vulcanized and unvulcanized bonding of natural, SBR and neoprene rubbers.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of natural rubber in an unspecified solvent. No reclaimed rubber is used.

PHYSICAL. The viscosity of the cement at 75 F is between 110 and 150 seconds (Ford cup, ¼ inch orifice).

PROCESS. The cement is applied by brushing, air dried until the odor of the solvent is no longer apparent, the joint closed and either vulcanized 30 minutes at 310 F under 500 psi pressure or cured 30 minutes at room temperature under contact pressure. The adhesive can be stored 28 days at 140 F in unopened containers.

PERFORMANCE. The cement, either aged (28 days at 140 F) or unaged, has a peel strength of 15 lb/in. of width at room temperature using both vulcanized and unvulcanized bonds of rubber (MIL-T-22755) to SBR or neoprene rubber (Fed Test Method Std No. 601, Method 8011).

FORM

The liquid adhesive is available in 4 and 8 ounce light resistant glass containers.

QPL

Yes.

MIL-T-23142 (Wep) TAPE, PRESSURE-SENSITIVE ADHESIVE FOR DISSIMILAR METAL SEPARATION

Issue: 10 May 1962 Revision: None Amendment: 1

SCOPE

This pressure-sensitive adhesive tape is intended as a separator for the prevention of galvanic attack between dissimilar metals.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The tape is no more than 0.004 inch thick, has a tensile strength at 75 F of at least 15 lb/in. of width and a puncture resistance of at least 325 F (1000 gram load applied through a 1/16 inch ball bearing).

PROCESS. The tape requires no solvent, heat or other preparation prior to or subsequent to application. It can be stored up to 14 days at 100 F under 85% RH and up to 1 year at room temperature in unopened packages without adhesive flow, telescoping or roll distortion greater than ½ inch.

PERFORMANCE. The tape will not lift or shrink from 2024 aluminum when overcoated with white acrylic-nitrocellulose lacquer (MIL-L-19537). Further, it will not corrode, pit or etch AZ31A-H24 magnesium after 48 hours exposure to synthetic sea water (MIL-C-18687) and after 4 cycles consisting of 100 hours in a weatherometer (Fed Test Method Std No. 141, Method 6151), 48 hours at 0 F, followed again for 100 hours in the above weatherometer. The tape has a peel strength of at least 20 oz/in. of width at 75 F and 14 oz/in. at 75 F after (separately) (1) 14 days at 100 F and 85% RH (prior to application of tape), (2) 48 hr in 155 F di-2-ethylhexyl sebacate and (3) 48 hr in 155 F mineral oil using an AZ31A-H24 magnesium substrate which has undergone a chrome pickle (QQ-M-44).

FORM

The tape, unless otherwise specified, is available in 72 yard rolls wound on 3 inch diameter cores in 1 inch widths.

QPL

No.

MIL-T-23397 (ASG) TAPE, PRESSURE-SENSITIVE ADHESIVE, FOR MASKING DURING PAINT STRIPPING OPERATIONS

Issue: 23 August 1963 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive is intended for masking purposes during paint stripping operations.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the tape is not given.

PHYSICAL. The tape has a tensile strength of at least 15 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. A maximum force of 4.0 lb/in. of width will unroll the tape. The tape can be stored 1 year in unopened containers without adhesive flow on sides, telescoping, or roll distortion greater than ½ inch.

PERFORMANCE. The tape has a peel strength of at least 25 oz/in. of width to stainless steel (QQ-S-766), AZ31 magnesium (QQ-M-44) and 7075 Alclad aluminum (QQ-A-287) and 20 oz/in. of width to its own backing. The tape is resistant to water rinsable paint remover (MIL-R-8633) and to steam cleaning at 90 to 100 psi steam pressure using steam cleaning compounds (P-S-751 or MIL-C-22542).

FORM

The tape, unless otherwise specified, is available in 60 yard rolls wound on 3 inch diameter cores in 2 inch widths. Each roll may contain up to three splices.

QPL

No.

MIL-T-23594 (Wep) TAPES, PRESSURE-SENSITIVE ADHESIVE, ELECTRICAL; HIGH TEMPERATURE INSULATION, POLYTETRAFLUORO-ETHYLENE

Issue: 8 February 1963 Revision: None Amendment: None

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 Figures 1 and 2. The other physical properties of the tape are given in Table I.

TABLE I. 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

MIL-T-23594 (Continued)

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 supercedes cancelled MIL-T-22742 and MIL-T-22260.

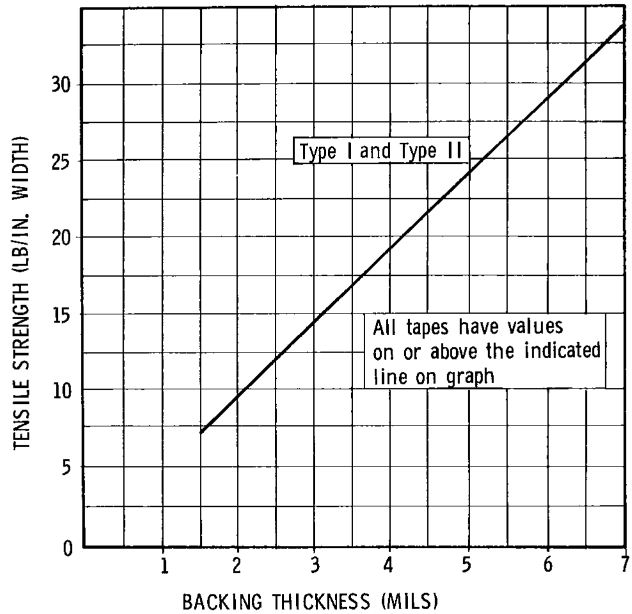


Figure 1. Tensile Strength Properties of MIL-T-23594 Tape.

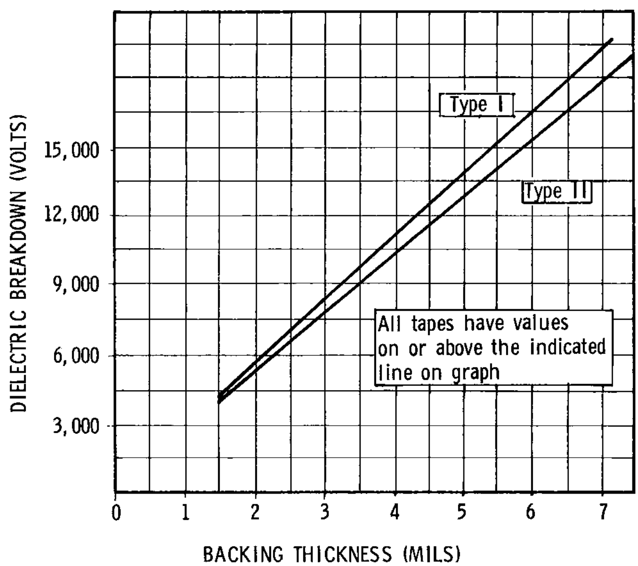


Figure 2. Dielectric Strength Properties of MIL-T-23594 Tape.

MIL-A-25055 (USAF) ADHESIVE, ACRYLIC MONOMER AND POLYMER BASE, FOR ACRYLIC PLASTICS

Issue: 17 June 1957 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding acrylic plastics (MIL-P-8184 and MIL-P-5425).

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of methyl methacrylate and an unspecified inhibitor. An unspecified catalyst is supplied separately.

PHYSICAL. The adhesive, prior to addition of catalyst, is a colorless, transparent liquid. It has at 75 F an index of refraction between 1.432 and 1.434, a specific gravity between 1.028 and 1.036 and a viscosity between Y (17.6 poises) and Z-2 (36.2 poises) on the Gardner-Holdt scale.

PROCESS. The adhesive is activated by mixing base resin and catalyst, applied by brushing, the joint closed and cured at room temperature for at least 12 hours under bonding pressures defined by the supplier. The adhesive should be stored preferably in a cool place and under no circumstances above 104 F for any protracted period. However, exposure to 122 F for 1 week in unopened containers will not alter the viscosity of the base resin.

PERFORMANCE. The adhesive has a minimum and average flatwise tensile strength of 2300 and 2700 psi at 75 F; 2300 and 3100 psi at 75 F after 24 hr at 160 F; and 2000 and 2700 psi at 160 F using acrylic plastic adherends (MIL-P-8184).

FORM

The liquid adhesive is available in pint, quart and gallon containers. The catalyst package in the required stoichiometric proportions is securely joined to the adhesive package.

QPL

No.

NOTE

(1) This adhesive should preferably not be procured in quantities greater than that which can be used in 5 months after date of manufacture.

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

Issue: 18 March 1957   Revision: A   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 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 adhesive after 6 hr, 24 hr, 72 hr and 7 day cures has a peel strength of at least 2, 8, ____, 10 lb/in. of width at 70 F using silicone rubber adherends (MIL-R-5847, Type II) and using silicone rubber to 2024 Alclad aluminum (QQ-A-362) 4, 8, ____, 10 lb/in. at 70 F; ____, ____, 8.5, ____ lb/in. at 70 F after 24 hr in water; ____, ____, 8.0, ____ lb/in. at 70 F after 24 hr in Medium No. 1 oil (Fed Test Method Std No. 601, Method 6001); and ____, 2.0, ____ lb/in. at 70 F after 24 hr at 212 F.

FORM

The paste adhesive is available in commercial packages; however, the two part adhesive is packed together in the proper stoichiometric proportions.

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-25463 (ASG) ADHESIVE, METALLIC STRUCTURAL SANDWICH CONSTRUCTION

Issue: 19 October 1961 Revision: None Amendment: 2

SCOPE

This adhesive is intended primarily for fabricating metal sandwich structures subjected to temperatures between -67 and 500 F.

CLASSIFICATION

The adhesive is available in four types and two classes.

Type I Long time exposure (-67 to +180F)
Type II Long time exposure (-67 to +300F)
Type III Long time exposure (-67 to 300F)
Short time exposure (300 to 500F)
Type IV Long time exposure (-67 to +500F)

Class 1 Bonding metal facings to metal cores only
Class 2 Bonding metal facings to metal cores, inserts, edge attachments and other components of sandwich structures.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given. Separate fillers, catalysts and solvents may be incorporated.

PHYSICAL. The adhesive is a liquid, solid, tape or film. The weight of the tape is normally 0.020 lb/sq ft.

PROCESS. The adhesive is activated by mixing base resin, catalyst, solvent and filler, if any, applied by brushing, the joint closed and cured in accordance with the conditions given in Table I. The solid film or tape adhesive, usually refrigerated, is applied directly after warming to room temperature. Application is normally between 60 and 100 F and relative humidities between 30 and 80%. Storage life conditions as well as other instructions are given by the supplier.

TABLE I. PROCESS PROPERTIES OF MIL-A-25463 ADHESIVE

CURING CONDITIONS	TYPES (1) I	II	III	IV
Temperature, °F, max	350	350	800	800
Pressure, psi, max	75	75	100	100
Time, hr, max	2	2	3	3

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

MIL-A-25463 (Continued)

PERFORMANCE. The performance properties of the adhesive are given in Table II. Class 2 adhesives also have minimum properties as specified in MIL-A-5090 (see abstract).

FORM

The adhesive is available in commercial packages.

QPL

Yes.

NOTES

(1) The supplier will advise if there are any restrictions with respect to usage with perforated and nonperforated core.

(2) The adhesive covered by this specification can be used to bond metal core to plastic facings, plastic core to plastic facings, and plastic inserts and edge members to plastic or metal facings. However, the above mechanical properties may not be applicacable.

MIL-A-25463 (Continued)

TABLE II. MECHANICAL PROPERTIES OF MIL-A-25463 ADHESIVE

PROPERTY	TYPE I Avg	TYPE I Individual	TYPE II Avg	TYPE II Individual	TYPE III Avg	TYPE III Individual	TYPE IV Avg	TYPE IV Individual
Flexure, lb, min (1)								
At –67 F, 10 min	1750	1575	1750	1575	1750	1575	1750	1575
At 75 F								
Initial	1750	1575	1750	1575	1750	1575	1750	1575
After 30 days immersion in								
Humid air (2)	1500	1350	1500	1350	1500	1350	1500	1350
Salt Spray (3)	1500	1350	1500	1350	1500	1350	1500	1350
Aromatic hydrocarbon (MIL-S-3136, Type III)	1500	1350	1500	1350	1500	1350	1500	1350
At 180 F								
After 10 min.	1200	1080	NR	NR	NR	NR	NR	NR
After 192 hr	1000	900	NR	NR	NR	NR	NR	NR
At 300 F								
After 10 min.	NR	NR	1500	1350	NR	NR	NR	NR
After 192 hr	NR	NR	1200	1080	1200	1080	NR	NR
At 500 F								
After 10 min.	NR	NR	NR	NR	1200	1080	1200	1080
After 192 hr	NR	NR	NR	NR	NR	NR	600	540
Creep, deflection, in flexure, in., max (1)								
After 192 hr at								
75 F – 1000 lb load	0.025		0.025		0.025		0.025	
180 F – 800 lb load	0.05		NR		NR		NR	
300 F – 1000 lb load	NR		0.05		0.05		NR	

MIL-A-25463 (Continued)

TABLE II. MECHANICAL PROPERTIES OF MIL-A-25463 ADHESIVE (Continued)

PROPERTY	TYPE I Avg.	TYPE I Individual	TYPE II Avg	TYPE II Individual	TYPE III Avg	TYPE III Individual	TYPE IV Avg	TYPE IV Individual
500 F – 500 lb load	NR		NR		NR		0.05	
Tension, flatwise, psi, min (4)								
At –67 F, 10 min.	350	315	350	315	350	315	350	315
At 75 F	450	400	450	400	450	400	450	400
At 180 F, 10 min.	220	190	NR	NR	NR	NR	NR	NR
At 300 F, 10 min.	NR	NR	350	315	NR	NR	NR	NR
At 500 F, 10 min.	NR	NR	NR	NR	270	240	270	240
Peel, lb in./in., min (5)								
At –67 F, 10 min.	2	1	2	1	2	1	2	1
At 75 F	8.5	7	8.5	7	3.5	2	3.5	2
At 180 F, 10 min.	5	3	5	3	3.5	2	3.5	2

(1) MIL-STD-401, using 6 inch span length, 1 inch overhang and double point loading at third points of sandwich. Types I and II use 0.063 ± 0.003 inch 2024-T3 Alclad aluminum facings (QQ-A-362) bonded to 0.50 inch thick perforated aluminum core (MIL-C-7438, Code 7.9 – ¼ – 40 P (3003)). Types III and IV use 0.050 ± 0.005 inch, Type 17-7 PH, Condition TH 1050 stainless steel facings (MIL-S-25043) bonded to 0.50 inch thick, ¼ inch cell size, perforated (unless otherwise specified) 0.002 inch foil size, Condition TH 1050 stainless steel honeycomb core (MIL-S-25043).

(2) 30 days at 120 F and 100% RH.

(3) Fed Test Method Std No. 151, Method 811.

(4) MIL-STD-401 and materials given in Note (1), except bare 2024-T4 aluminum (QQ-A-355) is used for facings with Types I and II adhesive.

(5) All types use 0.020 inch, 2024-T3 Alclad aluminum facings (QQ-A-362) bonded to 0.50 inch thick perforated aluminum core (MIL-C-7438, Code 7.9-¼-40P (3003).

NR = No Requirement

MIL-L-26147 (USAF) LABEL TAPE, PRESSURE-SENSITIVE ADHESIVE, LEGENDED RUSH HI-VALU

Issue: 26 February 1959 Revision: A Amendment: None

SCOPE

This printed pressure-sensitive adhesive tape is intended for labeling high value items and their shipping containers.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a laminated cellulose acetate plastic film and paper backing coated on the paper side with an unspecified adhesive. The laminating adhesive is pigmented.

PHYSICAL. The tape is no more than 0.0065 inch in thickness, has a tensile strength of at least 25 lb/in. of width and is imprinted with the legend per Figure 1 on a white background (Fed Std 595, Color No. 17875).

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. Storage should be limited to six months.

PERFORMANCE. The tape has a peel strength of at least 25 oz/in. of width as received and after aging the tape 5 days at 150 F under 85% RH prior to application, using commercial polish ground stainless steel adherends (QQ-S-766). The peel strength is not affected after 72 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151). The printing is not affected after 72 hours exposure to 120F.

FORM

The tape is available in 72 yard rolls wound on 3 inch diameter cores in 1½ and 3 inch widths. The 1½ inch wide tape, unless otherwise specified, is perforated every seven inches at the end of every two HI-VALU emblems. The three inch wide tape is perforated every 10 inches, also at the end of every two HI-VALU emblems. For all widths, the perforations are 1/8 inch from the end of every two emblems, each of which are separated by ¼ inch. Each roll may contain up to three splices.

QPL

No.

MIL-T-26317 TAPE, PRESSURE-SENSITIVE ADHESIVE, TRANSPARENT, FILM SPLICING

Issue: 27 October 1960 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for splicing photographic paper and film, connecting short lengths of film and connecting film to spools and to leaders.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The film consists of a polyester film backing coated on one side with a sulfur-free, unspecified adhesive.

PHYSICAL. The tape is clear and colorless. The other physical properties of the tape are given in Table I.

TABLE I. PHYSICAL PROPERTIES OF MIL-T-26317 TAPE

PROPERTY	VALUE
Thickness, in., max	0.003
Tensile strength, lb/in., at 75 F, min (1)	
Dry	17
Wet (5 min. in 75 F water)	17
Tear strength, lb, at 75 F, min (2)	16

(1) UU-P-31, Method 171.

(2) UU-P-31, Method 171, using a No. 1 Finch Tear Testing head.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application and can be stored 6 months. It does not delaminate when joined adhesive side to adhesive side.

PERFORMANCE. The tape has a peel strength of at least 20 oz/in. of width at 75 F, either as received or after aging the tape 14 days at 120 F prior to application, and 15 oz/in. of width after 20 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151 or ASTM D822) prior to application of the tape using commercial polish ground type 303 or 304 stainless steel (QQ-S-766) adherends (UU-P-31, Method 100). After indirect contact with undeveloped film for 7 days at 120 F, it does not cause an increase in fog density greater than 0.02 (ANSCO-Sweet Densitometer). Further, it does not corrode copper during 96 hours exposure to 70 C saturated salt water. The tape has sufficient adhesive strength such that approximately 9-½ inches wide, 1 inch splices of film leader to aerial roll film (L-F-330, Type I B, Class

MIL-T-26317 (Continued)

A, L or N) to photographic paper (MIL-P-4672, Type XII) to film leader do not separate or slip more than 1/8 inch after 1 hour immersion in water followed by drying 1 hour at 250 F under a 10 pound load or after processing in Type EH-7A, EH-7B or EH-6A photographic film processing machine with driers operating at 180 F.

FORM

The tape, unless otherwise specified, is available in 72 yard rolls wound on 3 inch diameter cores in 1 inch widths. Each roll may contain up to 3 splices.

QPL

No.

MIL-T-40102 (QMC) TAPE, THERMOPLASTIC ADHESIVE FOR MENDING BED LINEN

Issue: 22 January 1960 Revision: None Amendment: None

SCOPE

This adhesive tape is intended for mending light weight cotton fabrics and bed linens.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive tape consists of a bleached, fully shrunk, cotton print cloth backing coated with an unspecified, thermoplastic adhesive.

PHYSICAL. The tape has a tensile strength of at least 40 lb/in. of width, weighs 5.5–6.5 oz/sq yd, the white backing is plain woven using 80 warp threads/in. and 72 fill threads/in. to give 4 yd/lb (39 in. width). The adhesive mass is colorless or white.

PROCESS. The tape is laid over the area which is to be mended and the joint cured 5 seconds at 350 F under approximately 4 psi bonding pressure.

PERFORMANCE. The tape has a bond strength of at least 3.5 lb/in. of width (CCC-T-191, Method 5970) and when wet (1 hr in boiling 0.5% aqueous sodium stearate) creeps no more than 1.5 in./min./in. of width under 500 gr load, has a stiffness after laundering of no more than 60 mm (CCC-T-191, Method 5204) and no more than 10% strike back (flow of adhesive out of tape after ironing).

FORM

The tape adhesive is available in 60 yard rolls wound on 3 inch diameter cores in 1, 2, 3 or 36 inch widths. Each roll may contain up to 3 splices.

QPL

No.

MIL-T-40620 TAPE, PRESSURE-SENSITIVE ADHESIVE, LITHOGRAPH

Issue: 6 April 1962 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for masking, edging, and stripping photographic and lithographic negatives.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of an unspecified plastic film coated on one side with an unspecified adhesive. No liner is used.

PHYSICAL. The tape is ruby red in color, sufficiently transparent to permit the reading of 5 point printed type, is not greater than 0.0029 inch thick and has a tensile strength of at least 20 lb/in. of width.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. The adhesive does not separate from the backing and does not tear during the unwinding process.

PERFORMANCE. The tape has a peel strength of at least 20 oz/in. of width at room temperature using commercial polish ground AISI 302 or 304 stainless steel adherends. After 72 hours at 140 F and 80% RH, the tape adhered to bond paper does not exude adhesive around the sides or through the backing sufficient to cause blocking.

FORM

The tape is available in 72 yard rolls wound on 3 inch diameter cores in the widths specified by the purchaser. Each roll may contain up to three splices.

QPL

No.

NOTES

(1) Each roll is marked with month and date of manufacture as well as supplier's name and designation.

MIL-T-43036 TAPE, PRESSURE-SENSITIVE ADHESIVE, PLASTIC FILM, FILAMENT REINFORCED (FOR SEALING FIBER CONTAINERS AND CANS)

Issue: 29 March 1963 Revision: A Amendment: None

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-T-43115 (MR) TAPE, PRESSURE-SENSITIVE ADHESIVE; FOR PRESERVATION AND SEALING

Issue: 23 October 1962 Revision: None Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for sealing and exterior preservation of missiles, rockets, aircraft and ground support equipment during storage, handling and shipment where an excellent seal is necessary and where quick, easy and clean removal is required. The tape is designed to be suitable for application at 0 F and to perform satisfactory between -15 F and 140 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the tape is not given; however, a plastic film backing is used.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-T-43115 TAPE

PROPERTY	VALUE
Thickness, in., max	0.011
Color	Black
Tensile strength, lb/in., at 75 F, min	
Longitudinal	10
Transverse	10
Elongation, ultimate, longitudinal, %, at 75 F, max	300
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 72 hr at 100 F and 90–5% RH, max	0.5

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application. A force no greater than 2 and 3 lb/in. of width, respectively, is needed for unrolling the the tape as received and after aging the roll 10 days at 150 F and 80% RH. After aging, no more than ½ inch distortion of the rolls or adhesive flow out of the side occurs. The tape can be applied as low as 0 F.

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

MIL-T-43115 (Continued)

TABLE II. PERFORMANCE PROPERTIES OF MIL-T-43115 TAPE

PROPERTY	VALUE
Peel, oz/in., min (1)	
At 75 F	
Initial	20
After aging roll 10 days at 150 F and 80% RH prior to application	15
At –20 F, 4 hr (2)	Flexible
Creep in shear, hr, min (1) (3)	
At –65 F under 500 gr/sq in. load	
Initial	16
After aging roll 10 days at 150 F and 80% RH prior to application	16
At 140 F under 500 gr/sq in. load	
Initial	16
After aging roll 10 days at 150 F and 80% RH prior to application	16
Accelerated aging, 100 hr (4)	No deterioration

(1) The tape adhered to AISI 302 stainless steel, 12 to 16 microinch finish (QQ-S-766).
(2) No breaking, tearing, adhesive mass transfer or delamination occurs when peeled from the stainless steel substrate.
(3) The tape does not slip more than 1/8 inch during the specified time under 500 gr/sq in. load. After returning to room temperature, the tape can be stripped without adhesive mass transfer.
(4) No delamination, tearing, cracking, shrinkage, edge lifting or transfer of adhesive occurs per Fed Test Method Std No. 141, Method 6151, using salt spray.

FORM

The tape is available in 36 yard rolls wound on 3 inch diameter cores and, unless otherwise specified, in 1, 2, 3, 4 or 6 inch widths.

QPL

No.

MIL-A-45059 (MR) ADHESIVES FOR BONDING CHIPBOARD TO TERNEPLATE, TINPLATE AND ZINCPLATE

Issue: 3 February 1964 Revision: A Amendment: None

SCOPE

This adhesive is intended for bonding chipboard to terneplate, tinplate and zincplate primarily in the manufacture of containers where water, oil and mold resistance is not required.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is applied by brushing in thicknesses up to 0.002 inch, the joint closed and cured at least 1 hour at room temperature under contact pressure. It can be stored for 6 months at room temperature in unopened containers.

PERFORMANCE. The adhesive has a minimum and average shear strength of 30 and 40 psi at 75 F after 1 hr cure and after 1 week cure 65 and 75 psi at –40 F, 50 and 60 psi at 75 F and 17 and 25 psi at 140 F using separately tinplate, terneplate and zincplate to chipboard adherends (Fed Test Method Std No. 175, Method 1033.1 T).

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

NOTES

(1) In the manufacture of ammunition fiber containers, the adhesive is intended to provide a bond between chipboard and the metal between the time of manufacture and loading of the ammunition into the fiber containers.

MIL-A-46028 (Ord) ADHESIVE, FLASHOUT, COLD-SETTING (WATER CURED)

Issue: 29 January 1959 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding cellular polystyrene plastic to steel.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The chemical composition of the adhesive is given in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-A-46028 ADHESIVE

INGREDIENT	CHARACTERISTIC	PERCENTAGE BY WEIGHT
Polypropylene glycol	800-1200 mol wt	58-66
Tolylene di-isocyanate	2, 4 or a mixture of 2, 4 and 2, 6 isomers	33-41
Triethanolamine	2, 2', 2''	0.9-1.1

PHYSICAL. The adhesive has a viscosity at 25 C between 2000 and 8000 centipoises.

PROCESS. The adhesive is activated by mixing 50 drops of water to each 100 gram container of adhesive, stirred till the mixture becomes a creamy foam, applied by brushing, the joint closed and cured 18 hours at room temperature under contact pressure. The activated adhesive foams within 2 minutes after mixing which can be stirred down and has a pot life of not less than 2 hours.

PERFORMANCE. The water activated adhesive does not dissolve cellular polystyrene plastic (MIL-P-16591).

FORM

The liquid adhesive is available in 100 gram metal containers.

QPL

No.

NOTES

(1) This adhesive is suitable for bonding M5 Jato nozzle and nozzle closures.

MIL-G-46030 GLUE, ANIMAL (PROTECTIVE COLLOID)

Issue: 2 November 1960 Revision: A Amendment: None

SCOPE

This glue is intended for use as a protective colloid in the manufacture of propellants especially during the hardening operation in ball propellant manufacture.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The glue consists of the proteinaceous extract from animal base materials containing no more than 2.5% grease and an ash content not greater than 5.25%.

PHYSICAL. The glue is in granular or pelletized form passing 100% through U S Standard No. 7 mesh sieve and contains up to 11% moisture and a pH between 6.4 and 7.1. The glue as a 9% aqueous solution does not decompose or putrefy even after 48 hours at 40 C.

PROCESS. The glue is activated by mixing with water, melted at 60 C and applied hot to the propellant batches.

PERFORMANCE. The glue added to hardening batches made by the ball propellant manufacturing process shows particles of approximately uniform size and shape after both 1 and 2½ hours. After agitation the batch coalesces into particles of uniform size and shape.

FORM

The solid glue, unless otherwise specified, is available in 100 pound multiwall paper or burlap bags.

QPL

No.

MIL-A-46050 ADHESIVE, SPECIAL; RAPID ROOM TEMPERATURE CURING, SOLVENTLESS

Issue: 16 July 1963 Revision: A Amendment: None

SCOPE

This adhesive is intended for the rapid assembly of porous or nonporous surfaces.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not specified, although cyanoacrylate monomer can be used. Unspecified thickeners, plasticizers and catalysts may be used.

PHYSICAL. The colorless, transparent or translucent liquid adhesive has a viscosity at 75 F between 70 and 300 centipoises and the dried film a transparency approximating that of glass.

PROCESS. The adhesive is applied by brushing and bonds after closing the joints within a few minutes under contact pressure; however, joints are cured 24 hours at room temperature or 5 minutes at room temperature when one or both surfaces are treated with a catalyst. The adhesive can be stored 90 days between 35 and 45 F in closed containers.

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

TABLE I. PERFORMANCE PROPERTIES OF MIL-A-46050 ADHESIVE

PROPERTY	VALUE	
	AVERAGE	INDIVIDUAL
Shear, psi, min (1)		
After 5 min. cure with catalyst		
At 75 F	1300	1200
After 24 hr cure without catalyst		
At 75 F	1600	1200
After 7 days cure without catalyst		
At –65 F, 1 hr	1600	1500
At 75 F	2000	1800
At 160 F, 1 hr	1800	1600

(1) Fed Test Method Std No. 175, Method 1033, using 1020 steel adherends (QQ-S-633 or ASTM designation A-108).

MIL-A-46050 (Continued)

FORM

The liquid adhesive, unless otherwise specified, is available in ½, 1, 8 and 16 ounce capacity polyethylene bottles with dispenser tips.

QPL

No.

NOTES

(1) The adhesive is very expensive.

(2) The resulting bonds are not waterproof.

(3) Atmospheric moisture catalyzes the curing; consequently, curing time will vary with humidity.

(4) This adhesive will bond human tissue.

(5) Compatibility with ammunition must be checked prior to use.

MIL-A-46051 (Ord) ADHESIVE, ROOM-TEMPERATURE AND INTERMEDIATE-TEMPERATURE SETTING RESIN (PHENOL, RESORCINOL, AND MELAMINE BASE)

Issue: 20 November 1961 Revision: None Amendment: 1

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 (75-95F glue line temperature).
- Grade A 2 years storage life
- Grade B 6 months storage life

Type II Intermediate temperature setting (95-190F glue line temperature).
- Grade C 6 months storage life
- Grade D 30 days storage life

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 or incorporated hardener may be used.

PHYSICAL. The pH of the set film is between 3.5 and 11.0.

PROCESS. The adhesive is activated by mixing base resin, catalyst and filler, if any, applied by brushing, the joint closed and cured not longer than 5 hours at 190 F under 150-250 psi bonding pressure; however, Type I is usually cured 7 hours at room temperature. The activated adhesive has a working life of not less than 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 limit. Storage limits at room temperature are in accordance with the Classification section.

MIL-A-46051 (Continued)

PERFORMANCE. The adhesive has an interlaminar shear strength of at least 400 psi at 75 F and at 75 F after 3 hours immersion in boiling water or 48 hours immersion in RT water (Fed Test Method Std No. 175, Method 1032) using birch adherends. The block shear strength is 2800 psi at 75 F using maple adherends (Fed Test Method Std No. 175, Method 1031).

FORM

The liquid adhesive is available in pint and 1, 5, 30 and 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

Yes.

NOTES

(1) When volume is large, the shorter storage life adhesive should be ordered because of lower cost.

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

(3) This specification is essentially equivalent to MMM-A-00181 (Army-MR) "Adhesive, Room-Temperature and Intermediate-Temperature Setting Resin (Phenol, Resorcinol and Melamine Resin)".

MIL-A-52194 (Ord) ADHESIVE, EPOXY (FOR BONDING GLASS REINFORCED POLYESTER)

Issue: 22 January 1963 Revision: None Amendment: 1

SCOPE

This adhesive is intended for bonding glass reinforced polyester laminates where no peel or cleavage is anticipated.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin and an unspecified, separate hardner.

PHYSICAL. The adhesive, 5 minutes after incorporation of the hardner, has a Brookfield viscosity of at least 2400 poises at 75 F and no more than 3900 poises after 45 minutes at 75 F.

PROCESS. The adhesive is activated by mixing base resin and hardner, applied by brushing, the joint closed and cured 7 days at room temperature under contact pressure. The resin and hardner can be stored 6 months at room temperature in air tight containers.

PERFORMANCE. The adhesive on steel adherends (QQ-S-633) has a minimum and average shear strength of 1500 and 1790 psi at -65 F (4 hr), 1100 and 1360 psi at 75 F and 250 and 290 psi at 160 F (4 hr) (Fed Test Method Std No. 175, Method 1033); it has a minimum and average impact strength of 15 and 18 ft-lb at 75 F (Federal Test Method No. 175, Method 1051).

FORM

The liquid adhesive is available in pint, quart and 1 and 5 gallon containers. The hardner is packaged in quantities stoichiometrically equivalent to the quantity of adhesive supplied.

QPL

No.

NOTES

(1) The material is suitable for bonding the two halves of plastic gunstocks.

(2) The adhesive, because of its plastic consistency, will not drain off during cure even when mating surfaces are not plane.

(3) Service temperatures should not exceed 200 F.

MIL-A-52222 ADHESIVE, FOR REPAIR OF PONCHO, LIGHTWEIGHT WITH HOOD

Issue: 14 May 1962 Revision: None Amendment: None

SCOPE

This adhesive is intended for the repair of plastic coated ponchos.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is specified in Table I.

TABLE I. CHEMICAL COMPOSITION OF MIL-A-52222 ADHESIVE

INGREDIENT	SUPPLIER	% BY WEIGHT
Paracril CV (nitrile rubber)	Naugatuck Chemical Co.	11.14
Parlon 125 (chlorinated natural rubber)	Hercules Powder Co.	1.86
Heresite R088 (phenolic resin)	Heresite Chemical Co.	2.29
VMCH (vinyl chloride maleic anhydride)	Union Carbide Plastics Co.	0.38
Syloid 975 (silicate)	Davison Chemical Co.	1.26
Methyl ethyl ketone	(1)	54.12
Acetone	(1)	28.95

(1) Any available source.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is applied by brushing, left standing three minutes to dry to a tacky state, the joint closed and cured at least two hours at room temperature under contact pressure.

PERFORMANCE. The adhesive has a peel strength sufficient to sustain a 4 ounce load for one hour over a 4 inch width without separating more than 1/8 inch after a 2 hour cure and 5 ounces after a 3 day cure using vinyl coated nylon cloth adherends (MIL-C-40039). These bonded adherends can be bent over a ½ inch diameter mandrel at 10 F without cracking.

FORM

The liquid adhesive, unless otherwise specified, is available in 8 ounce containers.

QPL

No.

MIL-A-52247 ADHESIVE: PAPER LABEL, WATER RESISTANT, WATER EMULSION TYPE

Issue: 18 June 1963 Revision: A Amendment: None

SCOPE

This adhesive is intended for adhering printed paper labels to rigid substrates which are not subject to flexing.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, it is an emulsion.

PHYSICAL. The adhesive is nontoxic and nonflammable.

PROCESS. The adhesive is applied by brushing between 50 and 100 F, the label immediately laid, an additional coat of adhesive applied and the joint cured 24 hours at 75 F under contact pressure. The adhesive dries tack free in no more than 15 minutes (Fed Test Method Std No. 141, Method 4061) and can be stored 3 months in unopened containers at room temperature.

PERFORMANCE. The adhesive dries to a transparent finish which does not obscure or alter the legibility of the printed (TT-I-559) label even after drying 24 hours at 212 F or subjecting it to 60 hours accelerated weathering (Fed Test Method Std No. 141, Method 6151). The adhesive is sufficiently flexible such that after 72 hours drying at room temperature, it can be bent 180° over a ¼ inch diameter mandrel without cracking or flaking. Further, it does not become tacky (Fed Test Method Std No. 141, Method 4061), lose adhesion, strip from more than ¼ of the label area when peeled by hand, lift enamel, blister, buckle, curl or crack after 24 hour air dry, 24 hours at 140 F under 20% RH or 24 hours at 25 F using softwood (PPP-B-585, Type I), fiberboard (PPP-B-636, Type II, Class 2, V3s), black oxide coated or uncoated low carbon steel, galvanized iron, glass, tin coated steel, enamel paint (TT-E-485, Types I, II, III or IV), natural or compounded SBR 1500 rubber substrates.

FORM

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

QPL

No.

NOTES

(1) Use this adhesive in locations where toxicity and flammability of comparable materials containing organic solvents would be objectionable.

MIL-A-52264 ADHESIVE, SYNTHETIC-RUBBER; NITRILE-RUBBER AND VINYL-RESIN BASE (FOR BONDING PREFABRICATED AIRFIELD AND ROAD SURFACING MEMBRANE)

Issue: 15 January 1963 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding prefabricated airfield and road surfacing membranes.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of polyvinyl chloride dispersed in a solution of nitrile rubber and an unspecified solvent.

PHYSICAL. The nontoxic adhesive has a specific gravity between 0.82 and 0.88, a viscosity between 2300 and 2700 centipoises at 24 C, a maximum ash content of 1.0%, a nonvolatile content between 20 and 24%, and 90% of the solvent boils between 79.4 and 81.1 C.

PROCESS. The adhesive is applied by brushing, allowed to air dry till the surfaces are tacky, the joint closed and cured 24 hours at room temperature under contact pressure. The adhesive can be stored 1 year between 60 and 80 F in unopened containers.

PERFORMANCE. The adhesive on vinyl coated fabric adherends (MIL-M-52219) has a shear strength of at least 70 psi at -67 F (4 hr), 70 psi at 75 F, 60 psi at 75 F after either 48 hr in 75 F water or 24 hr in 75 F JP-4 fuel and 17.5 psi at 140 F (2 hr) (Fed Test Method Std No. 175, Method 1033); a peel strength of at least 7.0 lb/in. at –67 F (4 hr), 7.0 lb/in. at 75 F, 6.0 lb/in. at 75 F after 48 hr in 75 F water, 7.0 lb/in at 75 F after 24 hr in 75 F JP-4 fuel and 5.0 lb/in at 140 F (2 hr) (Fed Test Method Std No. 175, Method 1041.1).

FORM

The liquid adhesive is available in 5 gallon containers.

QPL

No.

NOTES

(1) Normally road surfacing membrane rolls are joined with 6 inch single lap joints and sewn panels are joined with 10 inch single lap joints.

MIL-P-55025 (Ord) POLYSTYRENE, UNMODIFIED (FOR USE AS A BINDER IN EXPLOSIVES)

Issue: 23 June 1958 Revision: None Amendment: None

SCOPE

This binder is intended for the manufacture of explosive compositions.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The binder consists of polystyrene containing no fillers, pigments, plasticizers or copolymers.

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

TABLE I. PHYSICAL PROPERTIES OF MIL-P-55025 BINDER

PROPERTY	VALUE
Particle size, % through, min	
U S Standard No. 6 mesh sieve	90
U S Standard No. 20 mesh sieve	0
Colorless, transparent	Yes
Impurities, infrared spectrophotometer	None
Viscosity, 2% toluene solution, 75F, centipoise	1.95-2.35
Methanol solubility, %, max	3.5
Iodine number, max (1)	5.0
Acid number, max (2)	0.25
Saponification number, max	2.0
Ultraviolet extinction coefficient limits (3)	1.5-3.5

(1) Fed Test Method Std No. 141, Method 5061.

(2) Fed Test Method Std No. 141, Method 5071.

(3) Beckman DV Spectrophotometer, or equivalent.

PROCESS. The binder is mixed with other compounding ingredients including the explosive charge and cured at low temperatures under contact pressure.

PERFORMANCE. No performance properties are given.

FORM

The solid binder is available in 200 pound containers.

QPL

No.

CS 168-50 POLYSTYRENE PLASTIC WALL TILES, AND ADHESIVES FOR THEIR APPLICATION

Issue: 15 July 1950 Revision: None Amendment: None

SCOPE

This adhesive is intended for bonding polystyrene plastic wall tiles.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of adhesive is not given; however, it does not contain more than 0.5% benzene or chlorinated hydrocarbon solvents. The tile consists of polystyrene plastic (ASTM D703, Types 1, 2 and 3).

PHYSICAL. Tile: The tile, available in all colors including mottled and white, has an opacity of at least 0.96, does not deform at 160 F, is slow burning (ASTM D635), does not change color after 50 hours accelerated weathering (ASTM D620), and will not warp, crack, or loosen (bonded to plywood using a 14 day cure at RT) when subjected to 5 cycles consisting of the following schedule: 2 hours at RT and 85% RH, 2 hours at 32 F and 100% RH, 2 hours at 140 F and 10% RH, 2 hours at 140 F and 88% RH, and 16 hours at 140 F and 10% RH.

Adhesive: The adhesive is mildew resistant (Aspergillus niger—USDA 215-4247, ATCC 6275).

Grout: Grouting materials used in conjunction with the polystyrene tiles and adhesive show no appreciable change in color after 50 hours accelerated weathering (ASTM D620) or after 7 days immersion in water.

PROCESS. The adhesive is applied by troweling at temperatures below 70 F, the polystyrene tiles laid in accordance with the supplier's instructions and the joint cured at room temperature under contact pressure. Full strength is achieved in 28 days. The adhesive wets polystyrene, plasterboard, plywood, masonite, bare plaster, painted plaster and concrete, such that a small glob when pressed onto the surface and then removed will fail in cohesion rather than adhesion.

PERFORMANCE. The adhesive has sufficient strength such that tiles bonded to Douglas fir plywood will not slip on a vertical surface or fall from an overhead horizontal surface during installation or during 7 days after installation. Polystyrene tiles show no slippage, warpage, or loss of adhesion to Douglas fir plywood when immersed vertically in water for 7 days after a 21 day cure at RT or when heated vertically at 140 F for 6 hours after a 3 day cure

CS 168-50 (Continued)

at RT. Additionally, the adhesive does not chemically attack the tiles or subsequent grouting materials such that after 90 days at 125 F, no noticeable pin-points, craters, bulging, and soft, bubbly or crazed surfaces are evident. Bonded tiles will not loosen from Douglas fir plywood, using a 14 day cure at RT, when subjected to the time-temperature-humidity cycle given in the Physical section. The other performance properties are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF CS 168-50 ADHESIVE

PROPERTY	VALUE
Shear, psi, at 75 F, min (1)	
Initial	
After 24 hr cure at RT (2)	1
After 28 day cure at RT (2)	10
After 24 hr in water (3)	10
After heating 7 days at 149 F and less than 10% RH (3)	10
Shear, double, psi, at 75 F, min (4)	
After heating 90 days at 125 F	10
Tension, psi, at 75 F, min (5)	0.25
Shrinkage, in., max (6)	0.015

(1) ASTM D1002.
(2) Polystyrene tile and Douglas fir plywood adherends.
(3) Douglas fir plywood adherends cured 21 days at RT.
(4) Polystyrene tile and plasterboard adherends cured 7 days at RT.
(5) No separation of bond occurs during 28 days under the indicated load using polystyrene tile and Douglas fir plywood adherends cured 3 days at RT.
(6) Using polystyrene tile and Douglas fir plywood adherends cured 90 days at 125 F.

FORM

The paste adhesive is available in commercial packages.

QPL

Yes (See Note section, No. 2).

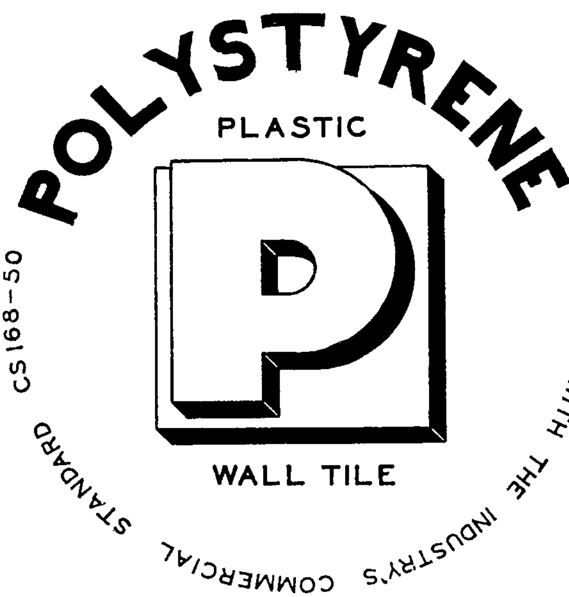
CS 168-50 (Continued)

NOTES

(1) Tiles and adhesives conforming to the requirements of this standard carries the following statement and Hallmark shown in Figure 1.

These (this) . . . .
(trade name of tiles or adhesives)
comply (complies) with Commercial Standard CS 168-50, as developed by the trade, under the procedure of the Commodity Standards Division, and issued by the U. S. Department of Commerce.

Figure 1. CS 168-50 Hallmark



(2) Suppliers providing tiles and adhesives conforming to the requirements are given in the standard.

CS 181-52 WATER-RESISTANT ORGANIC ADHESIVES FOR INSTALLATION OF CLAY TILE

Issue: 12 July 1952 Revision: None Amendment: None

SCOPE

This adhesive is intended for installation of clay tile.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The composition of the adhesive is not given; however, it does not contain more than 0.5% benzene or chlorinated hydrocarbon solvents.

PHYSICAL. The adhesive does not noticeably discolor clear water, is mold resistant (Aspergillus niger), non toxic, vermin-proof, and does not possess a noticeable or disagreeable odor after drying.

PROCESS. The adhesive is applied by troweling in thicknesses of approximately 1/16 inch, the tile laid and the joint cured 24 hours at room temperature under contact pressure. Full strength is achieved in 28 days. The adhesive can be stored 1 year at RT in closed containers and for 4 weeks between 25F (2 weeks) and 125F (2 weeks) without adverse effect.

PERFORMANCE. The adhesive has sufficient cohesive strength such that immediately after application it can sustain the weight of one tile in an overhead position. The other performance properties are given in Table I.

TABLE I. PERFORMANCE PROPERTIES OF CS 181-52 ADHESIVE

PROPERTY	VALUE
Shear, psi, min (1)	
At –20 F, 2 hr (2)	40
At 75 F	
Initial	
16 hour cure	0.5
7 day cure	
Dry	10
After 7 days in water	10
28 day cure (2)	40
After 7 days in water (2)	40
At 125 F, 2 hr (2)	30

(1) Using baked clay or ceramic tile adherends as described in THE TILE HANDBOOK, Tile Council of America, 10 East 40th Street, New York, N.Y.

(2) Specimens use an accelerated cure by force drying at 110 F to constant weight.

CS 181-52 (Continued)

FORM

The paste adhesive is available in commercial packages.

QPL

Yes (See Note section No. 2).

NOTES

(1) Each adhesive conforming to the requirements of this stand- carries the following statement and the Hallmark shown in Figure I.

This water-resistant organic adhesive for installation of clay tile complies with all requirements of Commercial Standard CS 181-52, as developed by the trade under the procedure of the Commodity Standards Division, and issued by the U. S. Department of Commerce.

Figure 1. CS 181-52 Hallmark

(2) Suppliers providing adhesives conforming to the requirements are given in the standard.

AMS 3685 ADHESIVE, SYNTHETIC RUBBER, BUNA-N TYPE

Issue: 1 December 1951 Revision: a Amendment: None

SCOPE

This adhesive is intended for bonding fabric and synthetic rubber to plastics and metals requiring a flexible joint having good resistance to lubricating oil and fair resistance to aromatic fuels.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of nitrile rubber dissolved in an unspecified solvent.

PHYSICAL. The adhesive is a nontoxic liquid.

PROCESS. The adhesive is applied by brushing, requiring no more than 7.5% (vol) addition of thinner, allowed to air dry no longer than 20 minutes, the joint closed, 150–450 psi bonding pressure applied for 1 minute, and the joint allowed to cure at room temperature for 48 hours under contact pressure. Quarter-filled containers will not skin during 48 hours storage. The adhesive can be stored for 6 months in unopened containers at room temperature.

PERFORMANCE. The adhesive at RT using AMS 4041 Alclad aluminum and MIL-W-5665, Type II cotton webbing adherends has a peel strength of at least 3 lb/in. of width, a shear strength of at least 150 psi, 90 psi after 24 hr in 70-85 F ASTM Reference Fuel No. 2, 75 psi after 48 hr in 212 F water and 15 psi after 48 hr in 175 F ASTM petroleum base oil No. 1, a creep strength sufficient to sustain a shear load of 20 psi for at least 1 week and a softening point of 130 F (ASTM D816 except 5 lb load is used); using AMS 4041 Alclad aluminum and AMS 3208 synthetic rubber adherends a double shear strength of at least 75 psi; and using AMS 4120 aluminum and AMS 3208 synthetic rubber adherends a tensile strength of at least 125 psi. The adhesive causes no corrosion.

FORM

The liquid adhesive is available in commercial packages.

QPL

No.

NOTES

(1) The supplier specifies the weather resistance of the adhesive.

AMS 3690 ADHESIVE COMPOUND, EPOXY, ROOM TEMPERATURE CURING

Issue: 15 January 1960 Revision: None Amendment: None

SCOPE

This adhesive is intended for nonstructural bonding of aluminum, corrosion resistant steels, brass and many thermosetting plastics primarily for electrical applications operating at temperatures up to 185 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin base and a separate unspecified hardener. Fillers and modifiers may be included in either component.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is activated by mixing the resin with the hardener in accordance with the supplier's instructions, the joint closed and cured 1 week at room temperature under contact pressure. Once activated, it has a pot life at 75 F of not less than 4 hours. The mix reaches 90% of its ultimate strength in 24 hours and is fully cured in 7 days at 75 F or in 4 hours at 150 F.

PERFORMANCE. The adhesive has a shear strength of at least 1500 psi at –65 F (1 hr), 1800 psi at 70–85 F after 24 hr cure, 2000 psi at 70–85 F after 7 day cure, 1500 psi at 70–85 F after being subjected to 10 cycles each consisting of ½ hr at –65 F, ½ hr at 75 F, ½ hr at 160 F and ½ hr at 75 F, 1800 psi at 70–85 F after 200 hr at 185 F and 1800 psi at 185 F using steel (AMS 5044) adherends (ASTM D1002). The adhesive causes no corrosion and does not lose more than 2% weight after 96 hr immersion (separately) in di-2-ethylhexyl sebacate (containing 0.5% phenothiazine), ASTM oil No. 3 and ASTM Reference Fuel B.

FORM

The liquid epoxy resin and hardener, unless otherwise specified, is available in kits.

QPL

No.

AMS 3691 ADHESIVE COMPOUND, EPOXY, MEDIUM TEMPERATURE APPLICATION

Issue: 15 January 1960 Revision: None Amendment: None

SCOPE

This adhesive is intended for nonstructural bonding of aluminum, corrosion resistant steel, brass and many thermosetting plastics primarily for electrical applications operating at temperatures up to 250 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin base and a separate unspecified hardener. Fillers and modifiers may be included in either component.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is activated by mixing the resin with the hardener in accordance with the supplier's instructions, the joint closed and cured no longer than 4 hours at no higher than 200 F under 10 psi bonding pressure. Once activated, the adhesive has a pot life at 75 F of not less than 4 hours.

PERFORMANCE. The adhesive has a shear strength of at least 2000 psi at –65 F; at 75 F; at 75 F (1) after being subjected to 10 cycles each consisting of ½ hr at –65 F, ½ hr at 75 F, ½ hr at 212 F and ½ hr at 75 F, (2) after 200 hr at 250 F, (3) after 200 hr in 212 F water; at 250 F; and at 250 F after 200 hr at 250 F. The adhesive causes no corrosion and does not lose more than 2% weight after 96 hr immersion (separately) in di-2-ethylhexyl sebacate (containing 0.5% phenothiazine), ASTM oil No. 3 and ASTM Reference Fuel B.

FORM

The liquid epoxy resin and hardener, unless otherwise specified, is available in kits.

QPL

No.

AMS 3692 ADHESIVE COMPOUND, EPOXY, HIGH TEMPERATURE APPLICATION

Issue: 15 January 1960 Revision: None Amendment: None

SCOPE

This adhesive is intended for nonstructural bonding of aluminum, corrosion resistant steel, brass,. and many thermosetting plastics primarily for electrical applications operating at temperatures up to 500 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The adhesive consists of an epoxy resin base and a separate unspecified hardener. Fillers and modifiers may be included in either component.

PHYSICAL. No physical properties are given.

PROCESS. The adhesive is activated by mixing the resin with the hardener in accordance with the supplier's instructions, the joint closed and cured again in accordance with the supplier's instructions under 10 psi bonding pressure. Once activated, the adhesive has a pot life at 75 F of not less than 4 hours.

PERFORMANCE. The adhesive has a shear strength of at least 1500 psi at –65 F, 2000 psi at 75 F, 2000 psi at 75 F after being subjected to 10 cycles each consisting of ½ hr at –65 F, ½ hr at 75 F, ½ hr at 212 F and ½ hr at 75 F, 1000 psi at 75 F after 200 hr at 500 F, 1000 psi at 500 F and 1000 psi at 500 F after 200 hr at 500 F. The adhesive causes no corrosion and does not lose more than 2.0% weight after 96 hr immersion (separately) in di-2-ethylhexyl sebacate (containing 0.5% phenothiazine), ASTM Oil No. 3 and ASTM Reference Fuel B.

FORM

The epoxy resin and hardener, unless otherwise specified, is available in kits.

QPL

No.

AMS 3810 TAPE, ADHESIVE, CLOTH BACK

Issue: 15 June 1953 Revision: A Amendment: None

SCOPE

This pressure-sensitive adhesive tape is intended for effecting water resistant and reinforcing seals on moisture barriers and shipping containers for use between 32 F and 149 F.

CLASSIFICATION

One type only.

PROPERTIES

CHEMICAL. The tape consists of a 60 by 60 count cotton sheet backing coated on one side with an unspecified adhesive.

PHYSICAL. The tape has a tensile strength of at least 35 lb/in. of width either dry or after 6 hr immersion in RT water, a tear strength of 450 gr (Elmendorf), a moisture vapor transmission rate not greater than 1.0 gr/100 sq in./24 hr after 24 hr at 100 F and 88–92% RH and a water penetration rate of 30 gr/100 sq in./24 hr.

PROCESS. The tape requires no moisture, heat or other preparation prior to or subsequent to application.

PERFORMANCE. The tape has a peel strength at RT of at least 25 oz/in. of width to its own backing and to paper base phenolic laminate. This peel strength is achieved with the latter substrate even after aging the joint 72 hours at 145 F in a weatherometer and after 5 seconds immersion in AMS 3065 corrosion preventative compound (oil); no more than 25% adhesive transfer occurs under the latter immersion condition. In no case for either aging or oil immersion is the minimum individual value below 15 oz/in. of width. The tape does not lose adhesion to kraft paper or its own backing when bent over a 1½ inch diameter mandrel at -25 F after exposure to 140 F for 24 hours followed by -25 F for 2 hours. The tape adhered to steel, aluminum, brass and copper, and exposed 24 hr at 145 F in a weatherometer does not fade, corrode the substrate, or transfer more than 10% adhesive after removal of the tape.

FORM

The tape, unless otherwise specified, is available in 60 yard rolls wound on 3 inch diameter cores in widths and colors specified by the purchaser.

QPL

No.

APPENDIX A

SURFACE PREPARATION PROCEDURES FOR ADHESIVE BONDING

Surface preparation of materials consists of cleaning and, when necessary, etching. Cleaning removes contaminating materials such as (1) oxidation products from metals and (2) oil, grease and dirt from all substrates. Etching activates the surface of adhesive-resistant metals and plastics to accept the bonding material.

CLEANING

Removal of Surface Oxidation

Most metallic materials are subject to surface oxidation. These products must be removed prior to the other surface preparation processes, since they will represent a distinct point of weakness in the joint. Many adhesives will combine to varying degrees with metal oxidation products without significantly penetrating to the base metal surface. The joint would then consist of metal/metal oxidation product/adhesive/metal oxidation product/metal interfaces. The metal/metal oxidation product interface is inherently weak. Slight loads will cause failure at this interface resulting in destruction of the assembly.

Metal oxidation products are removed mechanically by sanding or by chemical sanding procedures. When mechanical methods are used, the partially cleaned surfaces are then subject to final cleaning with solvents.

Removal of Oil, Grease and Dirt Contaminates

All materials, regardless of composition, require clean surfaces prior to bonding. One technique for cleaning is vapor degreasing when adequate equipment is available. When it is not, cleaning may be done by immersion in solvents or by solvent wiping. Immersion in solvents is comparable in cleaning efficiency to vapor degreasing, provided the solvents are purified periodically to remove the accumulated contaminants. Wiping the surface with a solvent requires some skill on the part of the operator to remove the contaminating materials rather than just move them around the surface. Acetone, alcohol, toluene and trichloroethylene are typical solvents used for most materials.

Alkaline cleaners are preferred for most cleaning operations and may be used for thermoplastic materials which are solvent sensitive. Detergent cleaners are commonly used with thermoplastics. The alkaline cleaners are often used in conjunction with solvent cleaning of metals to assure complete removal of all organic contaminants.

ETCHING

Metals

Etching is the next step to be performed on surfaces which offer some resistance to bonding materials. Metals for structural applications are conventionally etched. Plastics such as the olefins and fluorinated materials must be etched to permit joining by conventional bonding technology.

Etchants for metals consist of strong oxidizing materials mixed with mineral acids. Contact with the metal substrate is critical since too little will not sufficiently activate the surface; too long will (1) build up a layer of chemical reaction products which may interfere with the adhesive reaction or (2) cause excessive removal of the base metal. Aluminum, for example, is immersed in a hot sodium dichromate sulfuric acid mixture for no less than five minutes nor more than fifteen minutes.

Plastics

Etchants for fluorinated plastics consist of nonaqueous mixtures of sodium metal. These mixtures are rarely, if ever, handled by a converter. A number of fluorinated plastic proprietary etchant materials have been developed which are less hazardous to use. These are described in the forthcoming recipes. Fluorinated plastics can be obtained in the etched state. Unlike etched metal, they can be stored for long periods of time prior to adhesive bonding.

Olefins such as polyethylene are made bondable by etching the surface in the oxidizing portion of a hot flame. This technique demands considerable skill on the part of the converter. The flame is applied to the surface for a long enough period of time to activate the surface but not sufficiently long to melt or burn the substrate. Bonding is usually accomplished immediately after flame activation.

New nonchemical etching techniques are being evaluated for use with some plastics. One of the more promising is by electrical means. Essentially, this technique employs electrical forces to alter the molecular structure of the surface such that adhesives will be accepted. However, since this and other techniques are still in the *Neanderthal* stage, they are not described in the subsequent recipes for surface preparation of commonly bonded materials.

Once surfaces have been prepared for bonding they should not be touched with bare hands or exposed to any environment which may contaminate the surface.

SURFACE PREPARATION RECIPES

METALS

Aluminum

Immersion Process

1. Vapor degrease in trichloroethylene or solvent clean by immersion or wipe-off techniques.
2. Immerse part into a low foaming, nonsilicated, noncorrosive, alkaline cleaner for a period of time at a temperature designated by the supplier (optional).
3. Rinse in demineralized water.
4. Dry no higher than 140F.
5. Etch by immersion in the following solution for 10 to 15 minutes between 150 and 160 F.

Sulfuric Acid	22-26%
Sodium Dichromate	2.2-2.8%
Demineralized Water	to 100%

6. Rinse with demineralized water until pH is neutral.
7. Dry no higher than 140 F.

Manual Process

1. Sand bonding surface with dry fine-grit abrasive paper.
2. Vapor degrease in trichloroethylene or solvent clean by immersion or wipe-off techniques.
3. Etch by wiping on either of the two following solutions. Solution No. 1 is applied so that the bonding surface remains wet for 2 to 3 minutes; solution No. 2 is applied for 22 to 28 minutes.

Solution 1		Solution 2	
Sulfuric Acid	0.9-1.1%	Sulfuric Acid	36-40%
Hydrofluoric Acid	0.9-1.1%	Sodium Dichromate	6-8%
Sodium Dichromate	5.5-6.5%	Silica	6-8%
Water	to 100%	Water	to 100%

4. Rinse with demineralized water until pH is neutral.
5. Dry no higher than 140F.

Brass

See copper and copper alloys.

Bronze

See copper and copper alloys.

Cadmium, Chromium and Zinc Plated

1. Remove plating with dry fine-grit abrasive paper.
2. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.

NOTE: If plating cannot or should not be removed, clean per step 2 only.

Copper and Copper Alloys

1. Sand bonding surface with dry fine-grit abrasive paper.
2. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.
3. Etch by immersion in the following solution for 10 minutes at 150 F.

Ferric Sulphate	11-13%
Sulfuric Acid	8-10%
Water	to 100%

4. Rinse in water.
5. Immerse in the following chrome acid bath solution at room temperature until the part is clean and bright.

Sodium Dichromate	5.5-6.5%
Sulfuric Acid	11-13%
Water	to 100%

6. Rinse in water.
7. Air dry.
8. Immerse in concentrated ammonium hydroxide (25-28%) for 10 seconds at room temperature.
9. Rinse with demineralized water.
10. Dry no higher than 140 F.

Gold

1. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.

   NOTE: Cold weldable gold for dental use should be heated in a flame to drive off absorbed gases.

Magnesium

Anodize Process

1. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.
2. Immerse part into an alkaline cleaner for a period of time at a temperature designated by the supplier (optional).
3. Rinse in water.
4. Dry.
5. Anodize between 160 and 180 F for 2.5 to 3.5 minutes (e.g. Dow 17 treatment).
6. Rinse in tap water at 150 F for 5 minutes.
7. Dry no higher than 150 F.

Etch Process

1. Repeat steps 1 through 4 above.
2. Etch by immersion in the following solution for 1.5 minutes at room temperature.

Sodium Dichromate	13-15%
Nitric Acid	18-20%
Water	to 100%

3. Rinse with water until pH is neutral.
4. Dry no higher than 140 F.

Nickel and Nickel Alloys

1. Sand bonding surface with wet fine-grit abrasive paper.
2. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.
   NOTE: For surfaces which cannot be abrasively cleaned, etch for 60 to 90 seconds in 5% nitric acid solution at room temperature. The part should be immediately rinsed with water until pH is neutral.

Silver

1. Follow procedure for gold.

Steel

1. Remove scale and rust by sandblasting or by sanding with dry fine- or medium-grit abrasive paper.
2. Vapor degrease or solvent clean by immersion or wipe-off technique.
3. Etch by immersion in 30-35% hydrochloric acid for 3 to 5 minutes at room temperature (optional).
4. If etched, rinse with water until pH is neutral.
5. Dry immediately no higher than 140 F.
   NOTE: Bonding of nonstainless steels must be started within minutes after drying since the steel will start to rust.

Platinum

1. Follow procedure for gold.

Titanium

Immersion Process.

1. Immerse part into an alkaline cleaner for a period of time at a temperature designated by the supplier.
2. Rinse in water.
3. Etch by immersion in the following solution for 4 to 6 minutes at room temperature.

70% Nitric Acid	52-58%
Ammonium Fluoride	2.8-3.2%
Water	to 100%

4. Rinse in water.
5. Immerse in the following solution for 2 minutes at room temperature.

Tri-Sodium Phosphate	4.5-5.5%
Sodium Fluoride	0.8-1.0%
Hydrofluoric Acid	1.4-1.6%
Water	to 100%

6. Rinse in water.
7. Soak for 15 minutes in 140-150 F water.
8. Rinse with demineralized water.
9. Dry no higher than 140 F.

Manual Process.

1. Sand bonding surface with dry fine-grit abrasive paper.
2. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.

3. Wipe on the following solution so that bonding surface remains wet for 2 to 3 minutes.

Tri-Sodium Phosphate	4-5%
Sodium Fluoride	1.1-1.3%
Hydrofluoric Acid	2.5-2.9%
Water	to 100%

4. Rinse with water until pH is neutral.
5. Dry no higher than 140 F.

NONMETALLICS

Cork and Wood

1. Sand bonding surface with abrasive paper until a fresh surface is exposed.
2. Remove loose particles by oil-free compressed air or by vacuuming.

Concrete

1. Sand by wire brushing.
2. Remove loose particles by oil-free compressed air or by vacuuming.
3. Clean with a detergent.
4. Etch surface with 10% hydrochloric acid until all bubbling ceases.
5. Rinse with water until pH is neutral.
6. Dry.

Glass

1. Vapor degrease with trichloroethylene or solvent clean by immersion or wipe-off techniques.

Plastics

Thermoplastic (except fluorinated plastics and olefins)

1. Sand bonding surface with wet fine-grit abrasive paper (optional).
2. Clean with a detergent.
3. Rinse with water.
4. Dry at room temperature.

Fluorinated Plastics

1. Solvent clean with naphtha by immersion or wipe-off techniques.
2. Etch with proprietary etchants such as Bondaid (W.W. Shamban & Co., Culver City, California), Tetra-Etch (W.L. Gore & Associates, Newark, Delaware), etc. Supplier provides details concerning application technique, time, temperature and rinsing procedures.
   NOTE: Fluorinated plastics can be obtained already etched by the supplier of the plastic. These are called bondable fluorinated plastics.

Olefins

1. Solvent clean with naphtha by immersion or wipe-off techniques.
2. Impinge the oxidizing portion of a hot flame on the olefin surface for a few milliseconds.
   NOTE: Surface assumes a distinctly different gloss after treatment.

Rubber

1. Solvent clean with alcohol by immersion or wipe-off techniques.
2. Etch by immersion in concentrated sulfuric acid for 5 to 15 minutes at room temperature (optional).
3. Rinse with water until pH is neutral.
4. Dry at room temperature.
   NOTE: Treatment with sulfuric acid is called cyclizing. The surface becomes brittle and contains many small fissures, which add to mechanical adhesion. An alternate procedure for rubber is sanding followed by solvent cleaning with toluene.

APPENDIX B

INDEX OF ADHESIVE BONDING SPECIFICATIONS

This index lists all of the specifications abstracted. Suffix letters following specification numbers are not reproduced here, but are shown in the individual abstract. Thus, for example, U-S-00156 (GSA-FSS) is shown as U-S-00156.

MILITARY

FEDERAL STANDARDS

MILITARY STANDARDS

U.S. DEPARTMENT OF COMMERCE

AMERICAN DENTAL ASSOCIATION

AMERICAN SOCIETY FOR TESTING AND MATERIALS

AMERICAN STANDARDS ASSOCIATION

SOCIETY OF AUTOMOTIVE ENGINEERS

INDEX