

## **PACKAGING OF MATERIEL**

# **PRESERVATION**

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DEPARTMENTS OF THE ARMY, THE NAVY, THE AIR FORCE,  
AND THE DEFENSE LOGISTICS AGENCY

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Chapter 1

## Introduction - Packaging Policy

### GENERAL

AR700-15/NAVSUPINST 4030.28D/AFJMAN 24-206/MCO 4030.33D/DLAD 4145.7 Packaging of Materiel, is a joint regulation for all Department of Defense (DOD) components which establishes policies on the development of uniform requirements for the packaging of materiel acquired, stored, or shipped. The joint regulation implements DOD 4140.1-R, DOD Materiel Management Regulation, and covers policy requirements concerning the following:

- X Packaging
- X Specifications and Standards
- X Levels of Protection
- X Project Information Exchange

It provides uniform criteria for the selection and prescription of packaging at the time of acquisition, storage, or shipment.

While the Packaging of Materiel publication relates to both preservation of the unit packs and packing of the shipping containers, this document will only address preservation requirements, including the levels of protection. Unit packs and intermediate packs will also be discussed in this chapter.

### UNIT PACK

Unit packs are often referred to as interior packs. Figure 1-1 is a diagram which conceptualizes a shipping container with four unit packs and two intermediate packs. Listings of intermediate and shipping containers are found in the MIL-STD-2073-1C, Standard Practice for Military Packaging. This document will be discussed later in the chapters on preservation and preservation methods.

A unit pack is defined as the first tie, wrap, or container applied to a single item, or a quantity thereof, or to a group of items of a single stock number, preserved or unpreserved, that constitutes a single complete or identifiable package.

Unit packs are, for the most part, interior packs; however, there are preservation methods requiring the unit pack to also be the shipping container. Those situations will be presented in chapter four.

### INTERMEDIATE PACK

An intermediate pack is a wrap, box, or bundle that contains two or more unit packs of identical items. Intermediate containers or packs are used when they facilitate handling, storage and reshipment; when the exterior surface of the unit pack is a bag or wrap; when the unit pack volume is less than 64 cubic inches and the exterior container is a rigid type; and when specified by the procuring activity.

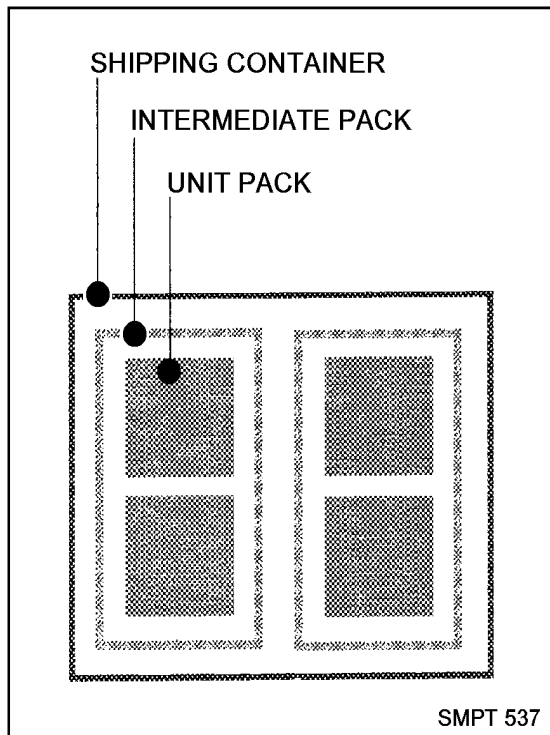


Figure 1-1. A packaging diagram.

The development and ordering of quantities to be placed in the unit, intermediate, and exterior pack require coordination with the managing activity. These quantities will be established after evaluating all known factors, including the following:

- X maintenance concept for the item being supported
- X basis for issue such as allowance and load list
- X life expectancy such as shelf-life and mortality rate
- X chemical and physical characteristics
- X construction and functional requirements
- X fragility or unit cost
- X ease of accountability and inventory
- X commercial practice quantity for like items
- X military standards or applicable regulations

### **EFFICIENT AND ECONOMICAL HANDLING**

The military concept of economy in preservation is to obtain maximum output of adequately protected items at a minimum cost. Economy measures, consistent with the degree of protection required by an item, should be of prime concern to individuals establishing preservation and packaging requirements. They must also be a concern to personnel in charge of or performing packing operations.

Significant savings can be accomplished by reducing the weight and cube; by the employment of options concerning packaging materials, i.e., barriers, wraps and cushioning; and automation. The concepts of "minimum weight and cube packs" and in addition, "a packaging design to fit the item", may not always be possible nor practical. The unit and intermediate packs, shall, however, be of uniform size.

## LEVELS OF PROTECTION

“Levels of protection” is defined as a means of specifying the level of military preservation and the levels of packing that a given item requires to assure that it is not degraded during shipment and storage.

Military level of preservation is the packaging protection given an item during shipment, handling, indeterminate storage, and distribution to consignees worldwide.

The military levels of packing consist of the following:

- X Level A. Protection required to meet the most severe worldwide shipment, handling, and storage conditions. Examples of situations which indicate a need for use of a Level A pack are as follows:
  - o war reserve material
  - o mobilization
  - o strategic and theater deployment
  - o open storage
  - o deck loading

Examples of containers used for Level A packing requirements include, but are not limited to, overseas type wood boxes, and plastic and metal reusable containers.

- X Level B. Protection required to meet moderate worldwide shipment, handling, and storage conditions. Examples of situations which indicate a need for use of a Level B pack are as follows:
  - o security assistance, e.g., Foreign Military Sales (FMS)
  - o containerized overseas shipments

Examples of containers used for Level B packing requirements include, but are not limited to, the following:

- X domestic wood crates
- X weather-resistant fiberboard containers
- X fast-pack containers
- X weather-resistant fiber drums
- X weather-resistant paper and multi-wall shipping sacks

## ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) ITEMS

Packaging required to protect ESDS items against damage and deterioration from the time of acquisition to anticipated use will be provided at the time of acquisition. MIL-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment, and MIL-HDBK-773, Electrostatic Discharge Protective Packaging, will be used as guidelines in the identification, packaging, handling, and storing of ESDS items.

## PROTECTING RETROGRADE CARGO OR RETURNED MATERIEL

Retrograde materiel will be protected consistent with provisions of the commodity grouping, in the original packaging.

## CONSUMABLE, SERVICEABLE (EXCESS) RETURNS

To prevent deterioration and damage, consumable, serviceable (excess) returns for credit will be returned in the original vendor or depot unit pack or in a unit pack which is the equivalent of the original unit pack. Consider the following before returning these items:

- X Ensure item serviceability and/or if condition warrants return. If not warranted, dispose of locally, as appropriate, through the servicing Defense Reutilization and Marketing Office (DRMO).
- X Failure to follow the above procedures for serviceable returns will result in the loss of credit. To minimize the possibility of credit loss, it is imperative that the item not be removed from the original unit pack until ready for use.

#### **HAZARDOUS MATERIALS RETURN**

When hazardous materials are being returned, packaging must conform to the applicable modal regulations. Modal regulations are found in the following:

- X International Civil Aviation Organization (ICAO) technical instructions,
- X International Air Transport Associations (IATA) regulations,
- X International Maritime Dangerous Goods (IMDG) Code of the International Maritime Organizations (IMO)
- X Title 49 Code of Federal Regulations (49 CFR), and
- X AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19/DLAI 4145.3, Preparing Hazardous Materials for Military Air Shipments.

#### **OTHER RETROGRADE CARGO**

Serviceable and unserviceable reparable materiel will be retained in the original packaging to maintain the integrity of the degree of serviceability of the materiel being returned.

Depot level reparable (DLR), serviceable and unserviceable, whose packaging prescription dictates the use of reusable containers, shall be afforded that protection throughout their life cycle.

All items will be identified with the national stock number (NSN), nomenclature, and quantity. Materiel condition tags or labels and markings will be applied as required by MIL-STD-129 and MIL-HDBK-129 and the DOD component. The shipper will be responsible for adequate packaging of materiel returns.

#### **OTHER POLICY REQUIREMENTS**

Other packaging or packaging related policies addressed in the uniform requirement covered by DOD 4140.1-R, previously mentioned, include the areas of commercial packaging, options, military markings, unit pack quantities, safety and health, and ecology.

#### **COMMERCIAL PACKAGING**

Commercial packaging shall be used by DOD components when it is cost effective and when commercial packaging will withstand anticipated logistics conditions. All packaging, including "commercial packaging" shall be based upon the following:

- X nature of the item,
- X known logistics requirements, and
- X economic or normal consumer order quantities.

As previously stated, MIL-STD-2073-1C provides a "military packaging development-decisions chart" which leads to the determination of whether "military packaging" or "commercial packaging" is warranted in accordance with (IAW) ASTM D3951, Practice for Commercial Packaging.

Items not going into stock shall be packaged IAW ASTM D3951. This includes items such as:

- X items intended for immediate use
- X items for not mission-capable supply
- X items intended for depot operational consumption
- X small parcel shipments (CONUS) not-for-stock
- X direct vendor deliveries (CONUS)

Items intended for deliver-at-sea, delivered during wartime, or items requiring reusable containers are exceptions to the above list of items.

#### **OPTIONS**

When standards, specifications, purchase descriptions, packaging data sheets or cards, special packaging instruction, drawings, or other authorized instructions contain options for selecting packaging methods, materials, or procedures, the option that provides protection at the lowest overall cost will be selected.

#### **MARKING**

DOD policy directs components to develop and apply uniform marking requirements to facilitate safe handling and efficient receipt, storage, and shipment of materiel. DOD 4500.32-R, Military Standard Transportation and Movement Procedures (MILSTAMP), provides policies and procedures required to manage and control the movement of materiel through the Defense Transportation System (DTS).

MIL-STD-129, "DOD Standard Practice for Military Marking," is to be used only for marking of military supplies which are intended for storage and shipment within the military distribution system, i.e., for marking of materiel not intended for immediate use, that is stored and/or moved within or between DOD facilities. This document complies with the wording and requirements of MIL-STD-2073-1C.

MIL-HDBK-129, "DOD Handbook Military Marking," is also available to DOD departments and agencies but is used for guidance only. This handbook, although based upon marking procedures from MIL-STD-129, cannot be cited as a requirement. If it is, the contractor does not have to comply.

Hazardous materials shall be packaged and marked in accordance with applicable Federal and international regulations such as the following:

- X Code of Federal Regulations Title 49, Transportation
- X International Civil Aviation Organization (ICAO) Technical Instructions
- X International Air Transport Association (IATA) Dangerous Goods Regulations
- X International Maritime Dangerous goods (IMDG) Code
- X United Nations Orange Source Book
- X Acceptance of Hazardous, Restricted or Perishable Matter, USPS Publication, 52
- X AFJMAN 24-204, Preparing Hazardous Materials for Military Air Shipments

For the purpose of packaging project information exchange, a project is any planned work load involving 160 or more man-hours (including all support functions). This entitles research, development, testing, or evaluation that may result in new or improved packaging concepts, methods, or procedures.

## CHAPTER 2

# Cleaning and Drying

## BASIC CLEANING PRINCIPLES

### IMPORTANCE OF CLEANING

The success of preservation and packing operations depends upon the cleaning of items by suggested processes. A preservative film will not protect an item if the surfaces are dirty or are covered with corrosion-producing particles. Inadequate cleaning makes all succeeding operations ineffective.

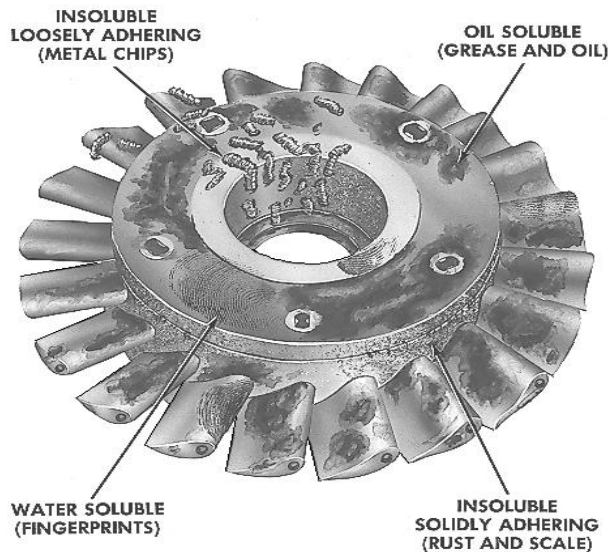
### CONTAMINATION

When surfaces of items are dirty or are covered with substances that are not part of the items, they are contaminated. Every manufactured item is subjected to many kinds of contamination from the time it is produced until it is received by the user. Examples of contaminants are drawing, milling, or cooling compounds, metal shavings, chips, abrasives, shop dirt, or corrosion products that form during various steps in manufacture.

### TYPES OF CONTAMINANTS (FIGURE 2-1)

Contaminants are classified into the following four categories:

- X Water soluble contaminants, such as heat treated salts, welding fluxes, soldering cleansers, chalk, fingerprints, and perspiration, which must be removed with water.
- X Oil (solvent type) soluble contaminants such as oils, greases, soaps, and cutting and drawing compounds which must be removed with solvents other than water.
- X Loosely adhering insoluble contaminants such as solid dirt particles, abrasive grains, metal chips, and filings which can be rinsed off with water or solvent.
- X Solidly (tightly) adhering insoluble contaminants such as mill and heat scale, carbon deposits, rust, and other corrosion products which cannot be removed except by mechanical means.



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Figure 2-1. Types of contaminants.

### **EFFECTS OF CONTAMINANTS**

Contaminants affect the surfaces of items in varying ways. Many contaminants are corrosive; others are hygroscopic (they absorb moisture) and promote corrosion. Some contaminants prevent adequate adhesion of an applied coating. Solid contaminants interfere with an applied protective film and provide points of entry for water or other corrosive agents. All of these properties of contaminants tend to cause items to corrode, since corrosion may occur on certain metals whenever any of the following conditions exist:

- X A metal (the item) plus oxygen and water.
- X A metal (the item) plus acids or alkalies and water.
- X A metal (the item) plus salts and water.
- X A metal (the item) plus corrosive gases or vapors and water.

Note that water in any form is the common factor in all four situations.

### **REMOVAL OF CONTAMINANTS**

Removal of contaminants depends upon the composition, degree of criticalness, and complexity of the item, and upon the type of contaminant present. Contaminants are not all affected in the same way by a given solvent. For instance, a cleaner that is suitable for removing oil-soluble contaminants may not be capable of removing rust and scale. Likewise, a cleaner that is suitable for removing rust and scale may not remove fingerprints and other water-soluble contaminants. Oil-soluble or easily emulsified contaminants can be removed either by solvents or water-emulsion solutions. Highly finished items contaminated with perspiration, fingerprints, and oil-soluble contaminants require a combination of cleaners to insure the removal of the fingerprints and perspiration. A cleaning process or combination of processes should be chosen that will remove all contaminants.

### **CLEANING REQUIREMENTS (figure 2-2)**

Basic cleaning requirements are listed in MIL-STD-2073-1C. Items shall be cleaned and dried by any suitable process or processes which are not injurious to the items. Critical surfaces (close machined tolerances) must be cleaned to ensure total removal of corrosion, soil, grease, fingerprints, perspiration and all other acid and alkali residues. Disassembly must be discouraged. Complex items will not be disassembled without prior authorization and/or technical instructions.

### **PROCESS SELECTION CRITERIA**

The selection of a cleaning process depends upon the characteristics of the item, the nature of the contaminants, availability of cleaning materials and equipment, and the safety hazards involved.

### **COMPOSITION OF THE ITEM**

The composition of the item limits the choice of the cleaning process. Aluminum or zinc items should not be cleaned in highly alkaline cleaners because of detrimental effect of the cleaner. Nonmetallic items of rubber, fabric, cork, or other organic composition should not be cleaned haphazardly in organic or water-soluble alkaline cleaners. If solvent cleaning is applied to such items, the solvent exposure must be brief and scrubbing action limited when dimensions and use conditions of the item are critical. Petroleum solvents are detrimental to most rubber and synthetic rubber materials. If metallic and nonmetallic materials are combined in an assembly, the cleaning process must be carefully considered and the choice of the process governed by the nature of the materials combined in the assembly.

### **SURFACE FINISH OF THE ITEM**

Some cleaning processes are safe to use on highly finished and precision surfaces while other processes are likely to mar the finish. For instance, alkaline cleaning should not be used on polished aluminum. Acid cleaners

are used on iron and steel with extreme care. For most critical surfaces of metal items, the petroleum solvent or vapor degreasing processes usually are recommended. Surfaces of rough forgings or casting, rough ground or rough machined items, or surfaces having no finishing after stamping or drawings are cleaned by alkaline cleaning processes. Items with porous surfaces, small crevices, or with capillary holes are not cleaned with alkaline cleaning processes because the complete removal of all residues is not possible and corrosion will result. This is also true of items which have extended lap joints, riveted areas, spot-welded additions, and similar constructions. Porous, oil-impregnated, or graphite lubricated items should be cleaned by wiping with a dry cloth. Items with porcelain or painted surfaces are not cleaned in strong alkaline solution. Solvent cleaning cannot be applied indiscriminately to painted surfaces; however, zinc-chromated primers, exterior paints, lacquers, and enamels are usually handled safely in petroleum solvent cleaners.



Figure 2-2. Cleaning requirements.



### **COMPLEXITY OF THE ITEM**

Items having irregular surfaces, crevices, undercuts, and pockets that could trap the cleaning fluids may only be cleaned by brushing or wiping when solvent cleaning is employed. Clean complex assemblies prior to assembly. Such assemblies as electric generators, motors, starters, gauges, meters, timing devices, and other complex units should be cleaned before assembly and kept clean thereafter.

### **AVAILABILITY OF FACILITIES**

Approved materials and equipment should be used wherever possible. If the desired cleaning materials and equipment are not available, consider carefully the selection of an alternate process. Solvent cleaning can be done in pails, buckets, drums, or barrels in an emergency. The hot vapor degreasing process requires specially designed equipment, but the solvents used for vapor degreasing can be used cold if due caution is taken to avoid overexposure to the vapors. Most cleaning processes are not too complex, and operations can be modified to meet the needs of the situation.

### **HEALTH AND SAFETY HAZARDS**

All cleaning materials must be selected and used in accordance with applicable Environmental Protection Agency (EPA) regulations, Occupational Safety and Health Standards (OSHA), Code of Federal Regulations (CFR) 29, Section 1910, General Industry and Air Pollution Control statutes, and regulations in force in the geographic and industrial area where the cleaning is performed. Many of the cleaning processes (for example, vapor degreasing, solvent cleaning, and fingerprint removing) involve the use of chemicals that could present a safety hazard. CFR 29, Section 1910.1200, (the "workers-right-to-know" standard) was written to reduce injuries or illnesses caused by personnel working with or exposed to chemicals. Workers need to know the chemical hazards they are exposed to and the safe practices linked with those chemicals used in the work place. CFR 29, Section 1910, requires that a Material Safety Data Sheet (MSDS) be available to workers at all times. A MSDS contains applicable information regarding product identification, hazardous ingredients, physical data, fire and explosion hazard data, reactivity data, health hazard data, spill or leak procedures, and precautions to be taken in handling and storing.

## **CLEANING PROCESSES**

### **ANY GENERAL CLEANING PROCESS (FORMERLY C-1)**

Any process not required by an order or contract may be used. Any process or combination of processes which will accomplish thorough cleaning without damage to the item will be appropriate. If a specific process cannot be cited, then any general cleaning process is in order. All cleaning processes must result in noninjury to items and the satisfactory passing of the quality conformance test as specified in the Preservation Inspection Provisions, of MIL-STD-2073-1C. Cleaning processes are either mechanical or chemical.

### **Mechanical Processes**

The mechanical processes are used to remove solidly or tightly adhering contaminants. These processes use abrasive materials, pressure tools and power tools and often subject the items to severe treatment. Some of the mechanical processes are air-vacuum cleaning, barrel tumbling, impact tool cleaning, and wire brushing.

#### ***Air-vacuum Cleaning***

This process is used to remove dust and lint from items during final assembly operations. The cleaning of electronic components is an example in which air-vacuum cleaning is used.

***Barrel Tumbling (figure 2-3)***

This process consists of the cleaning mass, composed of the items to be cleaned, an abrasive or rolling medium, a fluid lubricant (usually water), and a chemical corrosion inhibitor mixed together in a cylinder or barrel. This cleaning mass rolls and tumbles upon itself in the barrel by being carried up the side until it reaches a point where it slides down because of gravity, thus scrubbing and polishing all surfaces to be cleaned.

***Impact Tool Cleaning***

These processes are used on noncritical surfaces to remove mill scale, rust, or old paint coatings. They are done by pounding, hammering, or chiseling the surface of the item with manual or pneumatic hammers, chisels, scalers, scrapers, rotary wheels, or vibrators. Wherever these tools are employed, they must be suitably sharp. Dull tools tend to drive scale and corrosion products into the surface of the metal, creating a nucleus for corrosion. Because they prevent effective cleaning, oily and greasy contaminants must be removed before impact tool cleaning.

***Wire Brushing***

Wire brushing removes loose scale, corrosion products, old paint, and similar encrustations from metallic surfaces. It will not remove tightly-adhering mill scale, tight oxides, or embedded corrosion products.

***Chemical Processes***

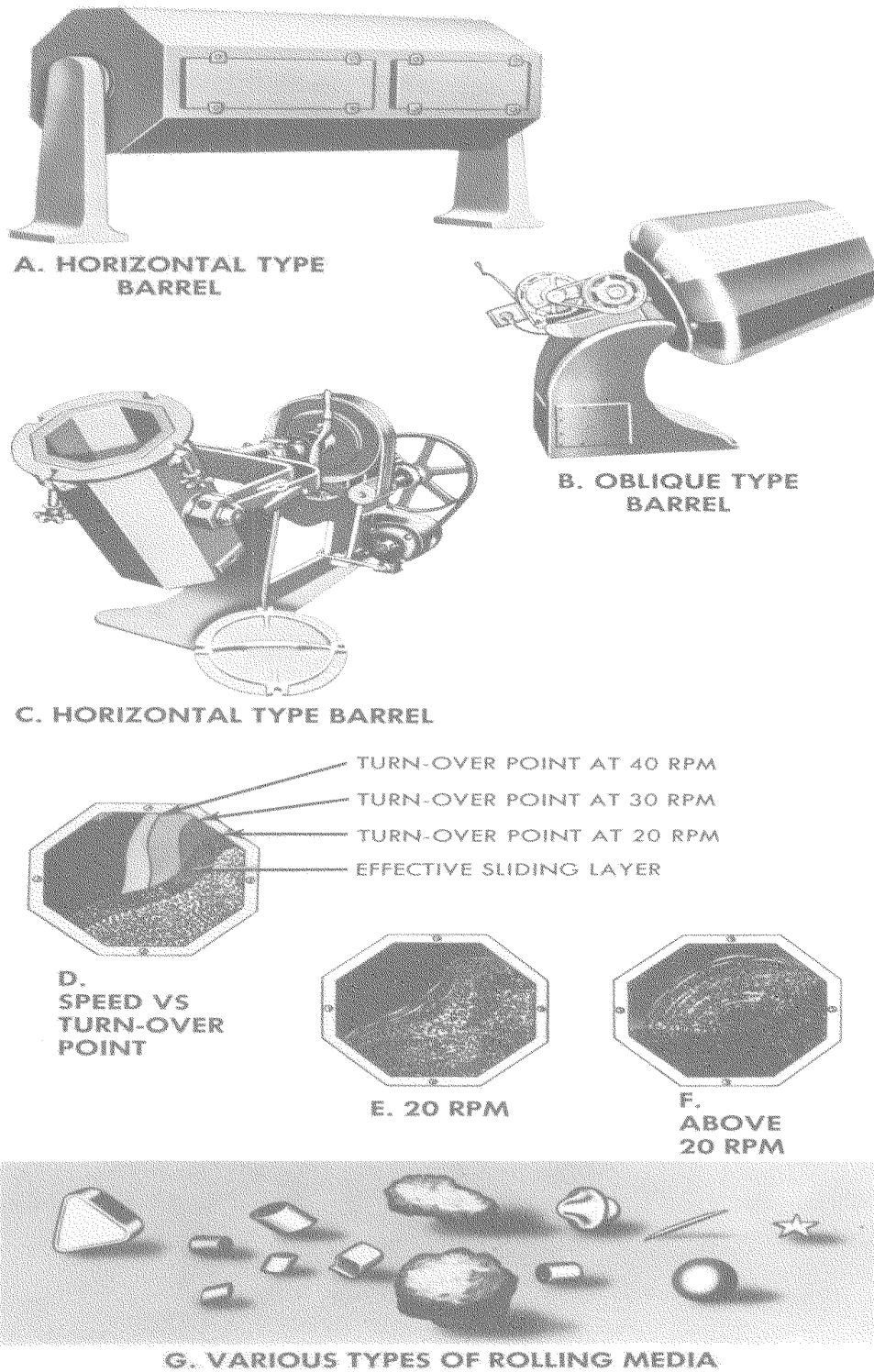
The chemical processes are acid, alkaline, and detergent cleaning.

***Acid Cleaning (pickling)***

Acid cleaning or pickling consists of removing surface oxides, scale, and rust from metal by immersion in an acid solution. Oil-soluble contaminants must be removed before acid cleaning. After immersion in the acid solution, the item is rinsed thoroughly to remove any remaining acid from its surface. In some operations, the acid residues are removed by scrubbing, while rinsing or neutralizing the items. In other operations, an alkaline rinse, used to remove the acid residues, is followed by a chromate or phosphoric-chromic acid rinse to neutralize the alkali and retard corrosion. In all cases, the surfaces of the item must be neutral before applying a protective coating. The most common types of pickling solutions are sulfuric and hydrochloric acids. Nitric, phosphoric, and hydrofluoric acids are used for some applications. One of the most serious problems in connection with the acid cleaning is what is known as "acid brittleness" or "hydrogen embrittlement" (Penetration of generated hydrogen on metal surfaces). This may be eliminated by soaking the items in boiling water immediately after pickling, or may be minimized by the use of the proper inhibitor. Water rinsing is a very important operation after pickling to remove all traces of acid and iron salts. If complete removal of such residues by the water rinse alone is doubtful or if the parts must remain unprotected for a period of time, an alkaline rinse is recommended to neutralize any remaining acid residues.

***Alkaline Derusting Compounds***

Alkaline derusting, using an immersion process with either electrolytic or nonelectrolytic equipment, removes rust from steel objects better than acid cleaning, and without affecting the dimensions of the base metal in the process. Much less hydrogen embrittlement (entrapped hydrogen bubbles within the porous structure of the metal and rerusting of the base metal) occur when alkaline derusting is used. MIL-C-14460 identifies two types of derusting compounds. Type I is a mixture of sodium hydroxide, sodium gluconate, a complexing agent, and a foaming agent. Type II is a mixture of sodium hydroxide, sodium cyanide, a complexing agent, and a foaming agent.



SMPT 651

Figure 2-3. Barrel tumbling.

Type I compound is used for rust removal by simple immersion of items in the heated derusting solution. The usual concentration of this compound is 5 pounds per gallon of solution. If type I material is used, the solution is heated to boiling. A "rolling" boil gives effective agitation.

**DANGER**

Type I compound causes severe burns to skin and eyes. Wear goggles or face shield when handling. Avoid dust and fumes. Keep away from food products. In case of eye or skin contact, flush immediately with plentiful amounts of water for at least 15 minutes and get immediate medical attention.

Type II compound is used for the most severe conditions of rusting on exterior or interior surfaces where equipment for electro-cleaning is available. Usually, it is mixed at the rate of 2 or 3 pounds per gallon of solution. This material should not be used at temperatures above 130°F. It should not be used for cleaning portable water tanks, food containers, and similar items.

**DANGER**

Type II compound contains sodium cyanide! Do not mix with or allow to come in contact with acids or acid solutions. Contact with acid liberates poisonous cyanide gas. Keep container closed and in a dry place.

Both type I and type II compounds are used for removing rust and scale from iron and steel. The compounds may be used for cleaning nonferrous metals. However, their effect on the metal to be cleaned should be checked before they are used for cleaning items. These compounds have been found to attack aluminum, copper, brass, and zinc. Articles should be thoroughly rinsed in clean hot water and dried immediately after removal from the corrosion removing compound.

***Detergent Cleaning***

Detergent material (MIL-D-16791) is used for removing contaminants from a vast range of items such as rubber, plastics, canvas, and metallic materials. For most cleaning operations, 1/4 to 1/2 ounce of detergent in a gallon of fresh water or sea water, preferably hot, is sufficient. The detergent will efficiently remove grease, oil, and dirt from a wide variety of surfaces.

**SOLVENT CLEANING PROCESSES**

Solvent cleaning makes use of several solvents, utilizing processes known as solvent cleaning and fingerprint removal. A combination of solvent cleaning followed by fingerprint removal will be discussed extensively in a later paragraph entitled "Perspiration and Fingerprint Removal."

**Applicability of the Processes**

The solvent cleaning processes are used to remove oils and greases remaining after machining, milling, polishing, and similar operations or any time the item is contaminated with oil-soluble contaminants. Solvent cleaning with pressure spray equipment removes loose chips and other loosely adhering particles produced during fabrication of the item. Solvent cleaning is used when the only contaminant is a light grease or oil. The spraying process is

used on items of simple construction with surfaces that can be reached by the solvent spray. Solvent cleaning will not remove rust or corrosion products.

### **Materials for Solvent Cleaning**

Solvent cleaning materials are dry-cleaning solvent, paint thinner, corrosion preventive fingerprint remover compound, and tetrachloroethylene.

#### ***Dry-cleaning Solvent (P-D-680)***

This is a clear, solvent-based liquid which is neutral to metals and only slightly irritating to the skin. It may be mildly nauseating when excessive vapors are breathed. It evaporates quickly without leaving a corrosion inducing film on metal surfaces. It is used especially for removing oils and greases from metal surfaces by brushing, wiping, spraying, or immersion. Dry-cleaning solvent has a flash-point (the point at which there are sufficient vapors from the solvent to ignite in the presence of a flame or spark) of 100°F., or higher. The material must be used only at room temperature, since heating significantly increases the fire hazard. See the paragraph in this chapter entitled "Environmentally Safe Solvents."

**WARNING**

Keep solvent away from any open flame or source of sparks.

#### ***Volatile Mineral Spirits, Paint Thinner (A-A-2904)***

Paint thinner is supplied as two grades of petroleum distillate. Only grade I (light thinner) is used for petroleum solvent cleaning. It is an excellent solvent for oils and greases. It is similar to dry cleaning solvent (P-D-680), having the same flashpoint and degree of toxicity, but is more highly refined and is usually higher priced.

#### ***Fingerprint Remover Corrosion Preventive Compound (MIL-C-15074)***

This is a homogeneous stable mixture of solvent, soap, and water. It is capable of removing water soluble contaminants such as fingerprints, suppressing perspiration corrosion, and temporarily protecting steel surfaces. It is nontoxic and free from disagreeable or offensive odors.

#### ***Technical Tetrachloroethylene (perchloroethylene) (ASTM D 4081, ASTM D 4376)***

Tetrachloroethylene is similar to trichloroethylene. Its differences make it the preferred solvent in some situations. It is completely insoluble in water. Any water that condenses in the degreaser at night is soon evaporated to steam before the solvent reaches its boiling point (250°F). This high boiling point also permits a longer cleaning cycle than possible with trichloroethylene because of the longer time required to reach temperature equilibrium. The vapor of tetrachloroethylene is six times heavier than air, thus restricting the loss of vapor. This permits construction of portable, air-cooled degreasers. Tetrachloroethylene is less toxic than trichloroethylene, but it must be handled with reasonable care. Strong vapor concentrations will result in symptoms similar to those caused by trichloroethylene, which is prohibited for DOD use. Tetrachloroethylene is more stable and requires no stabilizers. It is nonflammable and will only decompose at extremely high temperatures. It does not remove fingerprints, rust, or scale.

#### ***Equipment Used in Solvent Cleaning***

The equipment required for solvent cleaning includes petroleum solvent tanks, portable solvent degreasers, and solvent spray washers.

#### ***Solvent Tanks (figure 2-4)***

Solvent tanks are simply constructed but must be capable of holding the solvent. Where cleaning is conducted at an established installation, special safety features are required in the tank design. Tanks are constructed of low-carbon steel and are welded at the seams. A typical solvent tank with safety features consists of a rectangular compartment, with a tight fitting

cover held open during cleaning operations by means of a chain containing a fusible link. This is held together by a low-melting solder. Should the solvent catch fire, the heat evolved melts the solder and allows the lid to close and smother the fire. For this reason, it is important that the fusible link should always be in an operable condition. The lid should never be wired or fastened so that it cannot close automatically in case of fire. Tanks must be provided with a ground connection to carry off any static charges of electricity.

### ***Improvised Solvent Tanks***

In the absence of approved cleaning equipment, solvent cleaning can be done in drums, pails, cans, or other containers. Fifty-five-gallon drums split in half make suitable tanks for field expedience. Regardless of the container used, provision must be made to keep it closed when not in use.

Other types of solvent spray cleaners are shown in figure 2-5.

### ***Safety Precautions of Solvent Cleaning (figure 2-6)***

When not in use, covers must be kept in place on all solvent tanks. To prevent the accumulation of flammable vapor and the build up of an explosive mixture, adequate ventilation must be provided, especially if paint thinner is used. Carbon dioxide fire extinguishers must be located in the vicinity, and personnel must be trained in their use. A fire blanket should be located nearby. Solvents remove natural oils and may cause skin irritations. Some people are susceptible to the solvent and are afflicted with blisters and chapped skin upon exposure. Operators should wear oil-resistant rubber or plastic gloves and work aprons during cleaning operations to protect themselves and to keep the items free from fingerprints. High vapor concentrations of these solvents may cause dizziness, fainting, and nausea, if inhaled.

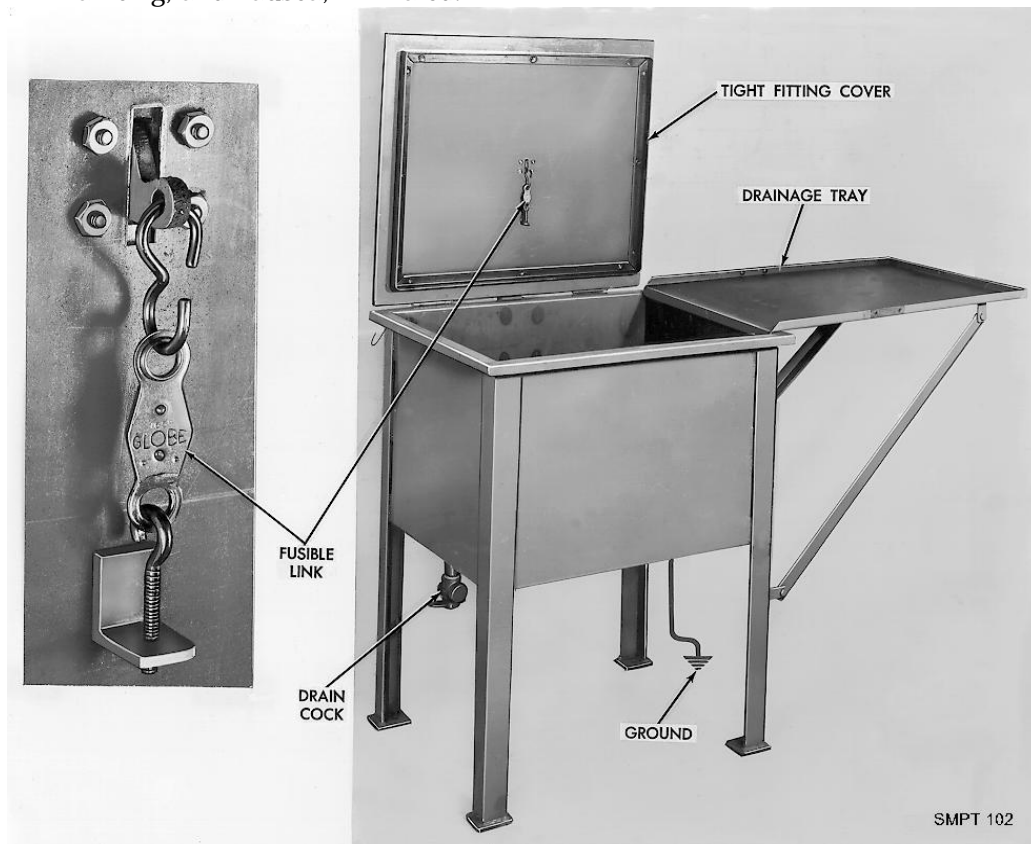


Figure 2-4. Solvent safety tank.

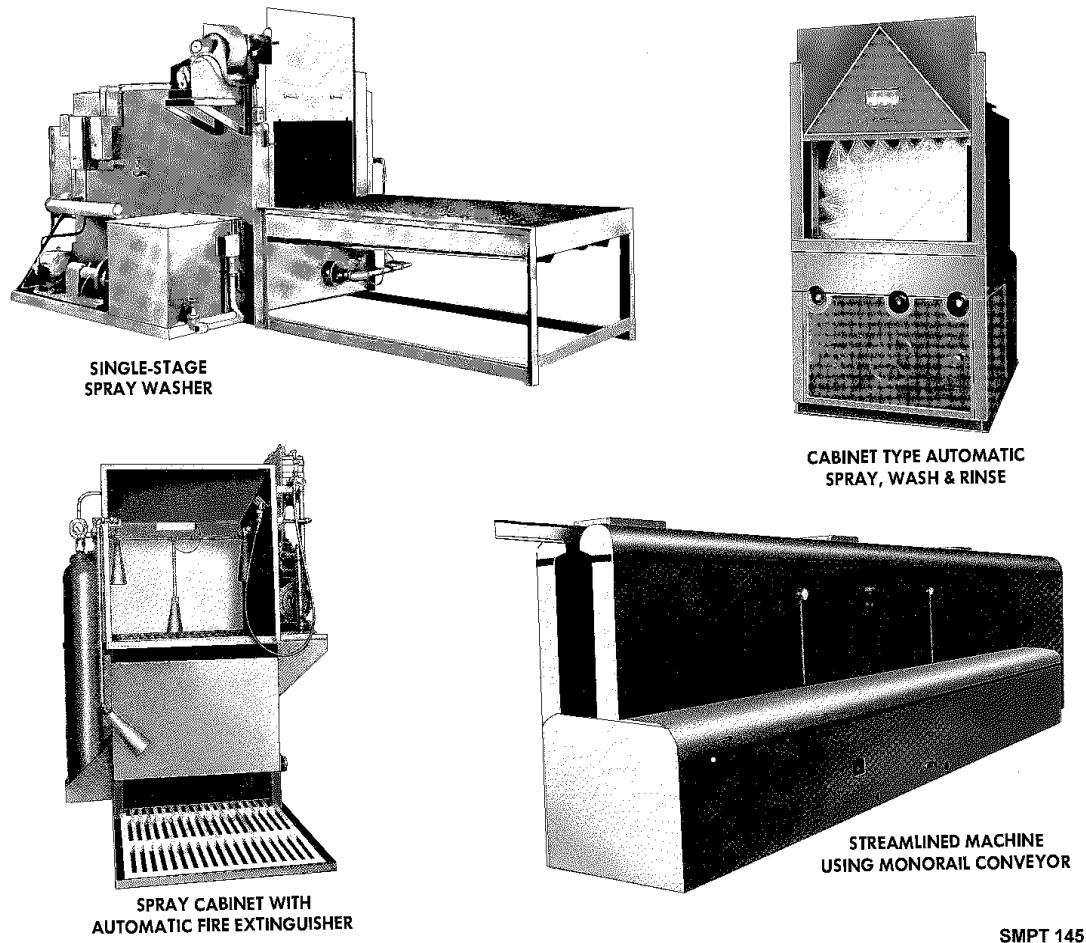


Figure 2-5. Solvent spray cleaners.

#### SOLVENT CLEANING METHODS

**Immersion (figures 2-7 and 2-8).** The solvent cleaning immersion operations are as follows:

- X Wear safety goggles, rubber gloves, and apron.
- X Immerse items in solvent.
- X Agitate items thoroughly. Position items to receive the most effective washing action.
- X Use a brush where necessary to remove dirt.
- X Remove items from tank when visually clean.
- X Drain completely, allowing excess solvent to return to the tank.
- X Immerse items in a second tank of clean solvent.
- X Agitate as necessary.
- X Place items on tray to drain.
- X Apply appropriate cleanliness tests.

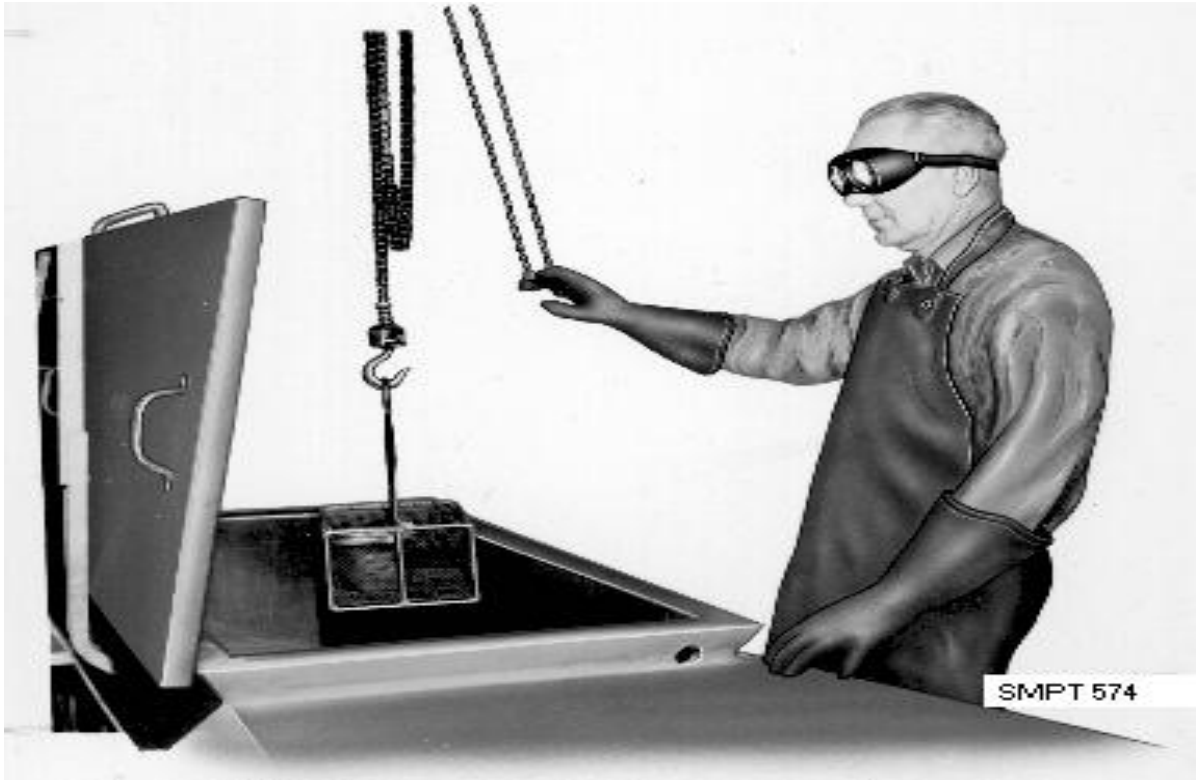


Figure 2-6. Solvent safety clothing.

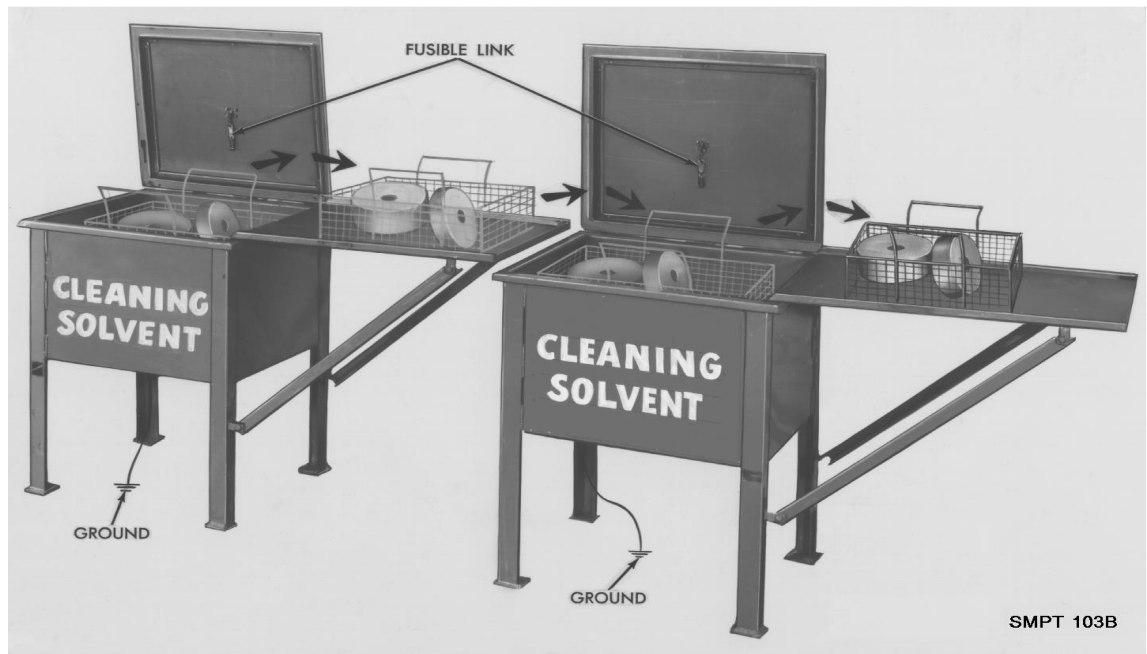


Figure 2-7. Solvent cleaning by immersion.



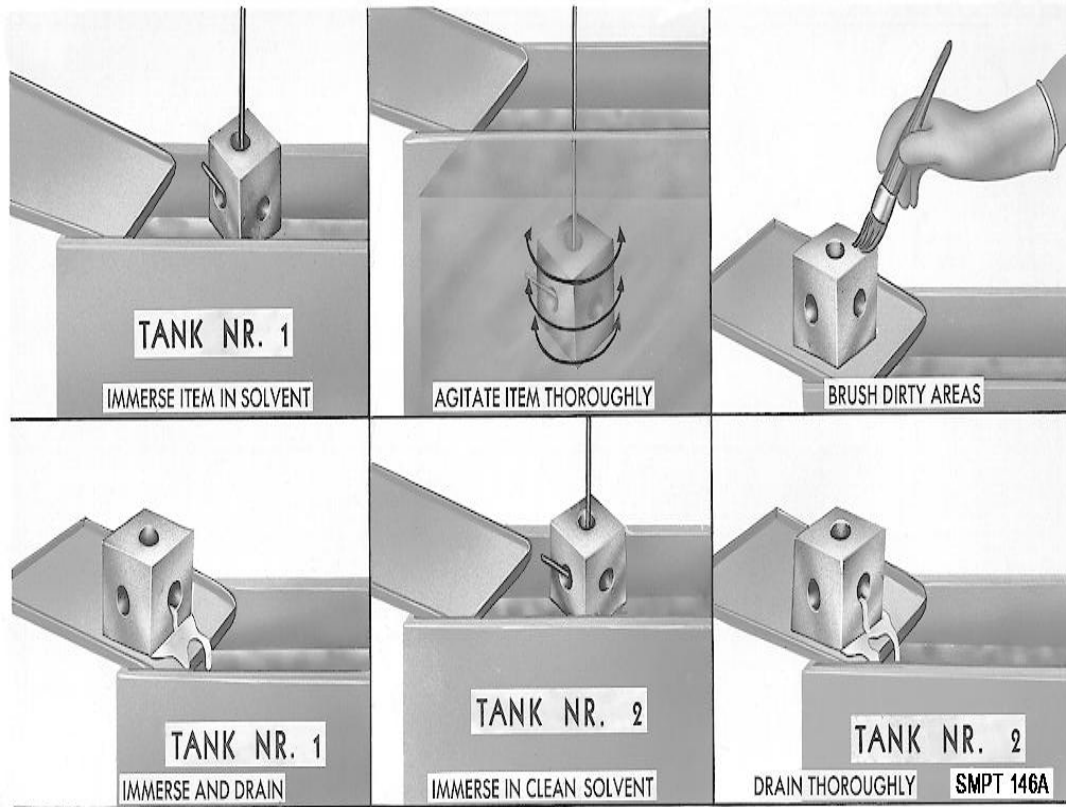


Figure 2-8. Solvent immersion operations.

**Scrubbing and Wiping (figure 2-9).**

When cleaning items that are too large for available cleaning tanks, or because it is impractical to clean by immersion or spraying, the sequence of operations is -

- X Wear safety goggles, rubber gloves, and apron.
- X Soak cleaning cloth or brush in clean solvent.
- X Apply cleaning cloth or brush in clean solvent.
- X Use a combination of soaking, scrubbing, and wiping as necessary.
- X Rinse off area with a clean cloth soaked in clean solvent. Flush over cleaned area and rinse.
- X Drain, shake, or wipe off excess solvent.
- X Apply appropriate cleaning tests.

**Spraying (figure 2-10)**

If items are of simple construction and free of cavities and indentations, and if the equipment is available, the solvent spraying steps are -

- X Wear rubber gloves, goggles, and apron.
- X Load items into solvent spray area.
- X Turn on spray pump and direct nozzle at items.
- X Shift items in basket so spray reaches all areas.
- X Remove items from spray zone and permit to drain.
- X Apply appropriate cleaning tests.

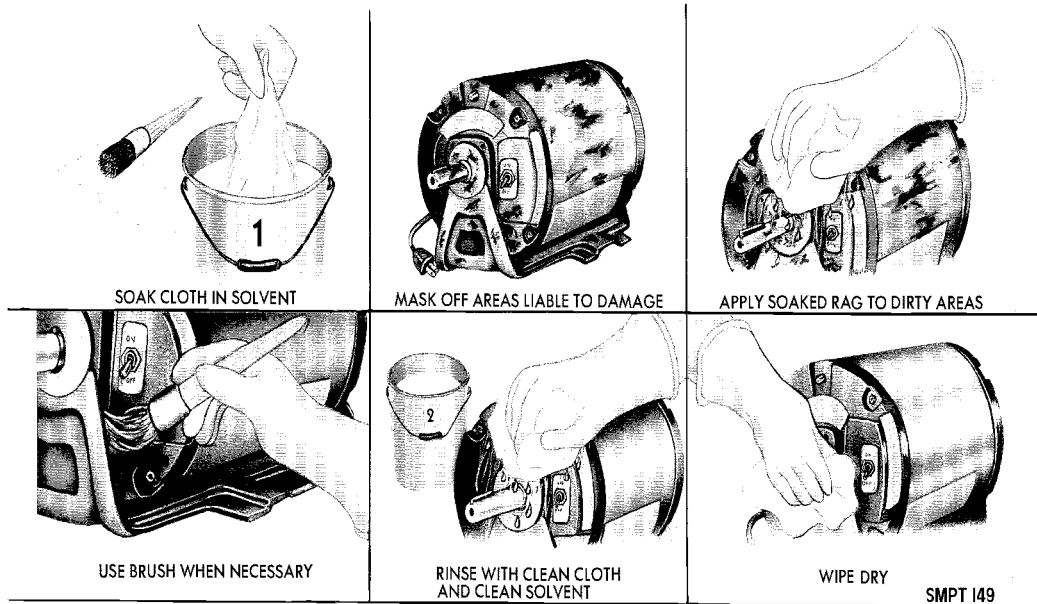


Figure 2-9. Solvent scrubbing and wiping.

#### PERSPIRATION AND FINGERPRINT REMOVAL

Perspiration and fingerprint removal equipment and processes are depicted in figures 2-11 and 2-12. All items with critical functioning surfaces or with close tolerances must be cleaned in perspiration and fingerprint remover until they will pass the cleaning tests as specified in MIL-STD-2073-1C. Items are treated for fingerprint removal (figure 2-12) by the following steps:

- X Wear safety goggles, rubber gloves, and apron.
- X Immerse items in perspiration and fingerprint removal compound.
- X Agitate items for a minimum of 2 minutes.
- X If item is too large for complete immersion, clean critical surfaces with a lint free clean cloth saturated in fingerprint remover.
- X After the petroleum base fingerprint remover (MIL-C-15074) is used, rinse items in a second tank containing clean solvent conforming to A-A-2904, ASTM D 4081, ASTM D 4376 (grade 1), P-D-680 or MIL-T-81533, to remove the fingerprint residue.
- X Agitate items in rinse solvent for at least 2 minutes.
- X After rinsing, drain items thoroughly.
- X Apply appropriate cleanliness tests.

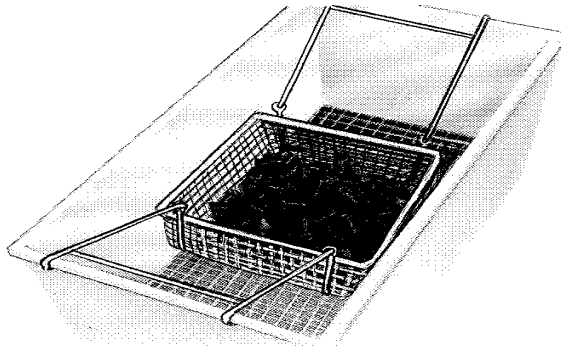
Solvent cleaning followed by fingerprint removal is shown in figure 2-13. The steps given previously for solvent cleaning followed by the steps for fingerprint removal are the same as the steps in vapor degreasing cleaning.

#### VAPOR DEGREASING

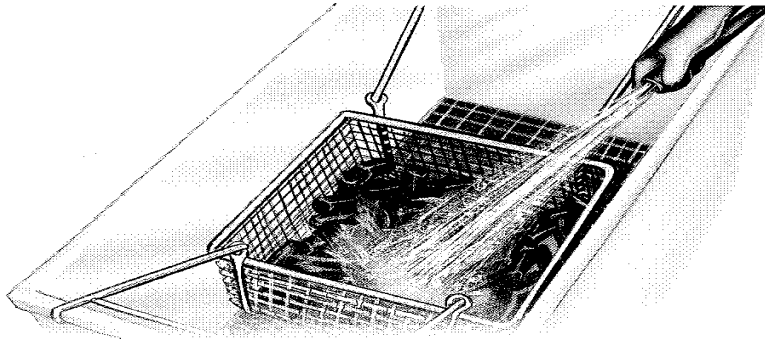
The basic principles of vapor degreasing are shown in figure 2-14. Vapor degreasing is used for the rapid and thorough removal of heavy oils and greases from most metal products. It utilizes the vapor of special grades of non-flammable, chlorinated solvents. When an oily, greasy item is lowered into the vapor, the vapor condenses on the item and the resulting hot liquid rapidly dissolves and rinses away the contaminants. As the item reaches the same temperature of the vapor, condensation ceases and cleaning stops. The degreasing process is quite simple, but must be performed only in specially designed equipment because of the health hazard involved. Operating rules as outlined in manufacturers' manuals must be strictly followed. This procedure is being replaced by a less environmentally hazardous procedure which will be discussed later in this chapter. See paragraph entitled "Restrictions in the Use of Solvents."



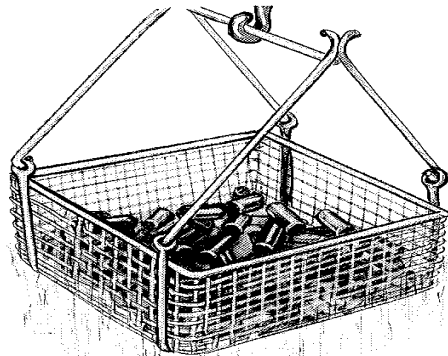
**LOAD ITEMS IN WORK BASKET**



**LOWER BASKET INTO SPRAY TANK**



**DIRECT NOZZLE AT ITEMS**



**REMOVE BASKET — ALLOW TO DRAIN** SMPT 152

Figure 2-10. Solvent spray cleaning.

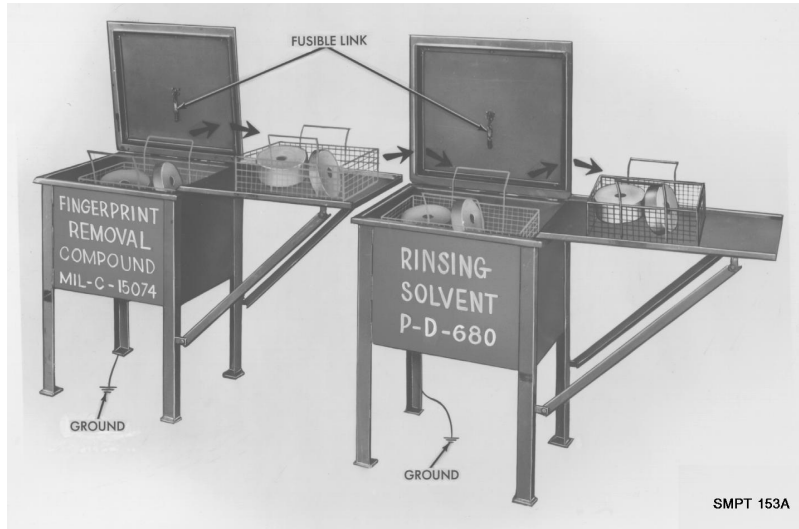


Figure 2-11. Perspiration and fingerprint removal.

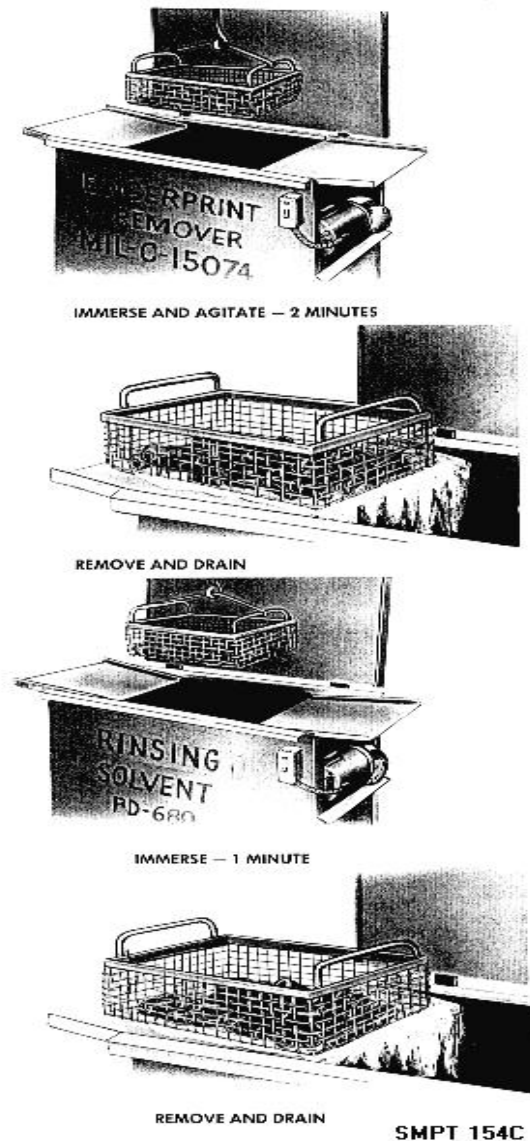


Figure 2-12. Fingerprint removal operations.

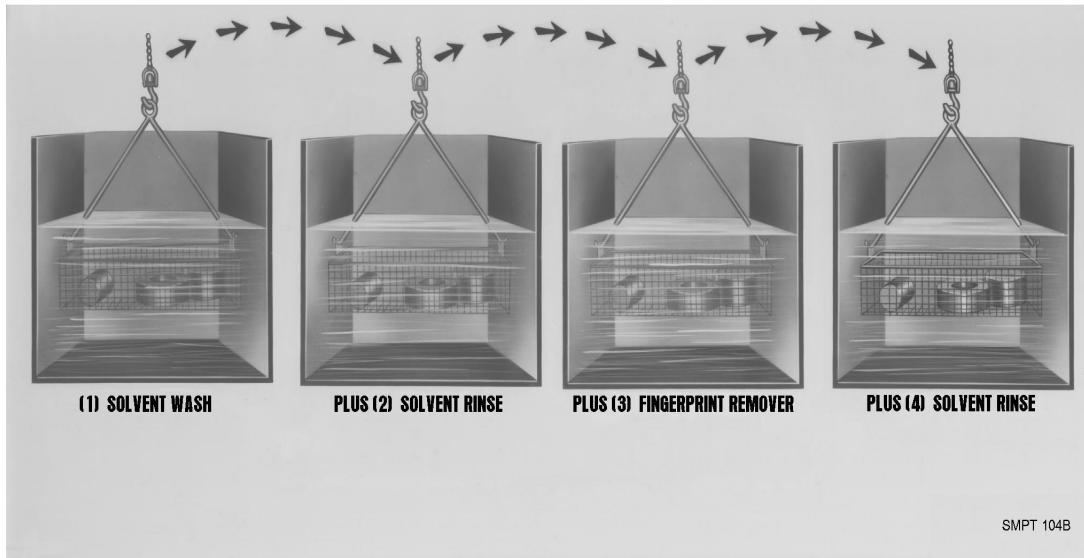


Figure 2-13. Solvent cleaning followed by fingerprint removal.

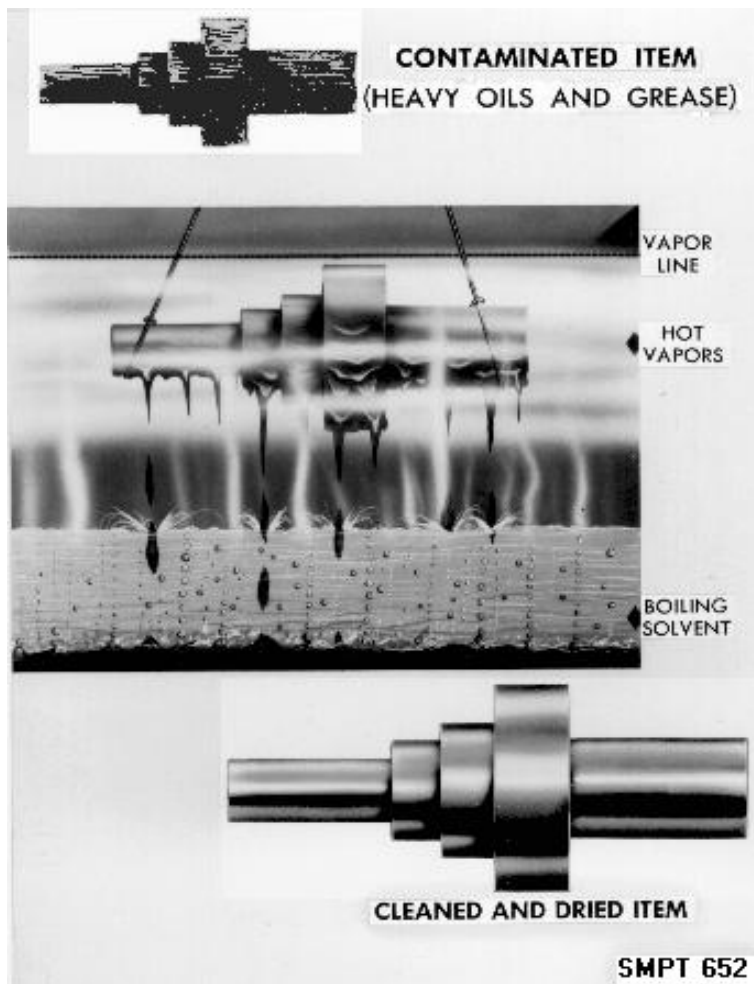


Figure 2-14. Vapor degreasing principle.

### **VAPOR DEGREASING FOLLOWED BY FINGERPRINT REMOVAL**

Items will be cleaned in accordance with the vapor degreasing process followed by the fingerprint removal process as detailed in this chapter.

#### **Applicability**

This process is used whenever the temperatures involved will not result in damage, injury, or malfunction of the item. Vapor degreasing is extensively used because of the ease and rapidity of removal of oils and greases from metal items of simple construction. The items are clean, dry, and ready for preservation and packing as soon as they are removed from the degreaser and allowed to cool. The process is economical, once the equipment is installed, and use is made of solvents that are free from fire hazards.

#### **Vapor Degreasing Materials (solvents)**

One of the materials used for vapor degreasing is a product of the chemical industry known as technical tetrachloroethylene (perchloroethylene) (ASTM D 4081, ASTM D 4376) and known as chlorinated solvent.

#### **Restrictions in the Use of Solvents**

Care shall be taken to assure that when these solvents are used, aluminum surfaces are not adversely affected by depletion of inhibitors or decomposition of the solvent.

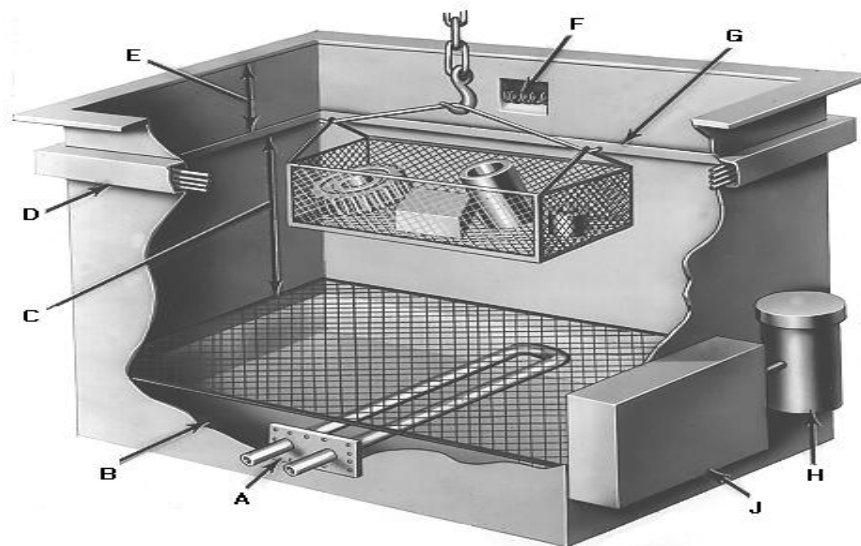
Any cleaning material used in the process must be selected to comply with Section 236 of Public Law 102-484 which prohibits the Government from awarding any contract which includes a specification or standard that requires the use of a Class I ozone-depleting substance identified in the Clean Air Act Amendment of 1990. The Federal and military specifications O-T-620, MIL-T-81533, and MIL-C-81302, are Class I ozone-depleting substances and should not be used. Substitute materials such as ASTM D 4081, ASTM D 4376, A-A-2904, or those which conform to ASTM D 4081 and ASTM D 4376 are free of ozone depleting materials and should be used. Preservatives, as well as cleaning materials, must be in compliance with the previously mentioned law.

Some of the solvents may not have "ozone-depleting" characteristics, but they may have some other environmentally unsafe attributes which render them undesirable for continuing use. P-D-680 is one of those solvents and will be mentioned later under the paragraph "Environmentally Safer Cleaning Methods". The practice of vapor degreasing by utilizing traditional chlorinated solvents is decreasing and will eventually be supplanted by a less environmentally hazardous procedure. The use of chlorinated solvents in vapor degreasing has been banned entirely in the State of California. There are various aqueous-based solvents available through the GSA sources, but there are none (for vapor degreasing) to this date, that have reached the level of efficiency comparable to the old chlorinated solvents for vapor degreasing. Testing of new solvents continues, of course. See the paragraph later in this chapter entitled "Environmentally Safe Solvents."

#### **Equipment Used in Vapor Degreasing (figure 2-15)**

Vapor degreasing should be performed only in properly designed and controlled equipment. The manufacturer's guide to operations must be carefully followed. Degreasers vary greatly in size and complexity, but they all have basic components that are included in all units. A vapor degreaser in its simplest form consists of the following components:

- X Heating elements (A). A source of heat designed to raise the temperature of the solvent to the boiling point.
- X Boiling chamber (B). A tank or vat capable of holding the solvent.
- X Vapor area (C). A work space between the surface of the boiling solvent and the top of the condenser, large enough to hold the vapor and accommodate the work.



A. HEATING ELEMENTS  
 B. BOILING CHAMBER  
 C. VAPOR AREA  
 D. CONDENSER  
 E. WORK CLEARANCE SPACE  
 F. SAFETY THERMOSTATS  
 G. DRAINAGE TROUGH  
 H. WATER SEPARATOR  
 J. CLEAN SOLVENT STORAGE TANK

SMPT 653

Figure 2-15. Basic vapor degreaser.

- X Condenser (D). The water jacket and coils used to balance the heat input and condense the vapor. (Degreasers designed for tetrachloroethylene only may be without a condenser. The walls of the tank are correspondingly higher to provide for air cooling.)
- X Work clearance space (E). Additional wall height above the condenser prevents normal air currents from pulling vapor from the degreaser.
- X Safety thermostat (F). This shuts off the heating elements if the vapor should rise above the condenser.
- X Drainage trough (G). This collects the condensed solvents from the walls and delivers them through the water separator to the storage tank or boiling chamber.
- X Water separator (H). This collects moisture, condenses it and separates it from the solvent.
- X Clean solvent storage tank (J). Where the returning solvent can be held or returned to the boiling chamber.

### Operating Characteristics

The solvent in the boiling chamber is heated by the heating elements until boiling begins and vapor rises into the vapor area. As the vapor reaches about midpoint of the condenser, it begins condensing along the walls of the degreaser. The condensed solvent then flows into the draining trough and back to the water separator where any moisture in the solvent is trapped and removed as necessary. From the separator, the solvent returns to the clean storage tank or back into the boiling chamber. If the condenser cooling water supply should fail during operations, the rise of vapor above the tank is prevented by a safety thermostat which automatically turns off the heating coils. Another thermostat is often located just above the heating coils to turn the heat on again when the vapor level drops too low.

### Types of Vapor Degreasers (figure 2-16)

Vapor degreasers are manufactured in many sizes and shapes, ranging from small, batch-type, manually operated models, to huge, continuous, fully

automatic, conveyORIZED installations. Vapor degreasers may be heated by gas, steam, or electricity. They may be designed for use with trichloroethylene or tetrachloroethylene only, or they may be capable of using either solvent.

There are manually operated, water and air-cooled degreasers; manually operated, flush vapor degreasers; manually operated, two- and three-dip vapor degreasers; and several designs of conveyORIZED vapor degreasers, which incorporate various special features. Several types of vapor degreasers are illustrated in figure 2-16.

### Installation

Vapor degreasers must be installed to keep solvent vapor loss to a minimum. The degreaser should, therefore, be located away from abnormal air currents such as heating and ventilating equipment, open windows and doors, and out of direct line of any air flow or down drafts. Air exhaust systems should be provided only when necessary, such as required for a pit-installed vapor degreaser. A degreaser should not be located near open flames, any high temperature surfaces (above 750°F), or where direct sunlight will reach the vapor zone. Flames, sunlight, high temperature, and water will cause decomposition of the degreasing solvent. Decomposition products are toxic and corrosive gases. They are extremely dangerous to personnel and cause rapid rusting of equipment within a considerable area of the degreaser.

### Miscellaneous Equipment

Other equipment that is necessary for efficient degreasing operations include storage tanks for retention of contaminated solvent, metal safety containers for the storage of cleaning rags, mops or absorbent materials, a solvent recovery still, and, where required, an air exhaust system.

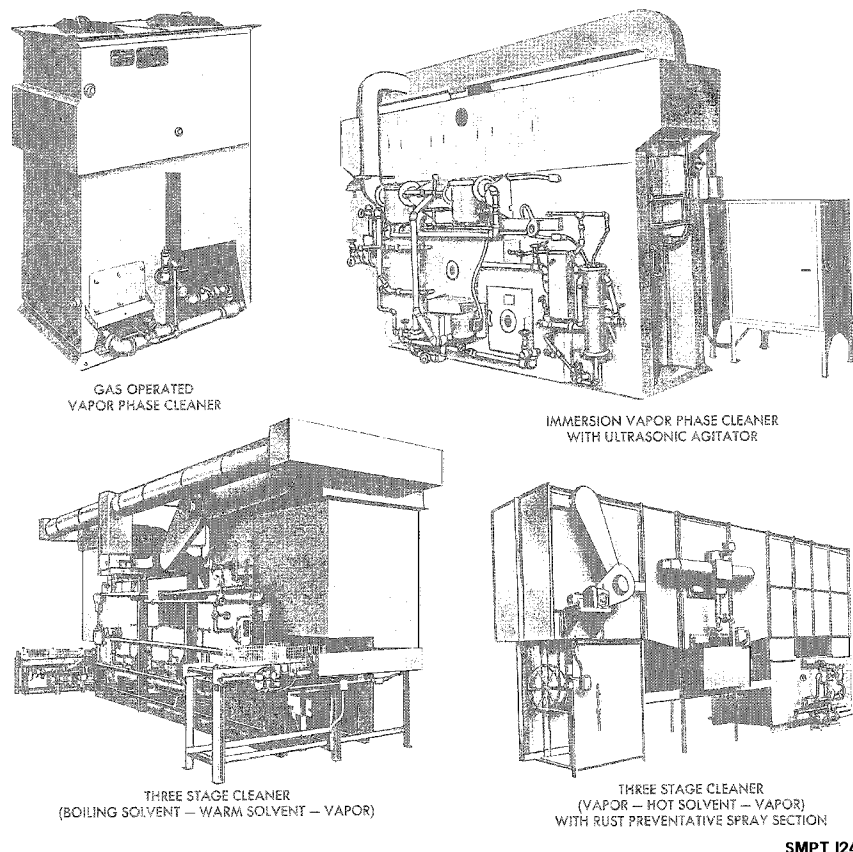


Figure 2-16. Types of vapor degreasers.



## **SAFETY PRECAUTIONS OF VAPOR DEGREASING**

### **Solvent Hazards**

Degreasing solvents are narcotic and produce a feeling of exhilaration and intoxication similar to the more pleasant phases of alcoholic intoxication. Do not overexpose anyone to the vapor. Overexposure to the vapor may produce nausea, dizziness, headaches, and general ill feeling. Skin contact with the solvent removes natural skin oils resulting in excessive dryness and subsequent cracking and chapping of the skin. Solvent absorption through the pores may produce effects similar to breathing the vapor. These solvents decompose at high temperatures, producing gases that are very dangerous and corrosive. Attempts to neutralize an acid condition by using alkalies is also particularly dangerous. This will result in an explosive mixture.

### **Handling Solvents**

Keep all solvent containers, drums, and storage tanks closed to avoid evaporation and vapor contamination of the area, except when using. Provide a pump for solvent transfer from storage containers to the degreaser. Never use buckets or pails for the transfer. This invariably leads to splashing and spillage. Clean up any spilled solvent immediately after adequately protecting yourself with safety equipment. Do not use forced air to dry up spills as this increases air contamination. Use mops, rags, or other absorbing materials to soak up the solvent, place them immediately in closed metal containers and remove for drying. Transport and store sludge and used solvent in closed drums.

### **Protective Equipment**

Personnel who use the degreaser should obtain protective equipment, maintain it in good condition, and replace it as soon as it becomes worn or unsafe. The following items of personal protective equipment should be furnished, consistent with the hazards involved:

- X Solvent-resistant gloves and aprons (fabricated from, or impregnated with polyvinyl chloride or neoprene plastics).
- X Chemical safety goggles, and acid-type goggles, where there is any possibility of splashing.
- X Hose masks, with hose inlet in a vapor free atmosphere; or air line masks with proper reducing valve and filter for use where conditions will permit safe escape if the compressed air supply should fail.
- X Self-contained breathing equipment with stored oxygen or air.
- X Rescue harness and lifelines.

### **Safety Rules**

If solvent is properly handled, and equipment well designed, maintained, and operated, health hazards will be at a minimum. The following rules must be posted and observed by all operators.

- X Know your equipment and its operation.
- X Do not smoke near a degreaser. Inhaled vapor breaks down into acidic components by the heat of cigarettes.
- X Handle all solvents in closed containers. Use pumps and pipelines to make transfers of liquid.
- X Maintain the vapor within the degreaser by careful operation.
- X Never spray solvent above the vapor level, thus driving vapor into surrounding area.
- X Do not lower work too rapidly into the vapor area, thus driving out vapor.
- X Do not bring open flames, hot surfaces, or open electric heaters near the vapor.
- X Do not permit the cleaning of clothing in the vapor degreaser. The vapor remains entrapped in the fabric and may result in serious blisters.
- X If a unit must be entered for cleaning, do so only after all solvent liquid and vapors have been removed or dissipated, and then only if at least one other workman is in attendance on the outside. A workman entering a machine for any purpose should wear a mask which provides a source of outside air.

### **Selection of Items for Degreasing**

Nonporous items of simple construction should be selected for vapor degreasing. Porous organic materials such as leather, rubber, and fabrics may be damaged by the heat and the solvent action. Items joined with low-melting solders may be injured by tetrachloroethylene degreasing.

### **Starting the Degreaser**

Before starting the degreaser, the operator must perform the following:

- X Check the degreaser and all pipelines for any evidence of leaks.
- X Check the solvent level. It must be above the heating elements, the depth (2 to 4 inches) as specified by the manufacturer.
- X Check the condition of the solvent. Determine its acid and sludge content.
- X See that water, heat, and power sources are available for full operation.
- X After making certain that the degreaser and equipment are in readiness, open the shutoff valve to the condenser and water separator precooler water line, if the degreaser is equipped with a precooler.
- X Turn on the power for auxiliary equipment.
- X Start the heating unit. For steam heated degreasers, open the stem valve slowly and permit a gradual buildup of steam. On electrically heated degreasers, turn the heat switch to the ON position. With gas-fired degreasers, follow manufacturer's manual for lighting the burners.
- X After starting the degreaser, but before commencing operations, check and adjust the cooling water temperature. Allow the vapor to reach the midcenter of the condenser coils and then adjust the water supply so that the temperature at the discharge end is slightly warm to the hand (90° to 120°F).
- X Raise the cover slowly to minimize vapor disturbance. Check for vapor buildup by observing the presence of a wet line along the degreaser walls at the condenser level.

### **Degreasing With Vapor Alone (figure 2-17)**

Items to be cleaned by vapor alone should be of simple construction and lightly contaminated. Perform the following degreasing steps:

- X Lower items slowly into the vapor area at a rate of not more than 12 feet per minute.
- X Suspend items from hooks, racks, or in baskets so that the liquid, as it condenses, can drain off without collecting in pockets or crevices. When the vapor stops condensing on items, the cleaning has stopped and items are ready for removal.
- X Remove items slowly from the vapor area. If items are of small mass and heavily coated, some soil may still remain. This requires a second pass through the vapor. Hold items briefly above the vapor level for cooling. When items have cooled slightly, return to the vapor area to complete the cleaning.
- X Keep items above the vapor line long enough for the liquid solvent to drain back into the degreaser.
- X Remove from degreaser.
- X Apply appropriate cleanliness tests.

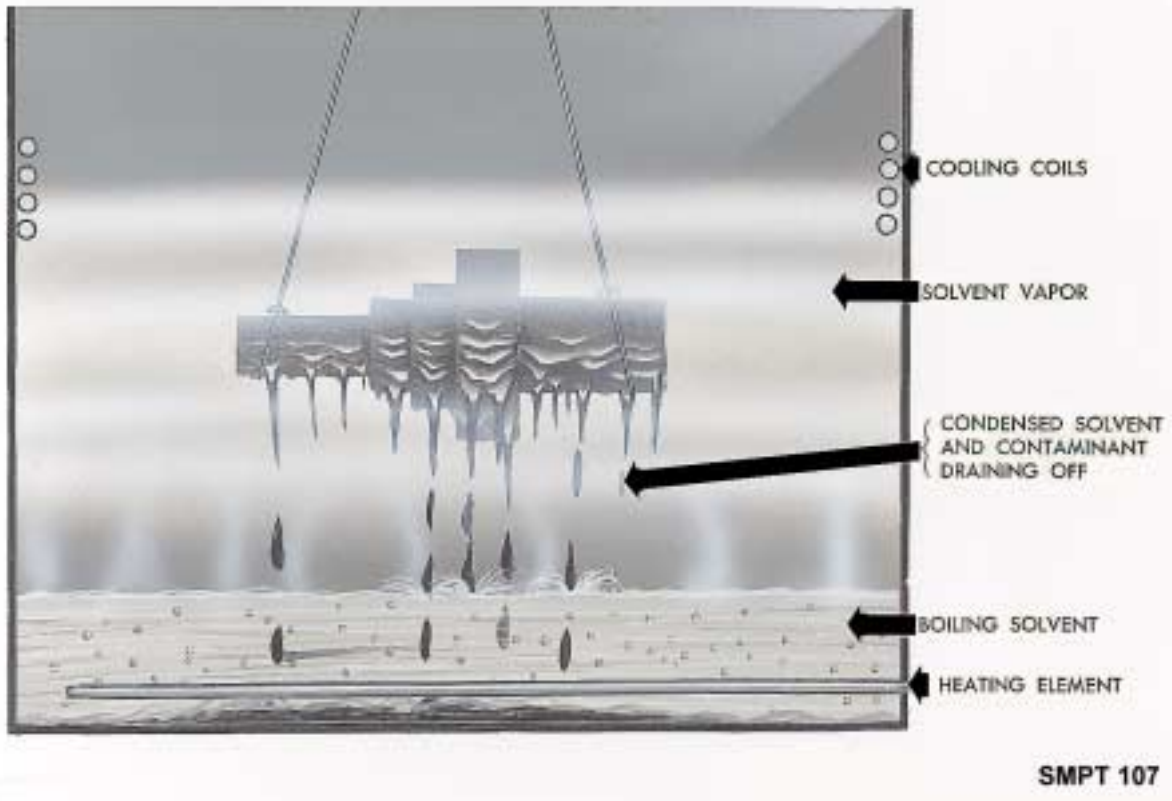


Figure 2-17. Degreasing with vapor alone.

**Degreasing With Vapor and Spray Cycle (figure 2-18)**

When contaminants on items include solid particles such as chips, dust, or turnings, and equipment is available, the use of a spray nozzle is advisable.

**Degreasing With Warm Liquid-Vapor Cycle (figure 2-19)**

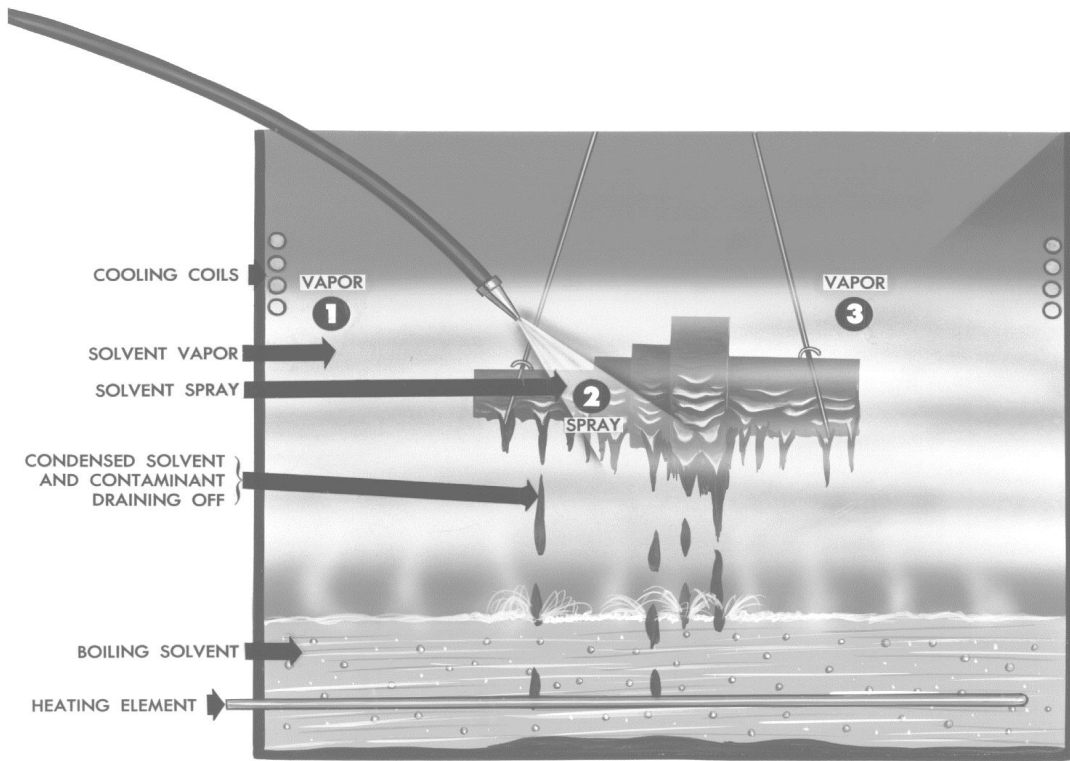
Items which heat up too rapidly and slow down the rate of condensation are effectively cleaned using an extra warm or hot solvent tank. The warm tank is suitable for small items closely packed together. The liquid penetrates into blind holes and recesses dissolving and loosening the dirt. The method is suitable for the removal of flammable solvents and low boiling point oils from items, before subjecting them to the high vapor temperatures.

**Degreasing With Boiling Liquid-Warm Liquid-Vapor Cycle (figure 2-20)**

This cycle of cleaning is used where complex oils, greases, waxes, and similar difficult contaminants are to be removed. The surging action of the boiling solvent loosens caked-on contaminants and penetrates hard-to-reach crevices.

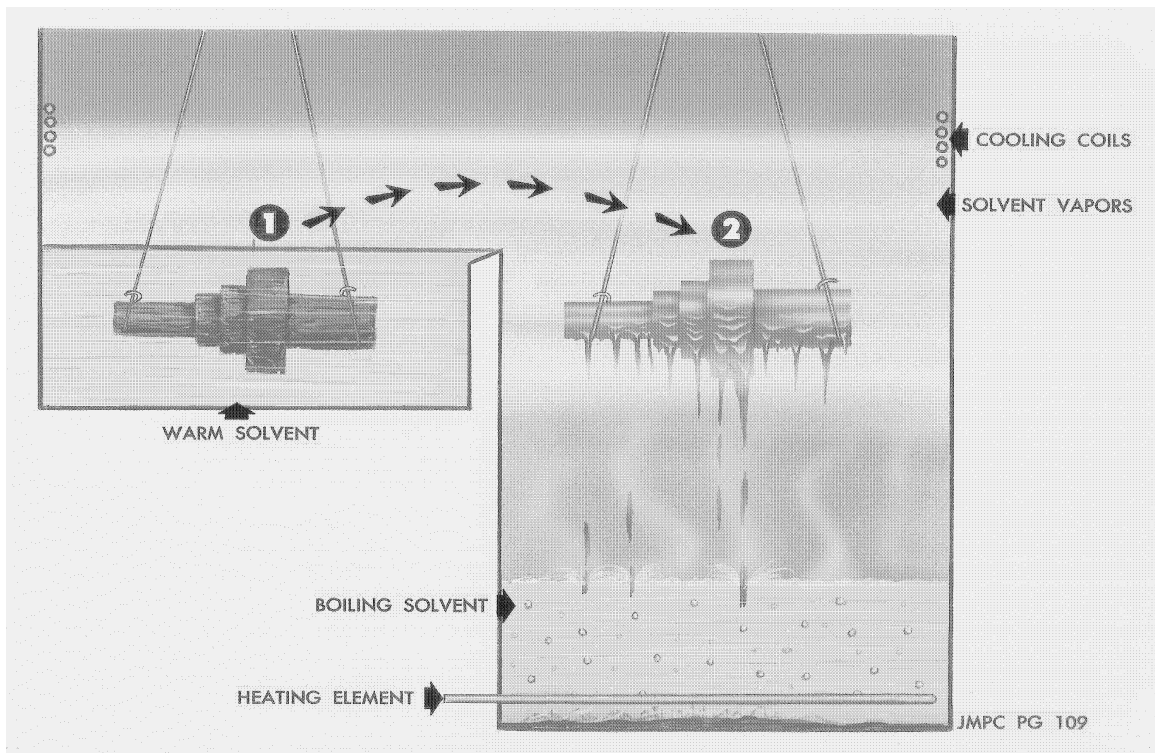
**ALKALINE CLEANING PROCESSES**

Alkaline cleaning will remove shop dirt, soil, oily and water-soluble contaminants, and heavy waxes and buffing compounds. Highly alkaline solutions are used for heavy-duty cleaning of steel, and the more moderately buffered solutions are employed for aluminum and for aluminum and zinc base castings. Almost all manufacturing contaminants, except tightly adhering, insoluble compounds such as chalk, etching inks, heavy rust, and mill scale are removed. Some alkaline derusting processes will even remove light rust.



SMPT 108

Figure 2-18. Vapor-spray-vapor cycle.



JMPC PG 109

Figure 2-19. Warm liquid-vapor cycle.

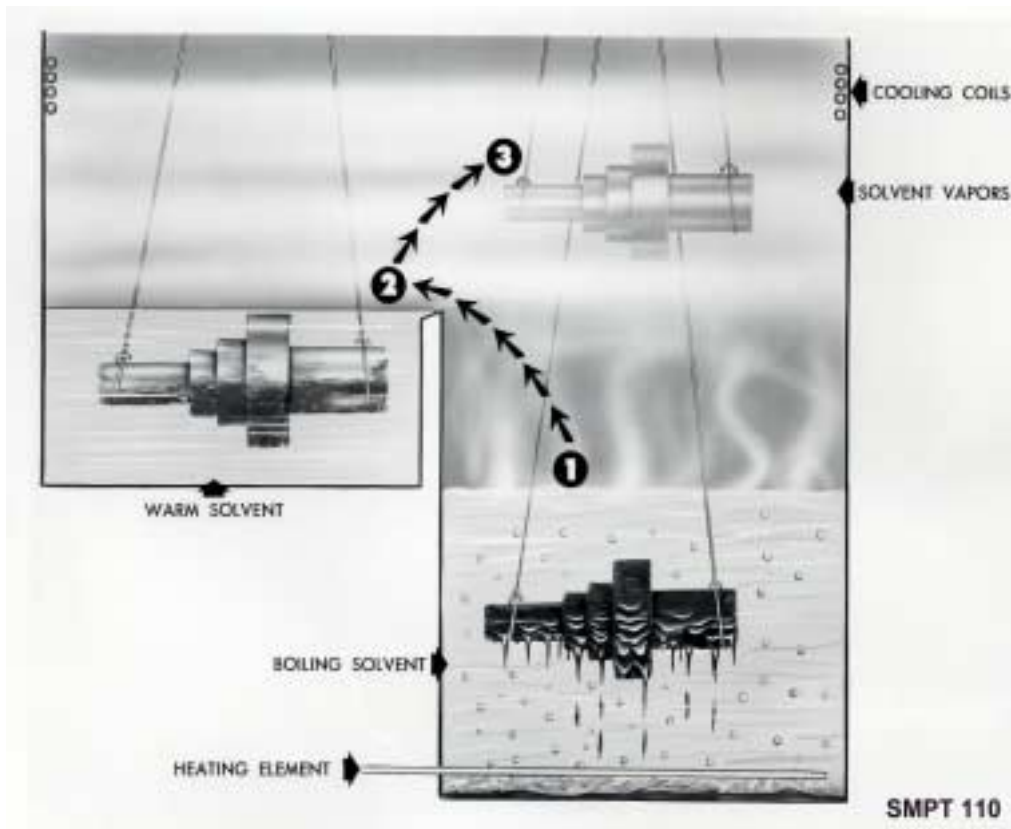


Figure 2-20. Boiling liquid-warm liquid-vapor cycle.

### Applicability

If items are of simple construction, have noncritical surfaces, and are composed of iron and steel, they can be effectively cleaned by the alkaline cleaning processes with an assurance that they will be thoroughly cleaned, uninjured, free from cleaner residues and fingerprints, and capable of passing the required test. Metals cleaned in alkaline cleaning solutions must afterwards be thoroughly rinsed in hot water at 180°F. A rinsing procedure that fails to remove residual alkali will give unsatisfactory results.

### Materials

Alkaline cleaners have become highly specialized and a great variety of compounds for specific cleaning jobs are available. Follow the supplier's recommendations when using these compounds. Alkaline cleaners are composed of mixtures of alkaline salts which loosen the soil for easy washing, plus small amounts of soap increasing cleaner penetration and buffering compounds for maintaining the alkalinity in the presence of acid-type contaminants that tend to neutralize the cleaner. The amount of soap present depends upon the type of equipment used and the hardness of the water. For example, alkaline cleaning by immersion requires more soap than pressure spray cleaning. This is because the pressure spray cleaning produces excessive foaming unless the soap concentration is reduced, so less soap is required.

#### ***Compound, Alkali, Boiling Vat (Soak) or Hydrosteam (A-A-59146)***

Alkaline cleaning compound A-A-59146 comes in one grade for use in the hot soak tank cleaning of ferrous and nonferrous parts. It is also used in hydrosteam units operating on existing steam supply for steam cleaning.

#### ***Cleaning Compound, High Pressure (Steam) Cleaner (A-A-59133)***

This cleaning compound is for use in steam cleaning machines for cleaning ferrous and nonferrous surfaces. Type I compound contains phosphates while type II compound does not.

***Alkaline cleaning compound for steel (SAE AMS 1547)***

Alkaline cleaning compound is required for steel. AMS 1547 is used when a heavy-duty anodic electro-cleaner is required.

**Equipment**

The equipment necessary for alkaline cleaning may vary with the process, but it must be capable of providing sufficient heat to maintain a boiling solution. There are several designs of cleaning machines equipped to furnish heat by gas, steam, or electricity. Steam is usually considered the most efficient source of heat.

**Immersion tanks (figure 2-21)**

Hot alkaline cleaning tanks are commercially available in many sizes with capacities ranging from 10 gallons to several hundred gallons. They are furnished with standard equipment consisting of sludge drains, scum gutters, drain valves, hinged covers, dial thermometers, removable grilles, and automatic temperature controls. Tanks are furnished for use with natural, manufactured, and liquid petroleum gas, kerosene, electricity, and steam heat. Under field conditions, tanks may be devised from steel drums, or fabricated tanks which will meet the minimum needs of field operations.

**Alkaline spray washers (figure 2-22)**

These machines are well adapted to large volume operations. The most widely used are the belt conveyor washers, built with cycles from single stage washing to multi-stage processing. These machines are adapted for cleaning many types of items of all sizes and shapes, placed singly or in baskets on a belt. Monorail spray washers carry items through washing, rinsing, and other stages. Some of these washers are arranged for straight line production. Others have a continuous return conveyor for loading and unloading at one station. Batch rotary-drum washers have a cylindrical drum with an interior spiral conveyor to carry work through the drum. The items are loaded in batches, cleaned while the drum rotates in one direction, and finally discharged by reversing the direction of the drum rotation. The rotation platform washers have a circular table that rotates slowly to carry work past washing and rinsing spray nozzles and through a drying section.

**Alkaline electrocleaning tanks (figure 2-23)**

These tanks, designed similar to immersion tanks, are equipped with heating coils and overflow dams. Sheet steel electrodes hang from electrode rods in front of the coils and dams. The electrodes should have the top edges about 3 inches below the normal solution level and porcelain insulators at the bottom edges to prevent contact with the tank sides.

**Safety Precautions**

The health hazards involved in alkaline cleaning are mainly skin irritations produced by the alkaline compounds. A high relative humidity in alkaline cleaning areas will aggravate irritations. Use protective goggles, gloves, and aprons to prevent eye or skin contact with the alkaline compounds. Avoid splashing hot solvents, which may result in burns and blisters.

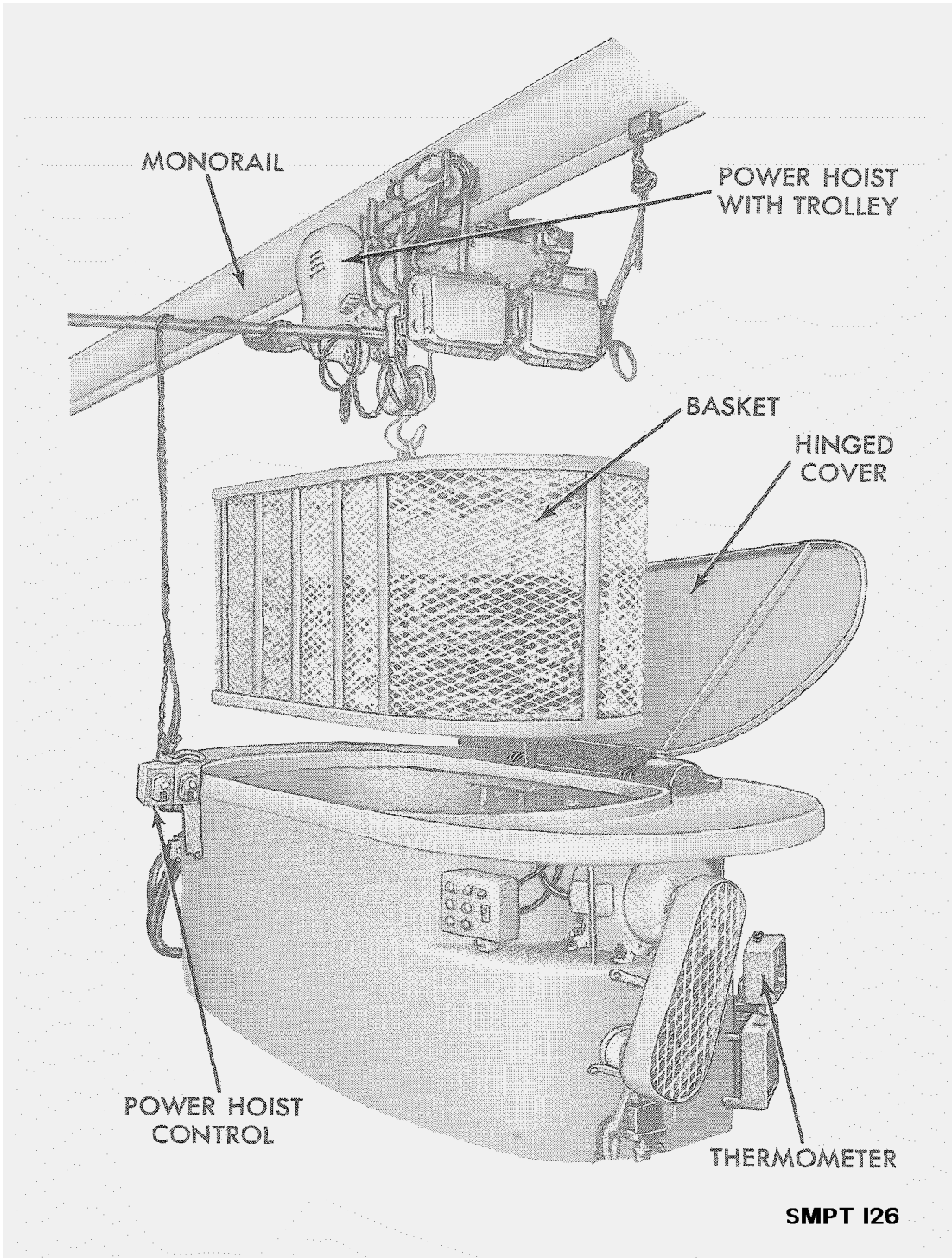


Figure 2-21. Alkaline immersion tank.

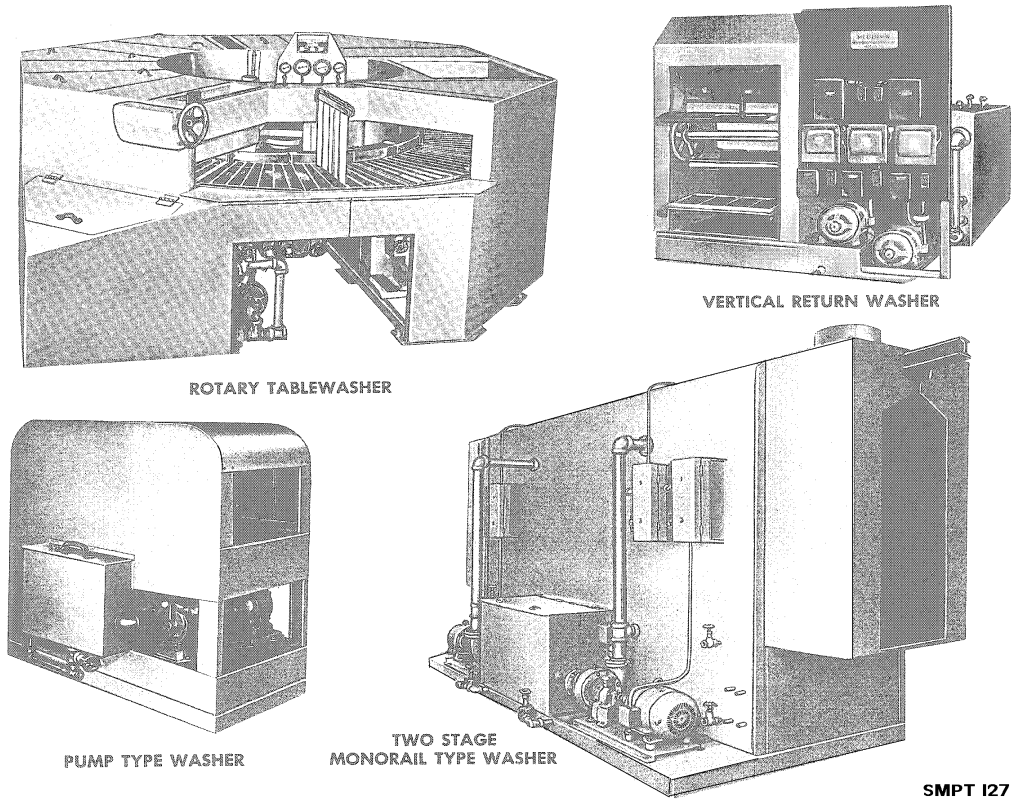


Figure 2-22. Types of alkaline spray washers.

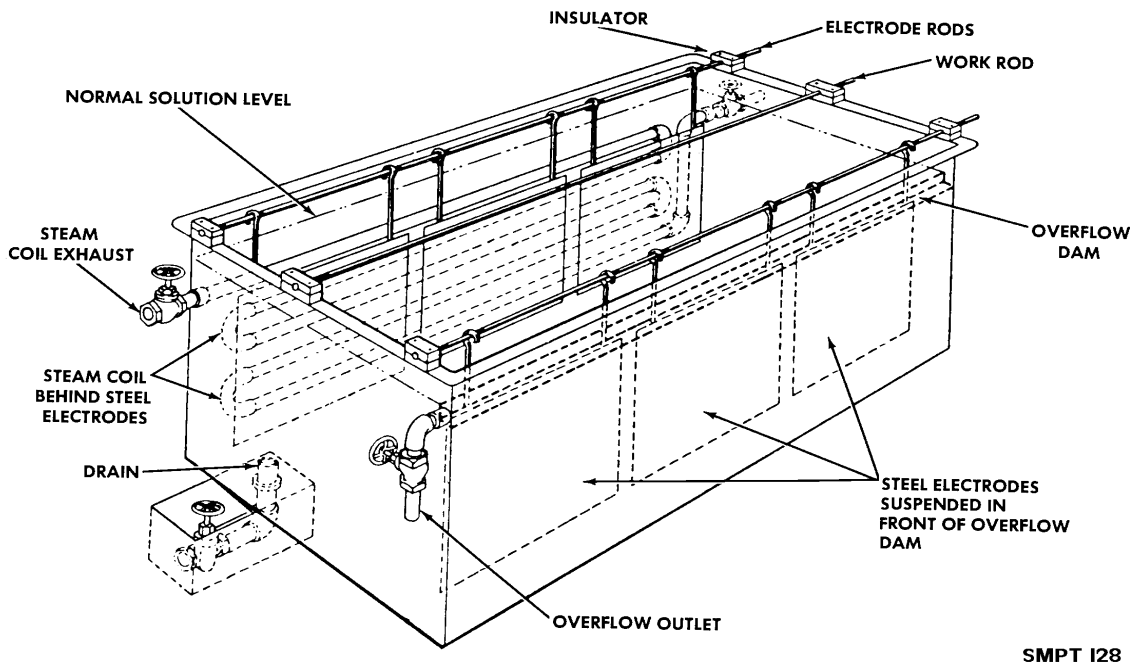


Figure 2-23. Alkaline electrocleaning tank.



**Immersion Technique (figure 2-24)**

This process consists of immersing and soaking items in an alkaline cleaner (A-A-59146) and rinsing in clean water above 180°F. To accomplish alkaline immersion cleaning, perform the following steps:

- X Wear goggles, rubber gloves, and apron.
- X Mix 7 oz. of compound per gallon of water at a rolling boil for soak cleaning. There must be no undissolved material in the tank.
- X Lower items to be cleaned into the hot (205° - 212°F) alkaline solution and allow to soak from 2 to 10 minutes, depending on the degree of contamination.
- X Agitate and brush items to speed up and improve cleaning.
- X Transfer items to the rinse tank, allowing sufficient time for the solution to drain.
- X Rinse items for 30 to 60 seconds in hot water 180°F or above.
- X Drain and dry immediately.
- X Apply appropriate cleanliness tests.

**Pressure Spray Technique (figure 2-25)**

This process consists of subjecting items to a pressure spray of alkaline cleaning solution (A-A-59146) followed by a rinse of hot water above 180°F. Alkaline spray cleaning is performed in mechanical washing machines as shown in figure 2-25. Spray cleaning is preferred to immersion cleaning when contamination on items is heavy enough to require the spray impact for removal. The force of the spray against the items removes both solid particles and soluble contaminants. The steps are-

- X Place items on the washer conveyor so that the sprayed solution can reach all of the surfaces of the item.
- X Adjust sprayer nozzles and conveyor feed for effective cleaning.
- X Pass items through the cleaning, rinsing, and drying stages. If the machine has no separate drying stage, dry items immediately after rinsing by an approved procedure.
- X Apply appropriate cleanliness tests.

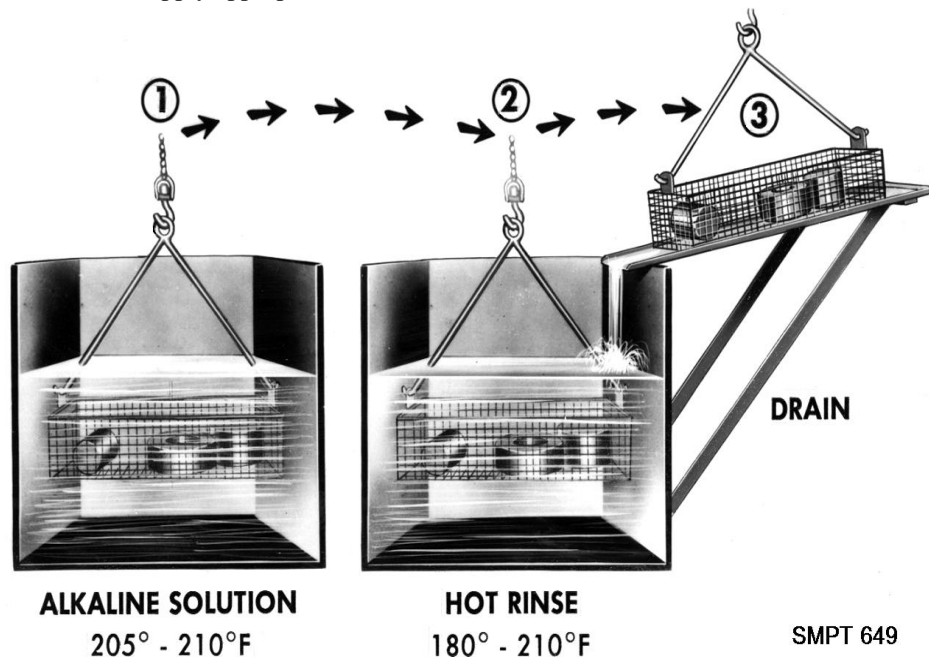


Figure 2-24. Alkaline immersion cleaning.

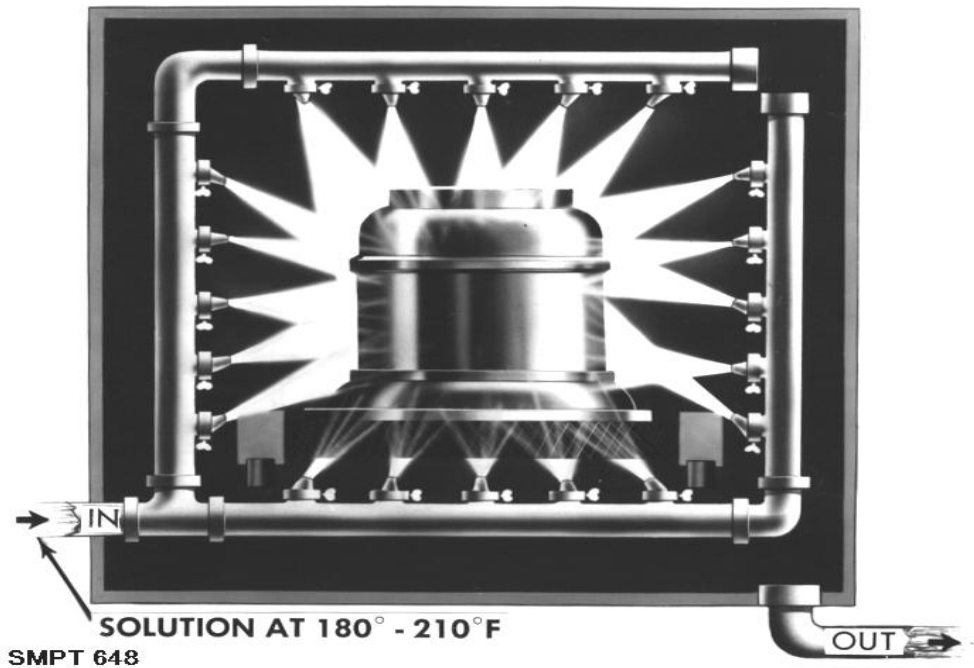


Figure 2-25. Alkaline cleaning by pressure spray.

### Electrocleaning (figure 2-26)

This process consists of immersing items in an alkaline cleaning solution with the item serving as an element of an electrochemical cell. Plater's electrocleaning compound for steel, SAE AMS-1547 (formerly P-C-535), is used for alkaline electrocleaning. A hot water rinse (above 180°F) must follow the electrocleaning process. Decomposition of water with the evolution of the gases results when a low voltage current is passed through the electrocleaning solution to the item. Gas bubbles develop on the surface of the item and as they expand and escape to the surface, they exert both a "throwing off" and a "scrubbing" action, which is very effective. This process should be used only on unit items or simple assemblies. Items having internal cavities should not be electrocleaned, since only small amounts of gas are liberated on these internal surfaces. Items of magnesium, zinc, or their alloys should not be electrocleaned unless special approval is obtained and special cleaners and special care are employed in their cleaning. Highly finished or critical surfaced items should not be cleaned by this process. The steps in performing this process are -

- X Wear protective goggles, gloves and aprons.
- X Attach items to cleaning fixtures and lower into cleaning tank with solution of 8 to 12 ounces of compound per gallon at 205° to 212°F.
- X Clean items by making them cathodic (charged negatively) for 1 to 5 minutes.
- X Relieve hydrogen embrittlement by reversing the current and making items anodic (charged positively) for 15 to 30 seconds. (If the tank does not have a reversing switch, two separate tanks are necessary.)
- X Transfer items to the rinse tank. Allow time for excess cleaner to drain, without drying on the item.
- X Rinse items for 30 to 60 seconds in overflowing hot rinse water (above 180°F).
- X Inspect item for cleanliness by watching for an even flow of water from surfaces without any breaking of the water film.

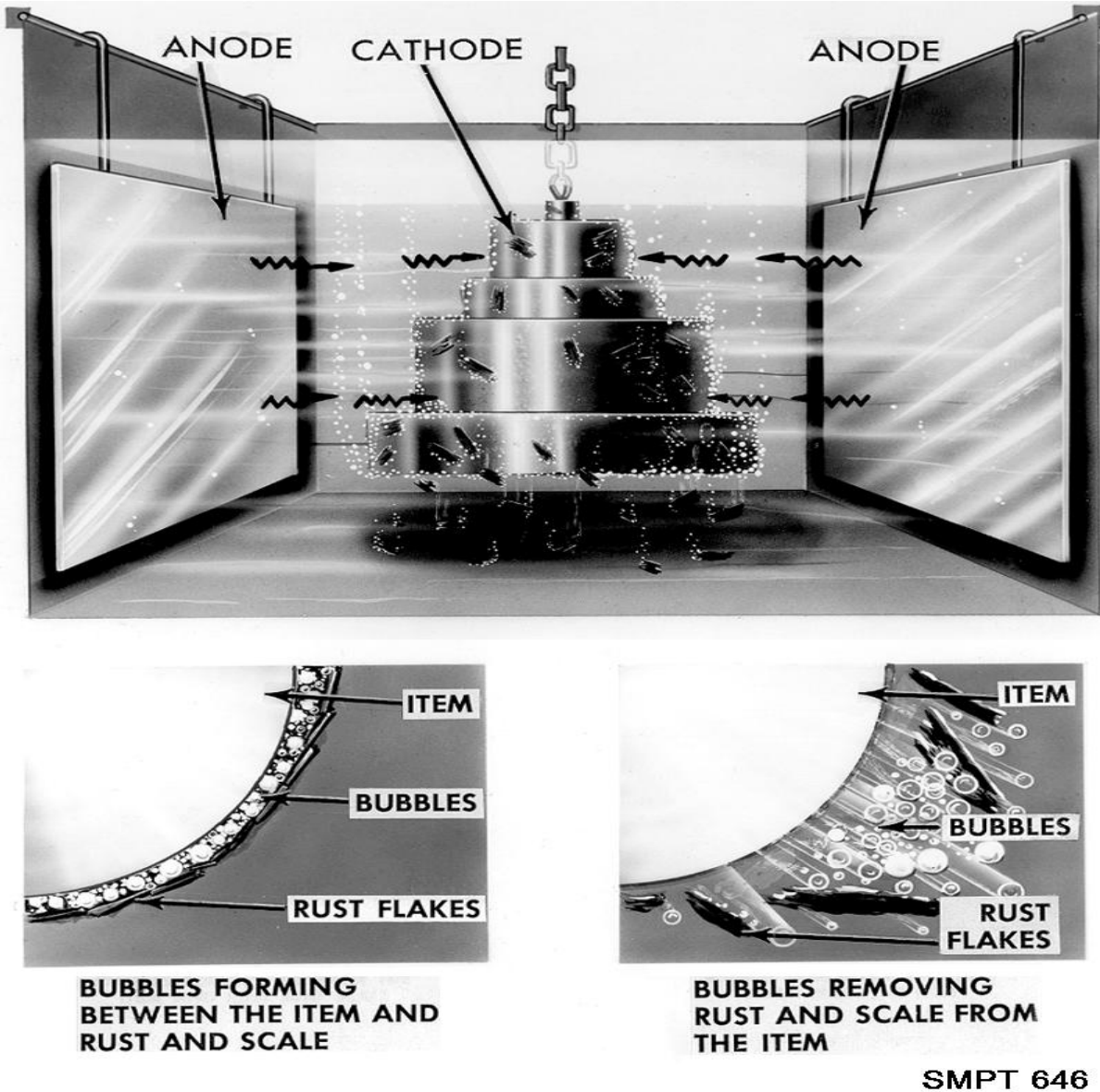
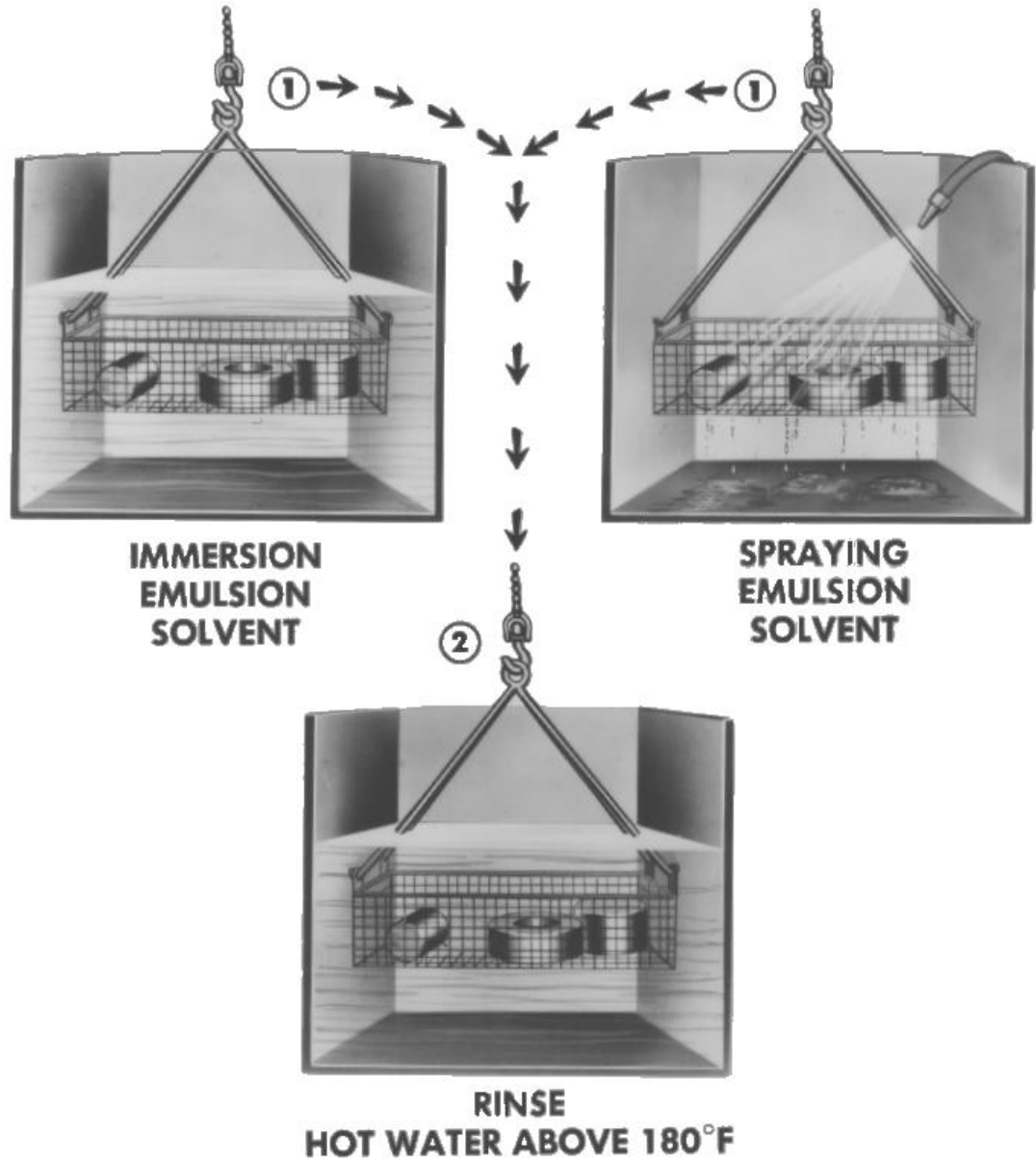


Figure 2-26. Electrocleaning.

**Emulsion Cleaning (figure 2-27)**

Emulsion cleaning is accomplished by blending an emulsifying concentrate with kerosene. The cleaning operation removes oil-soluble and water-soluble contaminants. Emulsion cleaning removes contaminants not readily removed by vapor degreasing alone or alkaline cleaning alone. It combines desirable features of both of these processes. Kerosene is mixed with the emulsifying agents and applied to items by immersion or spraying. Additions of small amounts of alkali to these emulsions are sometimes recommended where heavy oils and greases are to be removed.



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Figure 2-27. Emulsion cleaning.

**Applicability**

Emulsion cleaners are effective for removing stubborn pigmented, drawing, buffing, and polishing compounds and slushing oils. Since traces of a soapy film are left on an item's surface after emulsion cleaning, this type of cleaning is used only when the permitted degree of cleanliness is somewhat less than that obtained by the petroleum solvent or alkaline cleaning processes. Emulsion cleaning should not be used on any assemblies containing fabrics, rubber, and other organic materials, unless it has been reliably determined that no harmful effects will result. Also, it should not be used on any item or assembly which will tend to trap and hold rinse water that would eventually cause corrosion.

**Material**

An approved emulsion cleaning material is grease emulsifying, solvent cleaning compound (P-C-444). It is a liquid concentrate capable of mixing readily with kerosene or other solvents.

**Equipment (figure 2-28)**

The equipment required for emulsion cleaning is essentially the same as described for petroleum solvent cleaning. Representative types of spray equipment are shown in figure 2-28.

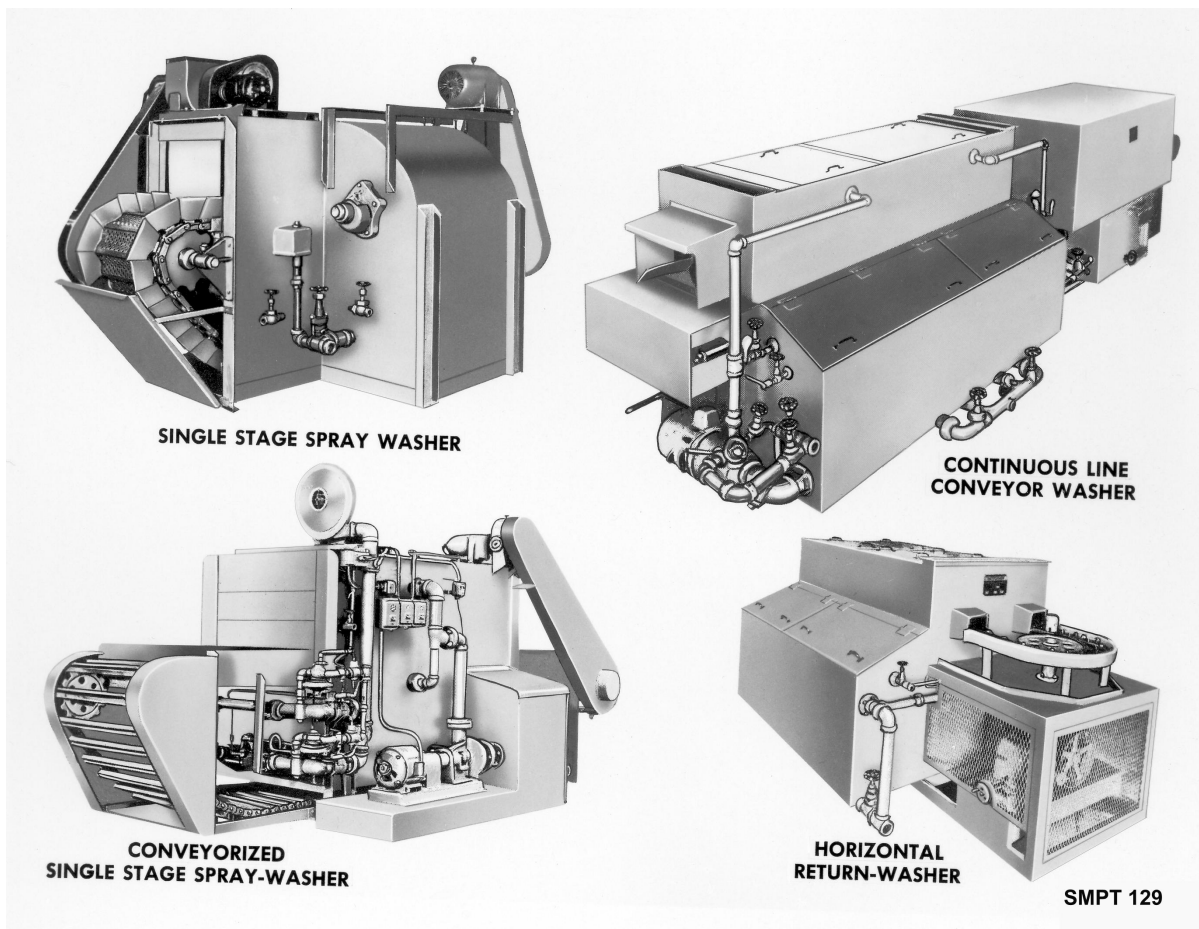


Figure 2-28. Emulsion spray washers.

### **Pressure Spray Technique**

This process subjects items to a pressure spray of emulsion cleaner. It should be limited to cleaning unit metal items or very simple assemblies, on which all surfaces can be reached by the spray, and on which no surface will tend to trap the solution. The steps for this cleaning are -

- X Wear protective goggles, rubber gloves, and apron.
- X Adjust all spray nozzles for proper spraying.
- X Check filter screens in the circulating system to permit a free flow of cleaner through the unit.
- X Adjust temperature controls to keep heaters operating within the range recommended by the manufacturer of the equipment.
- X Load items so that sprayed emulsion will reach all surfaces to be cleaned.
- X Adjust nozzle spray pressure so all surfaces will be reached with enough impact to remove the soil.
- X Pass items through or suspend them in the emulsion spray zone.
- X Check results of cleaning and readjust spray nozzles as necessary to insure effective cleaning.
- X Follow the pressure spraying by thorough immersion rinsing in clean hot water (180°F).
- X If machine is equipped with a drier, allow items to remain in the drying zone until dry.
- X If equipment does not have an automatic blowoff, dry items with clean compressed air or other approved drying procedure.
- X Inspect for cleanliness and test as necessary.

### **Immersion Technique**

This process consists of soaking items in a tank of emulsion cleaner at room temperature, followed by an immersion rinse in clean water above 180°F. The emulsion solvent cleaner must not be heated above room temperatures because of the fire hazard. The hot rinse helps remove emulsion cleaner residues and aids in the drying procedure. Accomplish the cleaning as follows:

- X Take necessary safety precautions and wear safety equipment.
- X Place items into baskets, on hooks, or on racks to provide for complete drainage from pockets and crevices.
- X Lower items to be cleaned into emulsion tank and allow them to soak for 1 to 10 minutes, as determined by amount of dirt to be removed.
- X If the tank is not equipped with agitation devices, agitate and scrub items to speed up the operation.
- X Take items from solvent tank after they have soaked enough to be clean.
- X Examine for cleanliness while items are draining.
- X Transfer, if clean, to a hot (above 180°F) water rinse for 30 to 60 seconds.
- X Remove, drain, and dry.
- X Test for cleanliness as appropriate.

### **Steam Cleaning (figure 2-29)**

#### **General**

Steam cleaning subjects items to a stream of steam alone or to a stream of steam with an added cleaning compound followed by steam alone. Steam cleaning is a common cleaning process because of the relatively low cost of material, the simplicity of steam generating units, and the adaptability to various items to be cleaned. Steam cleaning combines three powerful

cleaning actions: the chemical action of the detergent, in penetrating, wetting, and emulsifying surface deposits; the physical action of the high pressure steam and solution working their way through successive layers of dirt and grease; and the dissolving action of the heat on oils, greases, and other deposits.

**Applicability of Steam Cleaning**

Steam cleaning has wide applications. It is used on vehicles and other field equipment too large to be soaked in tanks or conveyed through spraying machines. By using steam with detergent, all types of contaminants except solid rust and scale are readily removed.

**Materials**

Materials required for steam cleaning are water for steam and steam cleaning compound.

**Water for Steam**

Water should be as free from scale forming contaminant as possible. Hard water will cause rapid formation of coil-clogging scale and increase the corrosion of the steam material. Use of water softening equipment is essential in hard water areas. Periodic descaling of steam coils is also an important preventive maintenance operation.

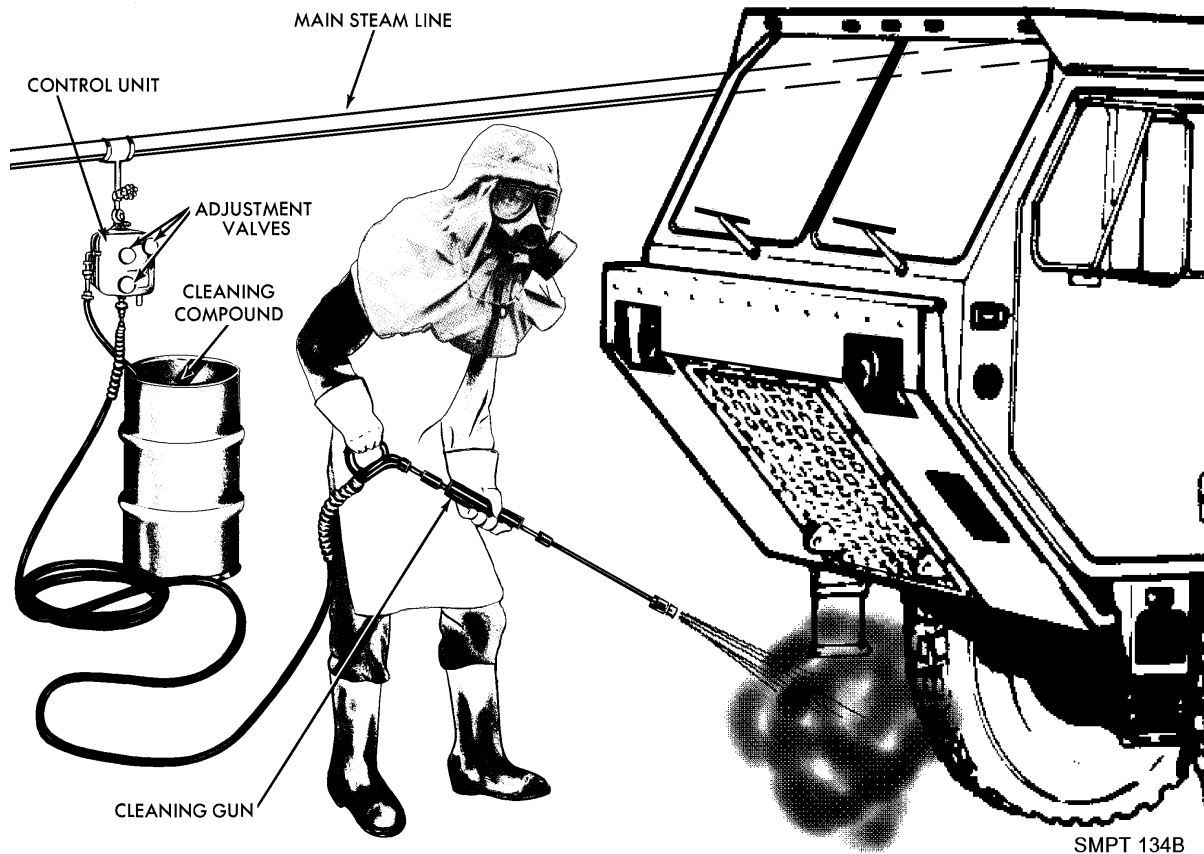


Figure 2-29. Steam cleaning.

***Steam Cleaning Compound (A-A-59133)***

This is a uniformly granular mixture of alkaline compounds and soaps developed for use in high pressure steam cleaning machines. It is a noncaking, nonclogging blend of powders which should not cause skin burn or sneezing to users.

**Equipment**

The equipment required for steam cleaning may be either stationary or portable.

***Cleaner, Steam, Pressure Jet, Skid-Mounted (MIL-C-9911 (USAF))***

This specification covers one type of electrically operated, skid-mounted, kerosene or diesel fuel-fired, pressure jet, steam cleaner. The cleaner covered by this specification is intended for use in the washing and cleaning of aircraft engines and components, vehicles, and miscellaneous ground equipment by the application of vapor pressure and cleaning compound solution.

***Cleaner, Steam, Pressure Jet, Trailer Mounted (MIL-C-23023 (MC))***

This specification covers one type of trailer mounted, gasoline engine driven, steam cleaner designed to remove surface deposits of foreign material by means of a forced stream of steam and water or steam, water, and detergent. This cleaner is intended for use in the cleaning of vehicles, vehicle parts, aircraft engines, machinery, and other surfaces. The unit may also be used for sterilizing, disinfecting, and paint removal. This cleaner may be connected to a cold water supply tank, pressure tap, a well, lake, stream, river, or any other available outside source of water.

***Cleaner, Steam, Pressure Jet, Wheel-Mounted (MIL-C-22894).***

This specification covers two sizes of electric-motor-driven, wheel-mounted, oil-fired, pressure jet, steam cleaners with a minimum discharge capacity of 100 gallons per hour (gph) or 180 gph. The cleaner is intended for the washing and cleaning of vehicles and miscellaneous ground equipment by the application of steam, pressure, and cleaning compound solution.

**Safety Precautions**

Boots, rubber aprons, gloves, and goggles must be worn to protect against the hot steam and avoid burns from handling the hose and nozzle. When steam cleaning compound is used, avoid excessive contact of the material with the eyes and skin. The closing off and shutting down of a portable steam cleaner requires careful safety procedures. The supplier's manual should be consulted at all times.

**WARNING**

Remember that steam causes very serious burns! Be careful at all times!

**CAUTION**

Steam cleaning may damage electrical wiring insulation, upholstery materials, antifriction bearings, etc.



### Steam Cleaning Operations

The detailed operations of steam cleaning will vary with the type of equipment. It is advisable to follow the operator's manual that is provided for each type of unit. The steps for operating one type of portable, electrically driven steam cleaner are -

- X Wear appropriate protective clothing.
- X Prepare the cleaner for operation by checking assembly, water supply, electrical source, fuel supply, proper lubrication, and position of all valves, open or closed, as required.
- X Follow the instruction manual for starting the jet cleaner. When water is circulating through the system at the proper rate, start the burner.
- X Prepare soap concentrate, following instructions on cleaner container.
- X Start soap pump assembly by turning on the soap control valve.
- X Exhaust excess air from soap pump assembly. By loosening the tube coupling nut on top of the soap pump, check valve housing assembly. Observe the appearance of vapor emitting from the cleaning gun assembly. It will change appreciably when the soap concentrate is blended with the hot vapor.
- X Direct discharge from cleaning gun assembly at the item requiring cleaning. Spray steam over the item requiring cleaning. Spray steam over the item allowing steam and compound to effectively carry out its cleansing action.
- X Shut off the flow of soap concentrate and turn gun control handle from VAPOR to RINSE. Open soap control valve 1/8 turn from closed position to allow a small amount of soap solution to flow and thus prevent heating coil restriction.
- X Rinse item with clean high pressure steam until all residues have been removed.
- X Shut off steam unit, following instruction manual details with great care.

### ABRASIVE CLEANING

Abrasive cleaning comprises three processes and several materials. Abrasive cleaning breaks down solid, tightly adhering contaminants on an item's surfaces by blasting them at a high velocity and impact with hard or soft granulated particles. The effect of this abrasive action may be modified by controlling the hardness and type of grain; choice of particle size; velocity of abrasive steam projecting on the item; and the method of application used in directing abrasive steam. The high velocity particles are directed against the item's surfaces with centrifugal wheels, high velocity air, or pressurized water. The choice of abrasive materials is so wide and varied that almost any type of surface finish desired may be obtained by the proper selection of abrasive type, mixture, size, and stream velocity. The selection of the right abrasive will depend on the cleaning process, the desired finish on the item, the hardness of the item, and the type of scale or soil being removed.

### Applicability of Abrasive Cleaning

With three processes of abrasive cleaning available, it is possible to clean a wide range of items contaminated with varying types and amounts of foreign materials. The processes can effectively produce a surface that is both chemically and mechanically clean. When surfaces are coated with heavy greases, this grease must be removed by a degreasing process before abrasive cleaning.

### **Abrasive Blasting Process**

This process consists of directing a high velocity stream of abrasive against an item, driven by either compressed air or thrown mechanically from a centrifugal wheel. This process is best suited for cleaning rough castings or other surfaces where the removal of some base metal will not impair the item's function.

There are materials consisting of cast iron or hardened cast steel grit and shot for blast cleaning of castings, forgings, ship hulls and decks, or other parts prior to use for the removal of sand, rust, and marine incrustation. There are also cast iron or hardened cast steel shot or cut steel wire shot for cleaning the surface of metals.

### **Cleaning process**

The procedure for abrasive blast cleaning will depend on the type of equipment employed. In general, the following steps are performed:

- X Protect yourself with approved protective equipment.
- X Mask off any portions of work that must not be blasted.
- X Adjust pressures of compressed air to the type of surface being cleaned 60 to 100 psi for hard materials or 30 to 50 psi for the softer materials.
- X Direct the stream of abrasive at a 90° angle to the work surface and move nozzle only as fast as the surface is cleaned.
- X Blow off with compressed air or rinse in an inhibited cleaning solution if surfaces are dusty and have metal chips clinging to them after blasting.
- X Demagnetize items prior to blast cleaning if iron dust and metallic particles continue to adhere to metal surfaces after rinsing.

### **Abrasive Blast Honing Process**

This process subjects the item to a steam of atomized water containing a selected abrasive and suitable corrosion inhibitors. Vapor blasting is applicable for the removal of light coats of rust or scale from item surfaces where a slight amount of polishing will not hinder the function of the item.

### **Materials**

There are several inorganic abrasives available in a wide range of grain sizes for use in the honing process. They are as follows:

Novaculite is a decomposed lava-type crushed rock that is available in mesh sizes from 100-mesh to 5000-mesh. The 5000-mesh material is about three times as fine as face powder. This material is used for close tolerance and precision work. When used with a corrosion inhibitor, it produces a finish that has extensive corrosion resistance.

Silica sand is available in sizes from 50-mesh to 400-mesh. It is used for general cleaning, either wet or dry, and as a carrier medium for other selected abrasives.

Quartz sand is the familiar cleaned and sifted beach sand. It is relatively cheap but does not possess the abrasive cutting qualities of some of the artificial abrasives.

Garnet abrasives have long life and are very aggressive. The comparable mesh size of garnet will produce a much rougher surface than silica sand.

Aluminum oxide is a hard, synthetic abrasive produced in an electric furnace.

Several grain sizes are available. It is used extensively in vapor blast operation.

Glass beads are used for cleaning selected surfaces of steel, aluminum, and magnesium.

### **Cleaning Process**

In using a vapor blast cabinet, follow these steps:

- X Wear rubber gloves while loading items into cabinet.
- X Place items on table, in tumbler, or in baskets depending on their size and ease of handling, pass through side door into the cleaning chamber and close door.
- X Thrust arms through rubber sleeve openings. See that sleeves fit tightly around the wrists and form a watertight seal.
- X Hold items in one hand while blasting. Direct the blasting stream with the other. Leave items on turntable and rotate slowly if they are too large to handle easily.
- X Adjust the pressure needed by moving the knee control lever.
- X Continue the vapor blasting operation until all contamination is removed.
- X Keep this rinse tank heated above 140°F or more to speed up the drying.
- X Dry the items as soon as possible after rinsing.

### **Soft Grit Blasting Process**

This process uses relatively soft abrasives with or without a corrosion inhibitor. The abrasive is carried by a high velocity stream of water directed at the contaminated surfaces of the item. This process is applicable to the removal of relatively soft contaminants and to cleaning items with surfaces that can tolerate only a minimum amount of metal removal during the cleaning process.

### **Material**

Soft abrasive grains conforming to A-A-1722 (formerly MIL-G-5634) must be used for this cleaning process. The material is used for the removal of carbon from metal surfaces and cleaning of operating jet engines. Abrasive grains of the following types are authorized:

- X Apricot pit shell or black walnut shell (for use on aircraft jet engines or general purpose use).
- X Pecan shell, corn cob, or rice hull (for general purpose use only).
- X English walnut shell, apricot pit shell or mixture of the two (for use on aircraft jet engines only).

### **Cleaning Process**

This process is accomplished in the same cabinet as for vapor blast cleaning. The soft grains are used alone or with a suitable corrosion inhibitor. The steps to clean the items are essentially the same as the honing process.

### **Equipment for Abrasive Cleaning**

Abrasive cleaning equipment may consist of specially designed blast cleaning cabinets, blasting rooms, or blast cleaning machines.

Blast cleaning cabinets are inclosures equipped with necessary devices through which abrasive materials are ejected by air pressure against the surfaces to be cleaned. There are two types of cabinets described by this specification:

Liquid abrasive cabinets, as shown in figure 2-30, have a window in the front or top and two or more arm openings fitted with rubber sleeves. They are provided with a slurry hopper tank for mixing, storing, and recollecting the abrasive slurry. The slurry is delivered to the blasting gun by compressed air or circulating pumps.

Dry abrasive cabinets shown in figure 2-31, are similar in design to liquid abrasive cabinets except a dust collector is used to return the exhausted dust from the cabinet, and an abrasive reclaimer unit replaces the slurry hopper tank. The abrasive is delivered to the blasting gun either by direct pressure or by suction.

Dry, knockdown, blasting room is shown in figure 2-32. This is a sectional blasting room that is large enough to accommodate the items, the sand blast hoses, nozzles, and the operators. The abrasives that are used are sandblast sand, refractory slag, metal cleaning abrasive grain, steel shot, and steel grit. The room consists of the sectional blasting room including floor-type screw conveyor, bucket elevator, abrasive separator, abrasive storage system, blast tank, dust collector, ventilating system, hoses, nozzles, and other equipment.

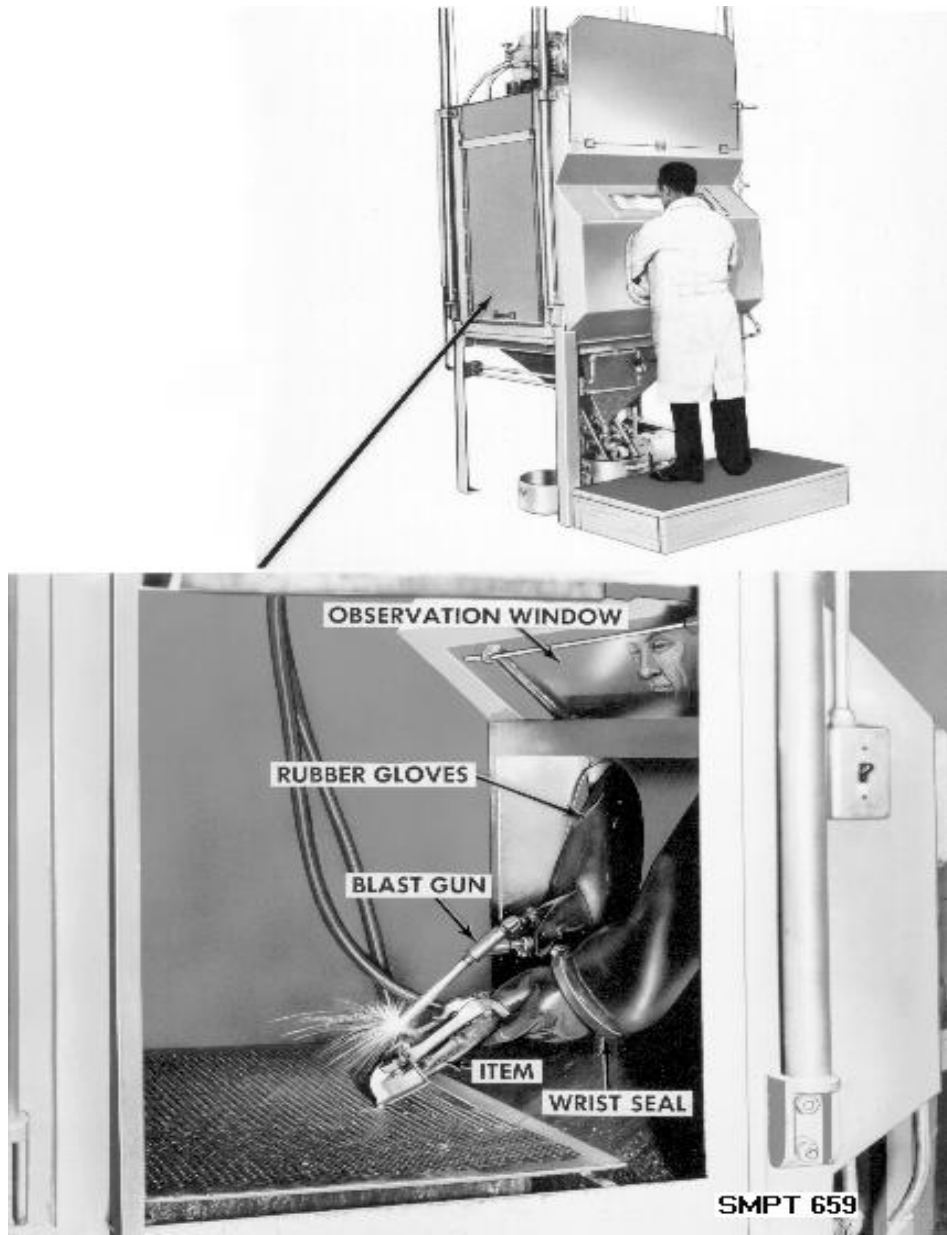
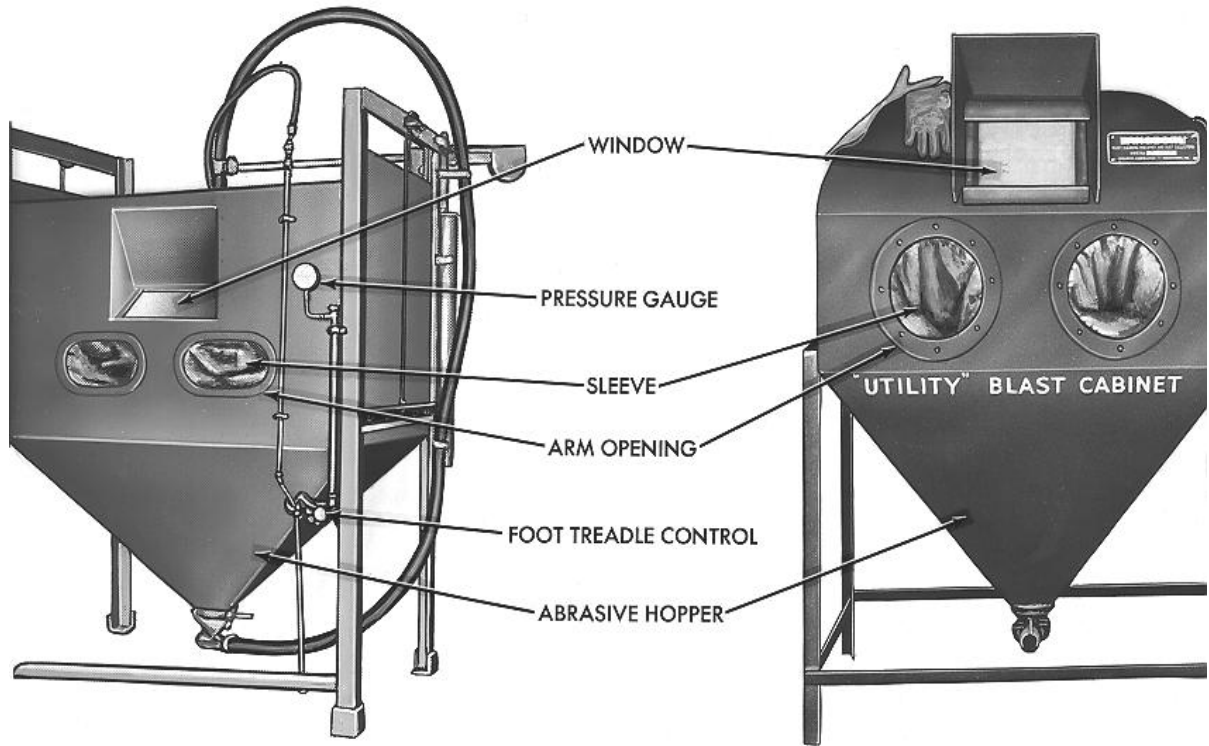
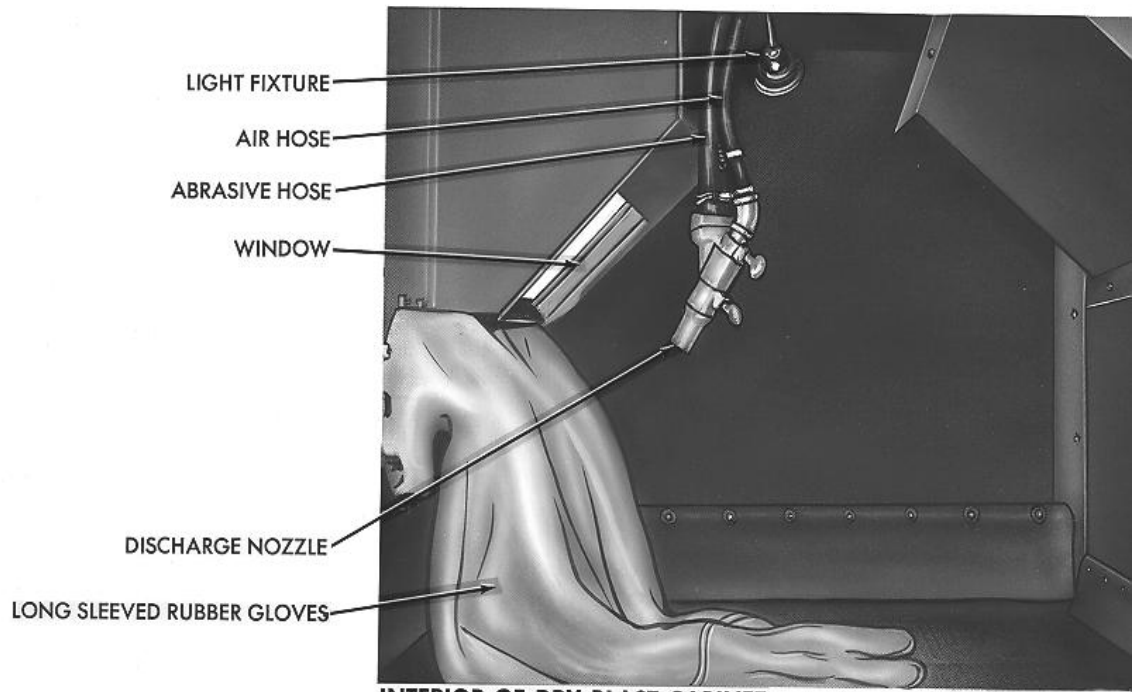


Figure 2-30. Liquid abrasive cabinet.



**AIR PRESSURE  
BLAST CABINET**

**SUCTION FEED CABINET**



**INTERIOR OF DRY BLAST CABINET**

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Figure 2-31. Dry abrasive cabinet.

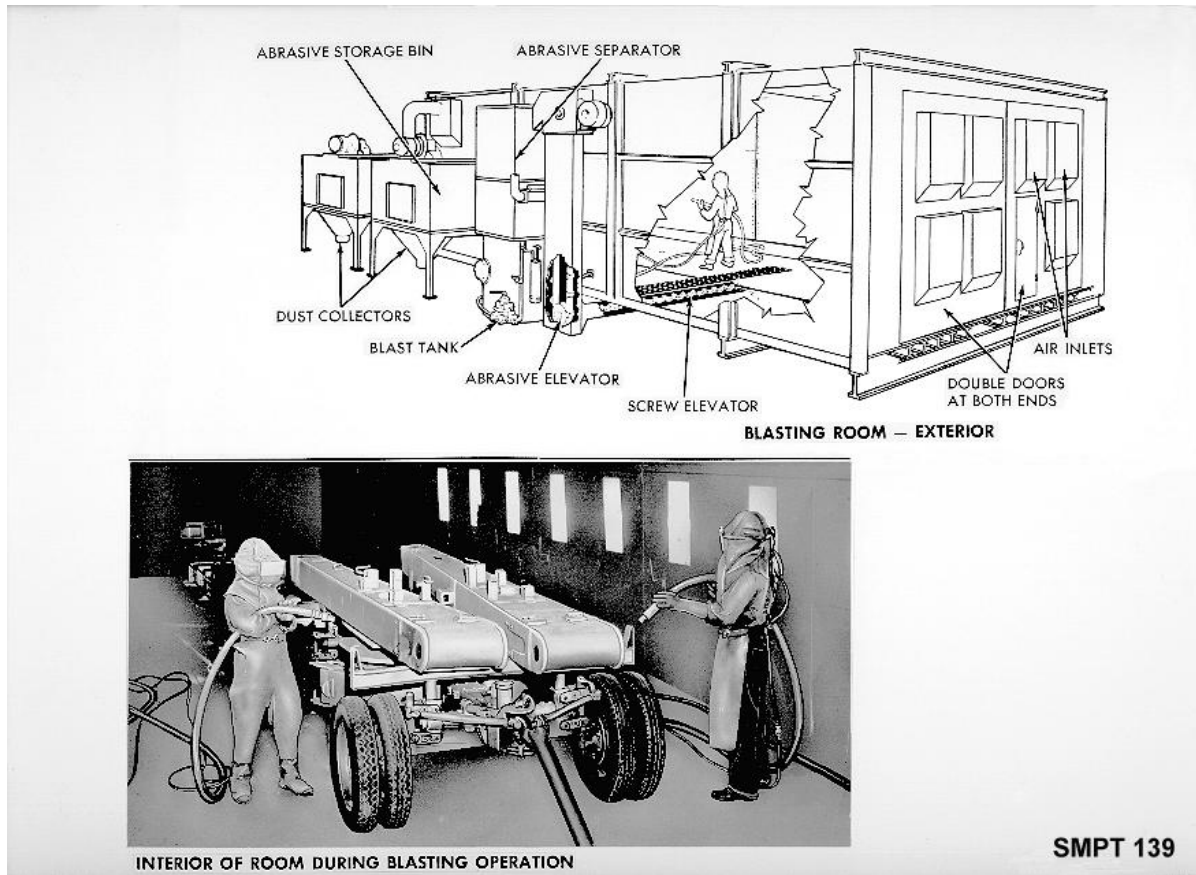


Figure 2-32. Blasting room with operations.

A tumbler-type abrasive blasting and cleaning machine with a dust collector is shown in figure 2-33. This is an airless tumbler machine with a load capacity of not less than 5 cubic feet. The cabinet houses an endless belt conveyor upon which items are loaded, agitated, and unloaded. When the cabinet door is closed, the unit is dust and abrasive tight. The blast action is provided by controlled centrifugal force acting upon the abrasive. An abrasive recovery and handling system is an integral part of the unit. The dust collector is a separate cabinet equipped with its own motor. The items are tumbled on the endless belt which moves vertically so the items are tumbled against the vertical portion of the belt. The cleaned items are discharged from the blast chamber by opening the cabinet door and reversing the direction of the belt. When using the tumbler-type equipment, follow these procedures:

- X Place items in the cabinet on the belt and close door.
- X Start the machine.
- X Stop the machine after about 5 minutes and inspect for cleanliness. If items are not clean, close door and run machine a few more minutes. Use rubber gloves when handling items for inspection.
- X Reverse machine, open cabinet door and deposit cleaned items in a receiving basket or tray.
- X Blow loose dust particles from items with compressed air or rinse in inhibited liquid rinse.

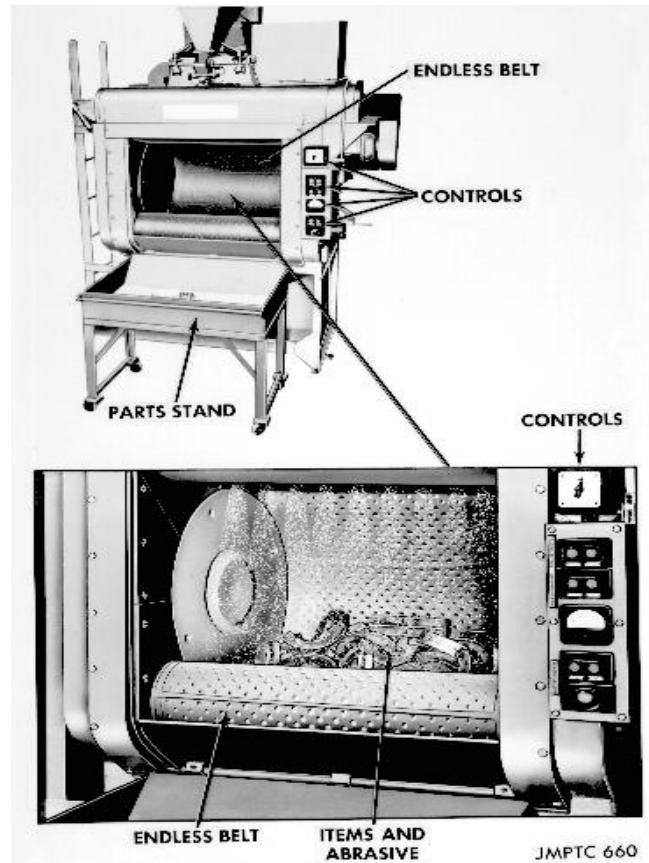


Figure 2-33. Tumbler-type abrasive blasting and cleaning machine.

A table-type abrasive blasting machine is shown in figure 2-34. These machines have a turntable on which the items are placed. The table rotates, carrying the items into the blasting zone where they are abraded and cleaned by the abrasive thrown against them by a centrifugal wheel. The blasting zone is a steel housing which covers 3/4 of the circular turntable. The entrance and exit are closed by split rubber curtains which retain the abrasive and dust. The turntable is perforated so that the spent abrasive and abraded particles can fall through to the collecting hopper. The usable abrasive is reclaimed and returned by elevator to the abrasive throwing device. When using table-type equipment, follow these procedures:

- X Wear protective clothing.
- X Place items to be cleaned on turntable. Items must be free of oil and grease. Do not overload the table. Place items so they do not shield each other from the blasting.
- X Start the machine and, as the table rotates, place additional items on the table. The rate of rotation of the turntable should be adjusted to the degree of contamination present.
- X Examine items as they come through the exit curtains and reposition any poorly cleaned items and pass them through the blasting zone again.
- X Remove items from the turntable. Use gloves to prevent further contamination.
- X Remove dust with compressed air or dip in an inhibited liquid rinse.
- X Clean dust collector periodically.



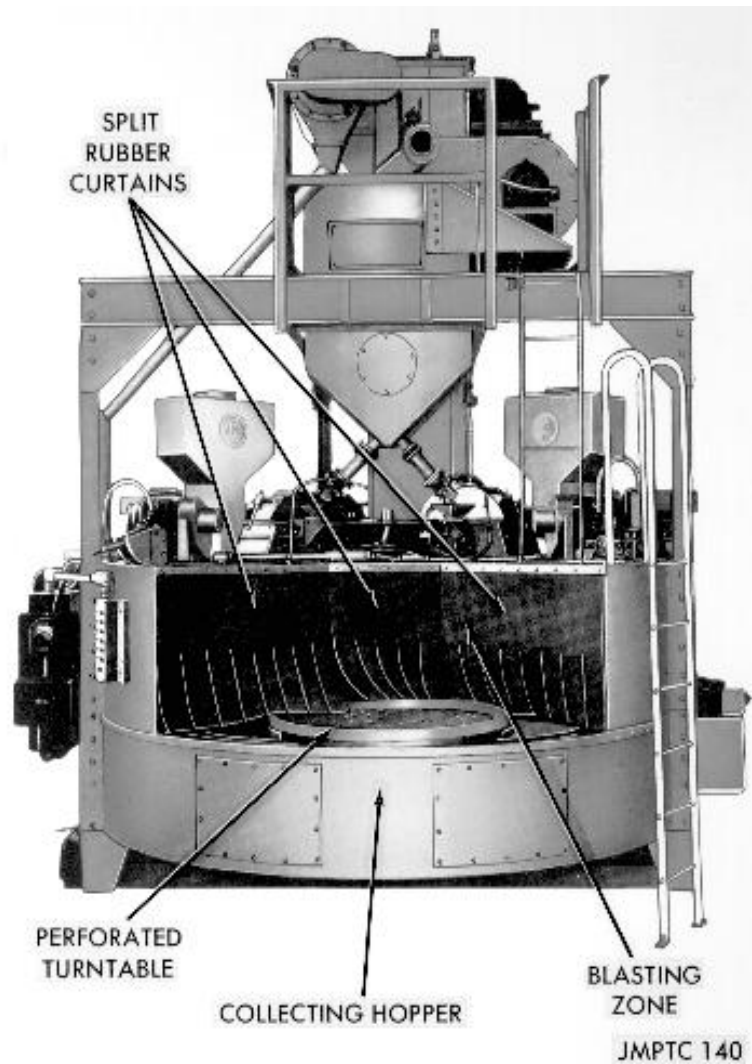


Figure 2-34. Table-type abrasive blasting machine.

**Safety Precautions**

Abrasive blast cleaning is hazardous to the extent that the high velocity of the abrasive particles a potential danger to the eyes and skin. Breathing of the dust created by the breakdown of the nonmetallic inorganic types of abrasive can lead to an occupational lung disease (silicosis). Proper protection is necessary.

**Protective Clothing and Equipment (figure 2-35)**

For blasting within an abrasive blast cleaning room, approved respiratory equipment should be provided. This should include rubber covered helmets with air fittings, hygienic helmet air supply units, replaceable plastic windows and protective screens. Armored leather gloves, leg and foot protectors, and protective aprons are also worn by operators within blasting rooms. Complete information concerning approved types of protective clothing and equipment for any types of blast cleaning may be obtained from the National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

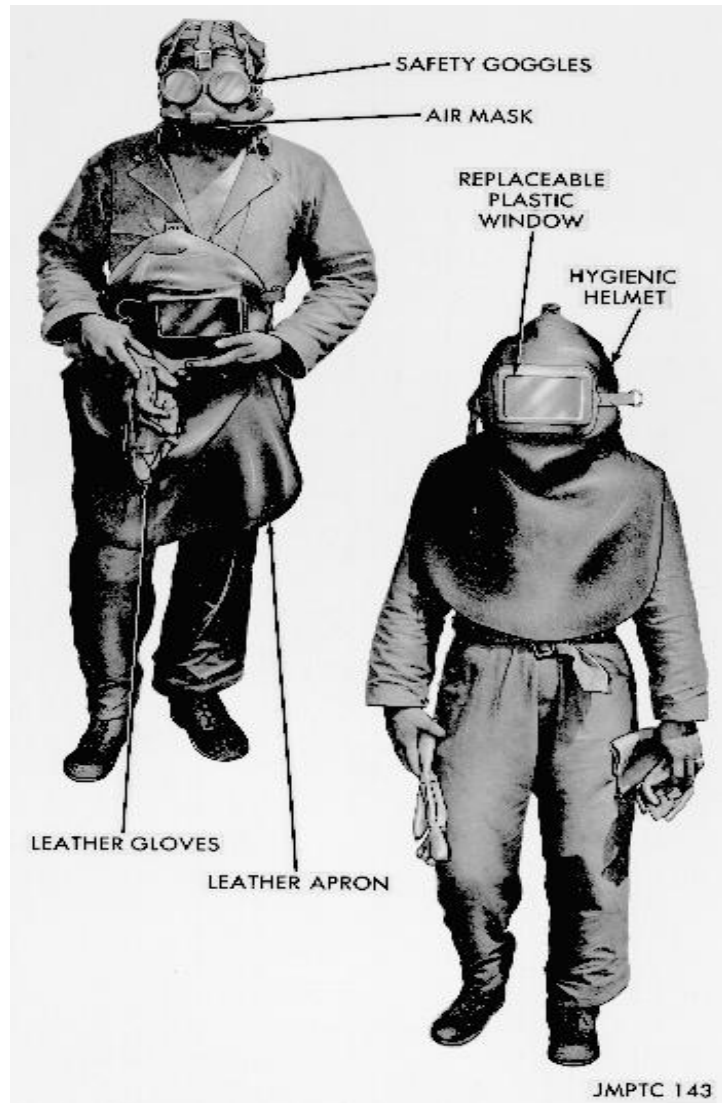


Figure 2-35. Protective clothing for abrasive blast cleaning.

### ULTRASONIC CLEANING (FIGURE 2-36)

This process converts electrical energy into high frequency sound waves. These sound waves help remove all foreign particles from the surface by focusing high frequency sound energy, above the human audible range of 20,000 cycles per second, upon the surfaces of the item while it is suspended in the bath. The ultrasonic waves do not replace the cleaning agent. They merely make the cleaning agent more effective by producing "cavitation" or "cold boiling" in the fluid. As a result, tiny bubbles form and collapse against the item being cleaned. The "bubble collapsing" provides the main suction or scrubbing action. Ultrasonic cleaning is applied to non-absorbent materials such as glassware, metals, electronic equipment, and molded products. Hand wiping or brushing operations are eliminated by this process. Contamination in cavities, hollow indentations, small holes, and on precision finished surfaces is removed, thus giving a degree of cleanliness not achieved by any other process. The cleaning operations are carried out in a tank or chamber connected to an electronic generator, which supplies high frequency power. A transducer unit converts the electrical energy into ultrasonic waves in the stainless steel cleaning chamber.

A recirculating filter reservoir removes the dirt from the cleaning solution and maintains the solution at a predetermined level and temperature. A rinsing area and a drier complete the equipment. Special water-detergent solutions are frequently employed but in some instances organic, chlorinated, or petroleum solvents may be used to advantage. Many cleaning agents commonly used for other cleaning processes are also excellent for use in ultrasonic cleaning. Some of these agents are water-emulsion cleaning compound (MIL-C-43616) and cold carbon remover (MIL-C-19853). Experience has shown that, when some special solvents are used, the sealing compound between the transducer disk and the solvent reservoir may be affected by the solvent. This is remedied by placing the special solvent in a pyrex beaker submerged in water in the solvent chamber and supported on rubber stoppers.

### SPECIAL SYSTEMS CLEANING

Cleaning in such areas as complex hydraulic, pneumatic, and propellant systems of missiles and rockets; intricate primary coolant systems of nuclear weapons; high speed bearing systems of turbines in vessels and aircraft; and specialized electronics equipment of tracking and guidance systems of space vehicles, demands special standards of cleanliness.

### Importance of Special Systems Cleaning

A single particle of steel can immobilize a critical bearing. Contaminants in the cooling system of a nuclear reactor could interfere with the movement of a valve, speed up corrosion, upset the water chemistry, or affect the heat transfer or radiation. O-rings, seals, and gaskets may leak if a particle becomes wedged between a smooth surface and the seal. Particle buildup in an orifice of a burning chamber may deflect the fuel stream creating a local "hot spot". Particles entrapped and accumulating in a noncritical area may break loose and result in the misfire or malfunction of a critical component or system. Organic particles, lint, oil, grease, etc., coupled with a sudden pressure change in a liquid oxygen system, could result in an explosion. It is necessary to obtain clean equipment delivered from the manufacturer and maintain this cleanliness. The accumulation of contaminants in a system must be controlled to avoid the possibility of system foulup or explosive conditions from developing.

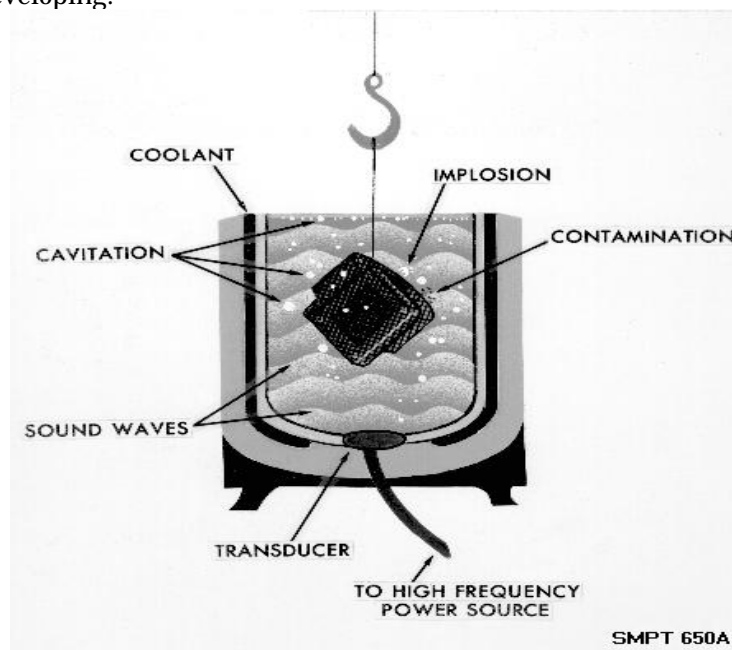


Figure 2-36. Ultrasonic cleaning.

### Degrees of Cleanliness

The degree of cleanliness must be adequate for the design and utility of the system component. For example, different cleaning requirements are established for fluorine and hydrogen peroxide systems than for liquid oxygen or hydrazine fuel systems. The size of the particles that are tolerated in a cleaning solution must be no larger than the smallest openings or orifices in the system. Particle size is determined through examination with a microscope of the filter taken from samples of the cleaning or flushing solutions. Particles are measured in terms of microns (0.00003937 inch or 0.000001 meter). Particle size limits have been established for the various degrees of cleanliness (figure 2-37).

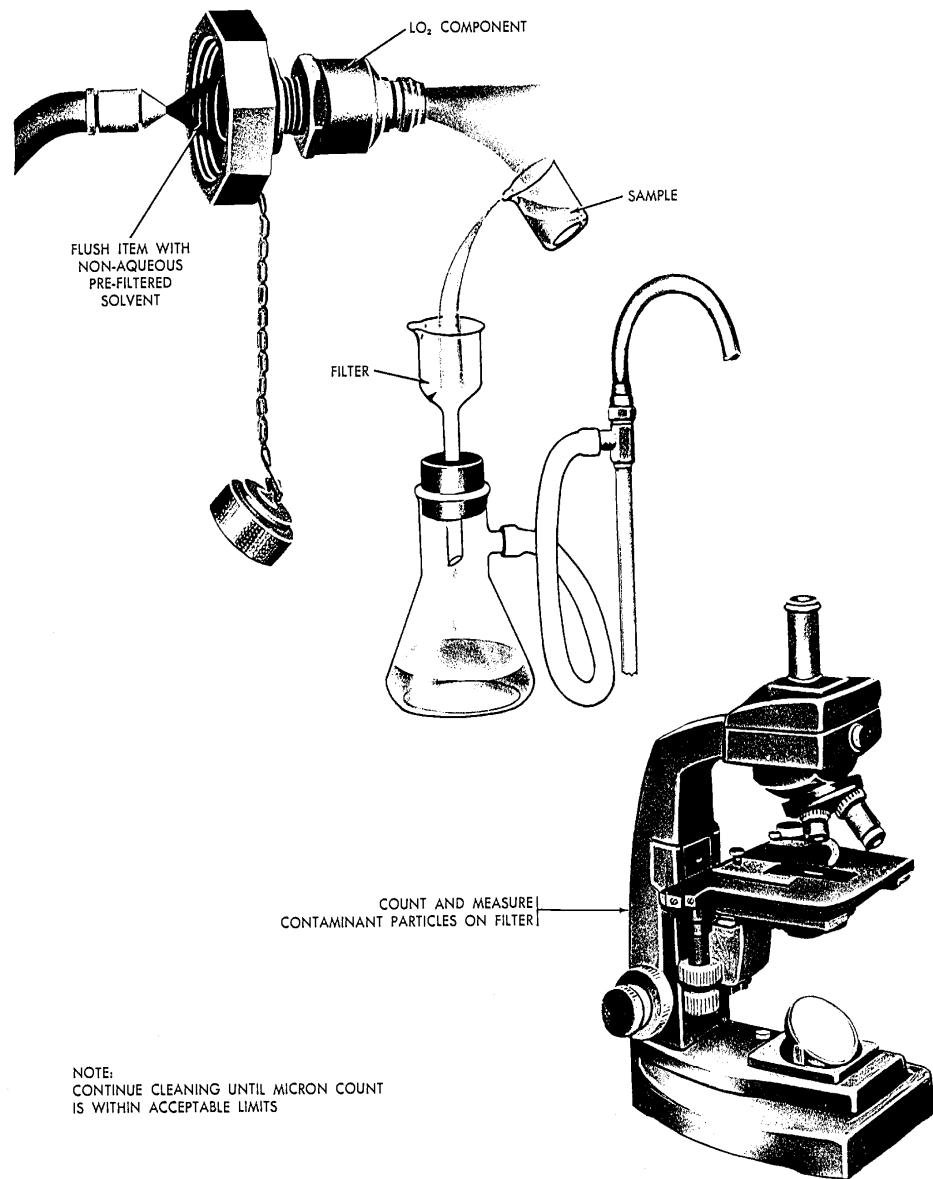


Figure 2-37. Determining particle size.

**Preservation Personnel's Responsibility**

Since the details of special systems cleaning are beyond the scope of this manual, it is imperative for preservation personnel to know and appreciate the fact that these systems have components that require extreme degrees of cleanliness. Items requiring this extra cleanliness will be processed in a specially designated clean room where the required degree of cleanliness may be accomplished. When such cleaning has been completed, items are protected by a contamination barrier, such as a bag, wrap, plug, cap, blind flange or other device which will prevent contamination of the cleaned surfaces during all succeeding operations. The cleaned items in the contamination barriers should be marked with an appropriate color code to designate the system for which they have been cleaned. Preservation personnel, receiving items that have been processed in this fashion, must realize that the contamination barrier is considered a critical part of the item being packaged and any damage, such as punctures, tears, abrasions, separation of seals, and leakage of flanges discovered upon inspection, necessitates a complete reprocessing through all previous steps. It is, therefore, incumbent upon all preservation personnel to recognize these processed items and handle them with the care their importance deserves.

**Cleaning Inspection**

Cleaning inspection insures proper cleaning before the item is processed further. It also conserves cleaning materials through their timely recovery for reuse. Cleaning inspection prevents inadequate cleaning losses in time, labor, and materials. In MIL-STD-2073-1C, Table G.I. "Preservation Inspection Provisions" outlines the criteria for cleaning and preservation inspections.

**Determination of cleanliness**

Items will be examined or tested for cleanliness in accordance with the following techniques of Method 4004 of Federal Test Method Standard No. 101 as applicable.

**Visual Test for Cleanliness (figure 2-38)**

This test visually determines freedom from or the presence of foreign materials or corrosion.

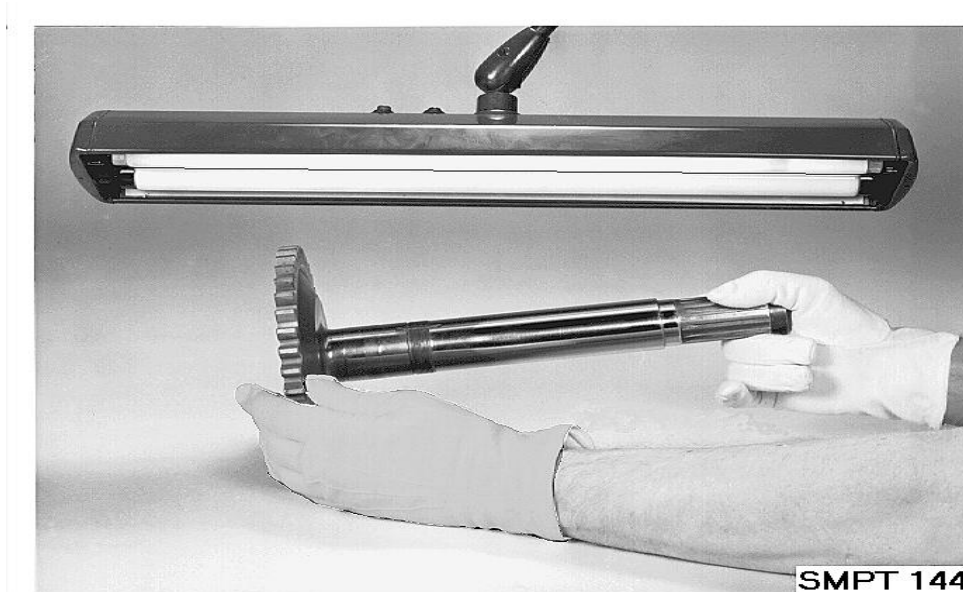


Figure 2-38. Visual test for cleanliness.

**Equipment Required**

- X Lamp to insure adequate lighting.
- X Gloves, barrier material, or other means of holding item to prevent contamination.

**Procedure for Test**

- X Hold item to strong light.
- X Examine all surfaces for the presence of foreign materials and corrosion.

**Interpretation of Test Results**

- X Presence of dirt, oil, grease, or other foreign materials on the item will be cause for rejection.
- X Presence of corrosion on the item also will be cause for rejection.

**Wipe Test for Cleanliness (figure 2-39)**

This test determines freedom from foreign material and corrosion that was not discovered in the visual test.

**Equipment Required**

- X Adequate light source.
- X One piece each of clean, lint free, white and dark cloth.

**Procedure for Test**

- X Wipe a portion of the item being tested with the white cloth.
- X Wipe another portion of the item with the dark cloth.
- X Examine both cloths for evidence of the presence of foreign materials.

**Interpretation of Test Results**

The presence of a dark smudge on the white cloth (or white deposit on the dark cloth) is cause for rejection.



Figure 2-39. Wipe test for cleanliness.

**Freedom From Alkalies and Acids Test (figure 2-40)**

This test determines if alkalies or acids remain on the item in quantities that would endanger the preservation of the item.

**Equipment Required**

- X Indicator papers methyl red and red litmus, or a universal indicating paper conforming to O-P-94.
- X Distilled or deionized water and medicine dropper (use if item is not still wet from final rinse).

**Procedure for Test**

- X Wet a small area of item with distilled water, if not still wet from final rinse.
- X Touch both the methyl red and the red litmus paper to the wet surface.
- X Examine the wet surfaces of the papers for color change.
- X Compare color change of universal indicating paper with color chart.

**Interpretation of Test Results**

- X A red tint on the methyl red paper indicates to much acidity.
- X A blue tint on the red litmus paper indicates to much acidity.
- X If the color change reading of universal indicating paper indicates a reading below pH 6.4 or above pH 8.3 when compared with the chart on the dispenser, this is cause for rejection of the items.

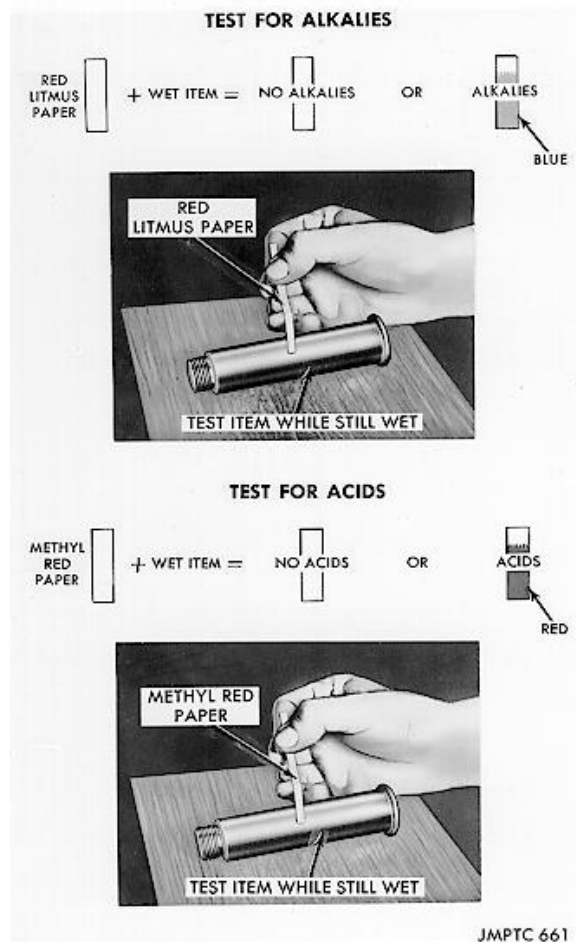


Figure 2-40. Freedom from alkalies and acids test.

## Materials Tests

Test to be performed on cleaning materials during cleaning operations are the determination of sludge concentrations in petroleum and chlorinated solvents and the determination of acidity in chlorinated solvents.

### Sludge Content of Petroleum Solvents (figure 2-41)

Solvents require frequent determinations of the sludge content. When the concentration of the sludge exceeds 30 percent, the solvent should be replaced. The requirements for this test is published by ASTM, the American Society for Testing and Materials. The sludge content is measured by taking a 100-cubic-centimeter sample of the cleaning solution. This sample is distilled in a laboratory distilling flask. The amount of solvent collected after distillation at the boiling point of the solvent is measured in cubic centimeters. The difference in amount collected from the original sample of 100 cubic centimeters represents the residue of sludge remaining in the distilling flask and is the percent of sludge in the solution.

### Sludge Content of Chlorinated Solvents.

As items are cleaned, there is a gradual buildup of sludge with an increasing rise in the boiling temperature of the resulting mixture. When the sludge concentration reaches thirty percent, it is not economical to continue to use the material. The percent of sludge in the solvent may be determined by the use of a thermometer or hydrometer.

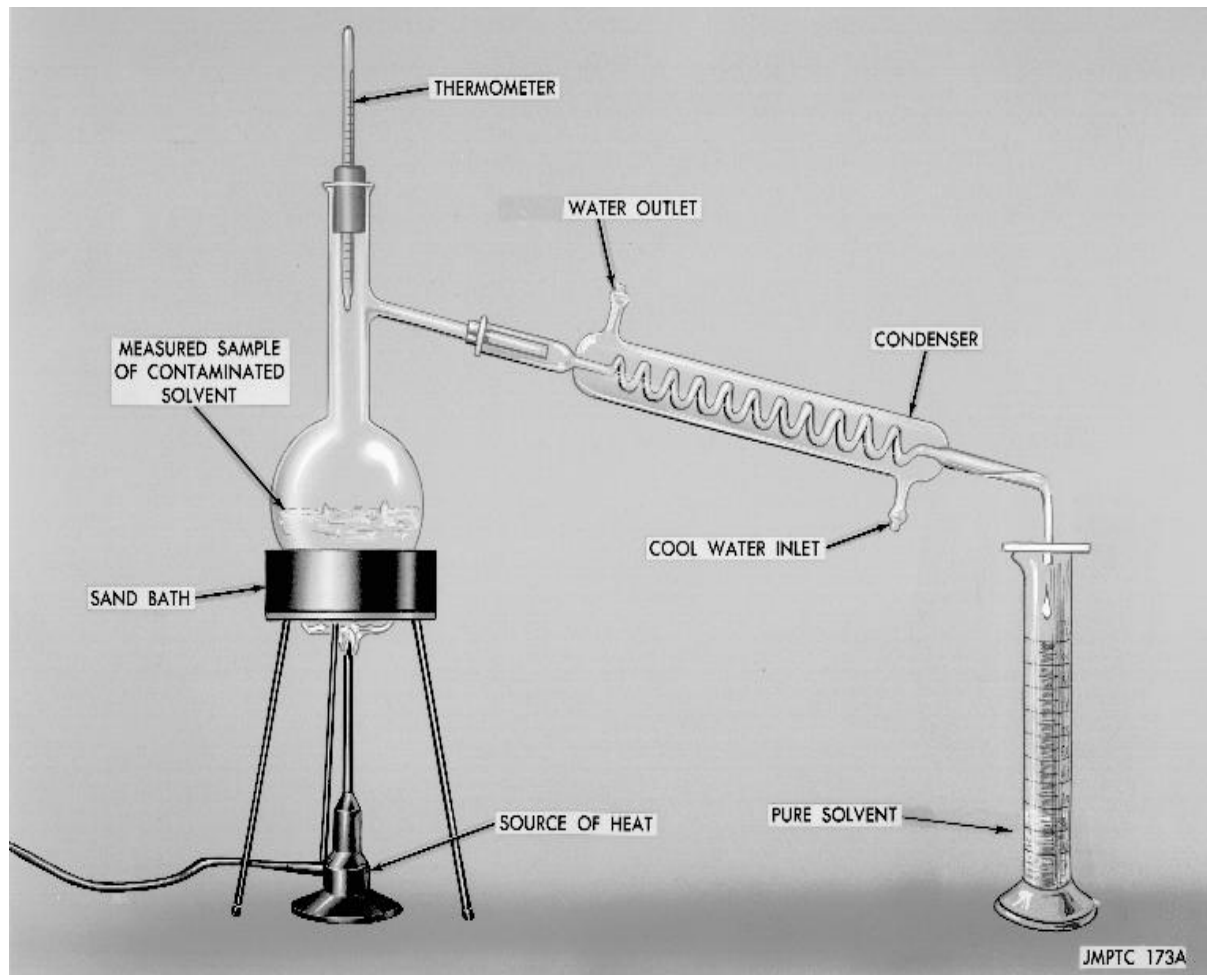


Figure 2-41. Determining sludge content of petroleum solvents.



**Sludge Content by Temperature Method (table 2-1 & figure 2-42)**

Figure 2-42 shows boiling points and the corresponding sludge content for ASTM D 4081 and ASTM D 4376. When the boiling point of tetrachloroethylene reaches 260°F, replace the solvent. The boiling points at 10, 20, and 30% are based on oil and grease contaminants.

The Specific Gravity Method is shown in table 2-1. A hydrometer may be used to determine the specific gravity of the dirty solvent. A reading is made at room temperature, using a sample in a hydrometer jar. Read the specific gravity and compare with the values shown in table 2-1.

Table 2-1. Determining Solvent Contamination.

Sludge Content	Reading (°F)	Hydrometer Reading
None	250	1.61
10%	252	1.47
20%	255	1.33
30%	260	1.22

Tetrachloroethylene ASTM D 4081/  
ASTM D 4376

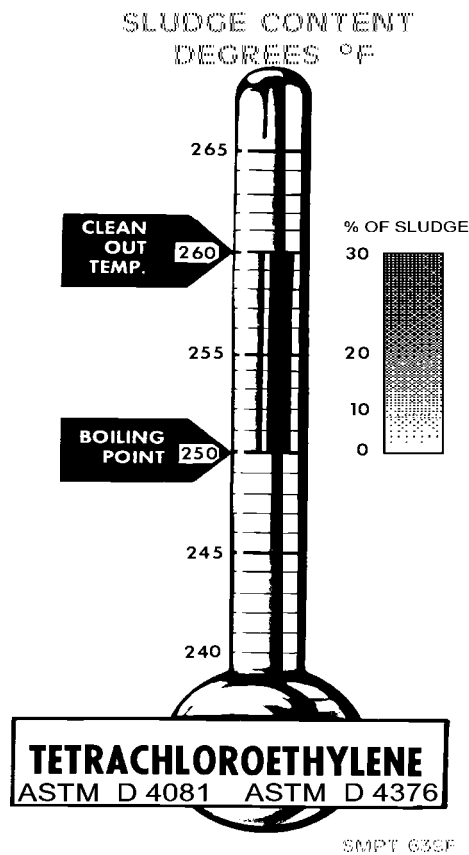


Figure 2-42. Determining sludge content by temperature method.

### **Acid Condition of Chlorinated Solvents**

Continuous operation during humid weather produces a gradual breakdown of the vapor by hydrolysis which result in the formation of hydrochloric acid. This requires frequent checking of the solvent acidity. A rough test is made by lowering a clean dry dipper into the vapor zone and collecting some condensate. Dip a strip of blue litmus paper moistened with distilled or deionized water into the condensed solvent. If the paper changes from blue to pink, acid is present in the vapor. This indicates that the solvent needs replacing. An accurate confirming check is made by sending solvent samples to a qualified laboratory where the acidity is determined by using a pH meter or a universal pH indicator test paper.

## **DRYING PROCEDURES**

Immediately after cleaning, items must be thoroughly dried to remove cleaning solutions or residual moisture. The drying may be accomplished by one or more of five different procedures, provided the item is not injured by the procedure.

### **DRYING WITH PREPARED COMPRESSED AIR (FIGURE 2-43)**

Drying is accomplished by subjecting the item to a blast of prepared dry and clean compressed air. The steps are -

- X Check the air supply to see that it is free from oil and dirt. Water in the air supply is detected by blowing the air on a polished metal surface or mirror at room temperature and checking for condensation.
- X Adjust the air pressure to 30 pounds per square inch (maximum to be used).
- X Apply the compressed air to the surfaces of the item until all traces of solvent have evaporated.

### **DRYING WITH OVENS (FIGURE 2-43)**

This procedure consists of exposing the items to heated air in a well ventilated and temperature controlled oven. The drying steps are -

- X Set the temperature of the oven to operate between 270°F and 350°F. Lower the temperature range if the items are liable to damage by the higher temperatures.
- X Place items in the oven in baskets or on racks.
- X Circulate and replace the air in the oven by a fan or air jet to hasten drying and remove excess solvent vapors.
- X Remove items from oven when dry.

### **DRYING WITH INFRARED LAMPS (FIGURE 2-43)**

This is a commonly used procedure for drying. It is adapted to conveyor systems of cleaning and preservation. To increase the effectiveness and hasten drying, items are often blown with compressed air prior to being placed in the infrared cabinet. The steps for infrared drying are -

- X Place items on conveyor or monorail and pass into infrared cabinet.
- X Adjust the speed of the conveyor so that items are thoroughly dried, but not overheated.
- X Set the thermostat so that the temperature of the item is maintained at 160°F. The temperature items will reach will depend upon the length of exposure under the lamps, the number and placement of the lamps, their distance from lamps, and the mass of the item.

### **DRYING BY WIPING (FIGURE 2-43)**

This procedure is accomplished only when it is impractical to use any other drying procedure. It is performed as follows:

- X Drying is accomplished by wiping the surfaces of the item with clean, dry, lint free cloths or specially prepared paper wiping towels (linen combed cotton and General Services Administration (GSA) Stores Stock Catalog listed lint free nonwoven fabric cleaning cloths may be used).
- X Change to fresh, clean, dry, lint free cloths and polish until assured of a thoroughly dried surface.
- X Discard wiping cloths when they become saturated or soiled by placing them in an all metal container with a closed lid. Empty container at regular intervals as required by safety regulations.

### **DRYING BY DRAINING (FIGURE 2-43)**

When the final step in cleaning involves a petroleum solvent, thorough draining of the solvent is permitted as a drying procedure. Unless otherwise specified, this drying procedure is used only when followed by the application of a cold application solvent cutback preservative. It is not intended for use under methods of preservation when a preservative is not applied. Precautions must be taken to insure that residual films of petroleum solvent will not reduce the effectiveness of the applied preservative compounds. Draining is completed as follows:

- X Remove the items from cleaning tank and place on rack to drain.
- X Check item surfaces to assure no residual solvent remains to dilute or interfere with preservative application.

### **JET SPRAY WASHING**

Jet spray washing is an advanced cleaning method designed to operate with very low buildup, emission, or generation of environmentally hazardous contaminants.

### **ENVIRONMENTALLY SAFER CLEANING METHODS**

Traditional cleaning procedures, previously mentioned, such as vapor degreasing, cold solvent cleaning, electrochemical cleaning, etc., which require the use of chloroflourocarbons and/or solid water contaminants that do not meet EPA's standards for clean air emissions and/or effluent standards for waste streams are becoming obsolete.

Jet spray washing provides an environmentally safer cleaning alternative that is attribute to the following:

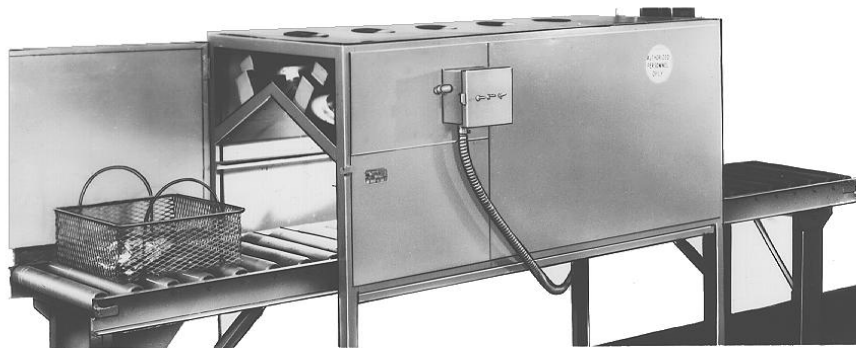
- X use of a cleaning compound MIL-C-29602 which meets EPA's standards for waste materials.
- X the new equipment developed for using the above cleaning compound.



**DRYING WITH COMPRESSED AIR**



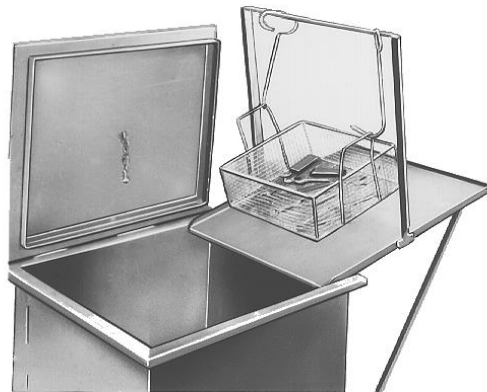
**DRYING BY HEATED OVEN**



**DRYING WITH INFRA RED LAMPS**



**DRYING BY WIPING**



**DRYING BY DRAINING**

SMPT 105A

Figure 2-43. Drying procedures.

DOD has authorized the purchase and use of cleaning materials cited in the publication TB 43-0135, Environmentally Safe Substances for Use With Communications-Electronics Equipment.

Cleaning materials cited in TB 43-0135 are used for many types of items and item managers may find many useful substitutes listed in TB 43-0135 for their present solvent cleaning materials which may be hazardous. The proponent for this document is

U.S. Army Communications-Electronics Command  
ATTN: ANSEL-LC-LM-LT  
Fort Monmouth, NJ 07703-5007

Alternate solvents and solvent substitutes are listed in the paragraph "Environmentally Safe Solvents" at the end of this chapter.

#### **JET SPRAY WASHING EQUIPMENT**

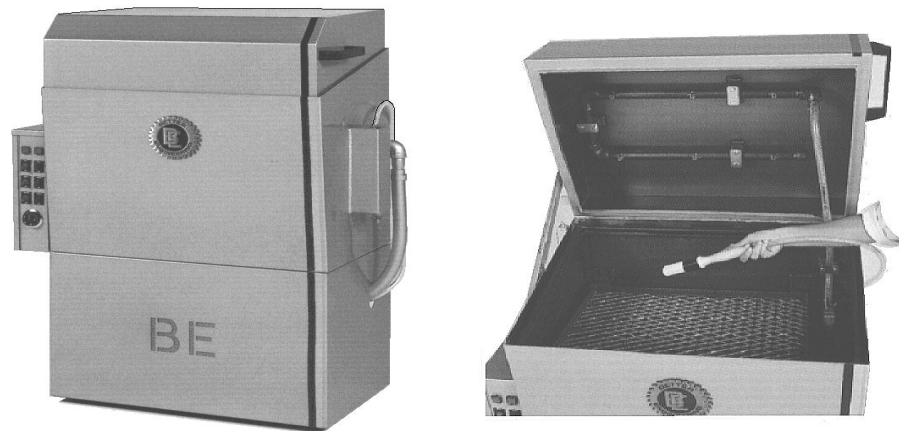
DOD has also authorized the purchase and use of equipment for using the cleaning materials. Examples of some of the units are shown in figures 2-44, 2-45 and 2-46, but not all units of this type are shown. The various sizes of equipment which may be used are depicted, depending upon the size, contour, or nature of the item to be cleaned.

#### **JET SPRAY CLEANING PROCESS**

In brief, the units work in the following way:

- X items with heavy or light greases or oils are placed into the units which are preheated to temperatures of about 95°F.
- X hot water and detergent (MIL-C-29602) are forcefully or "jet" sprayed onto the items until they are clean.
- X it is also possible to use a hand spray attachment for detail work which may be desired.
- X as the items are being cleaned, the contaminants (oils, greases, sludge, etc.) are scraped or skimmed from the surface of the cleaning solvent and are then compressed into very small units for subsequent disposal.
- X the liquid portion of the cleaning compound is a safe effluent for systems.
- X items receive thorough cleaning and are very hot at the end of the cleaning cycle. No special drying procedure is necessary.

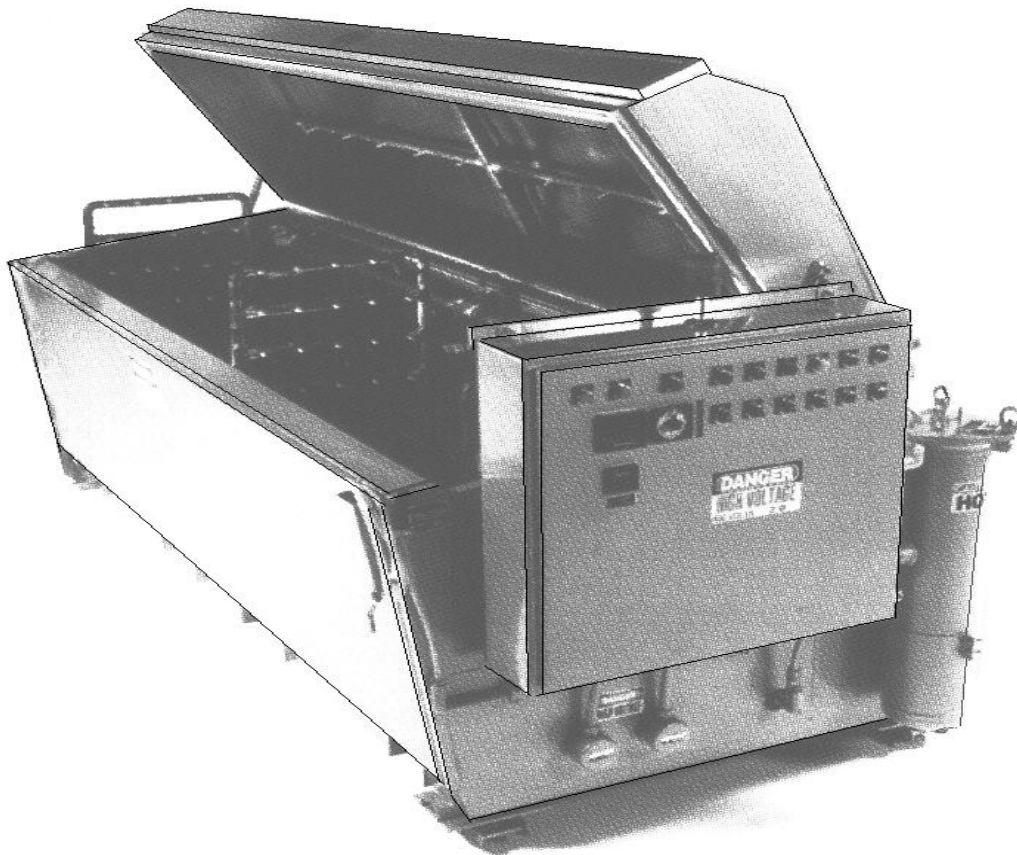
Regardless of the high cleaning temperatures, jet-spray washing will not remove fingerprints, perspiration, etc., from critical surfaces of metal items. The fingerprint removal compound process will still be necessary.



49" H x 38" W x 24" D

SMPT 3165

Figure 2-44. Automated cleaning unit with rinsing and drying capability.



62" H x 100" W x 92" D

SMPT 3166

Figure 2-45. Automated cleaning unit (Larger) with rinsing and drying capability.

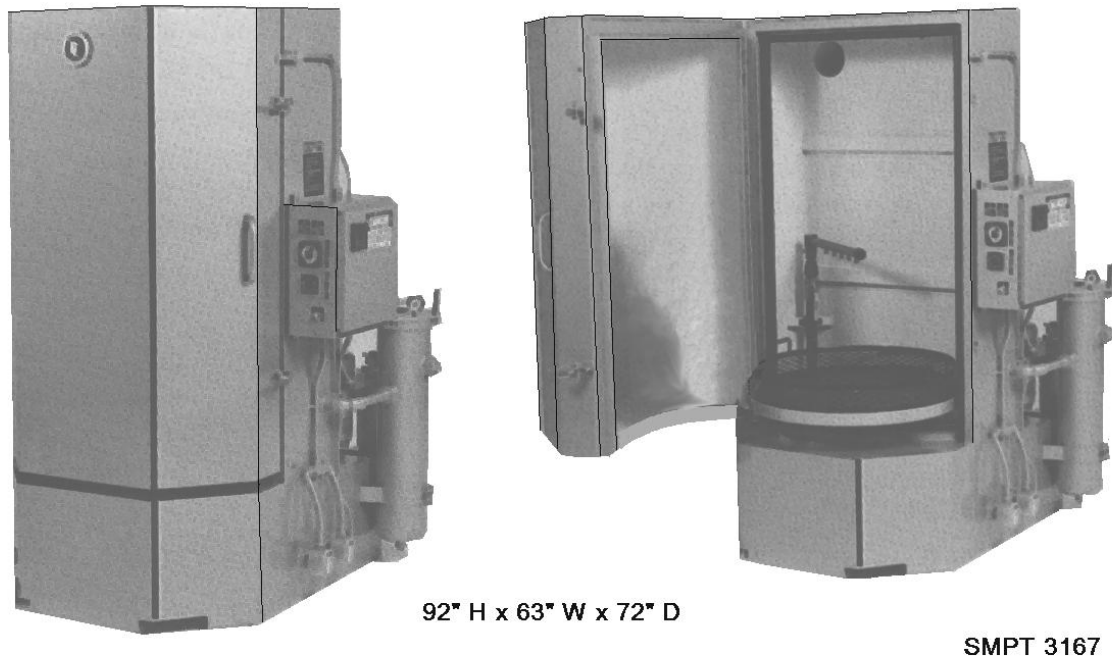


Figure 2-46. Automated cleaning unit with hand-detailing capability.

Use of the new cleaning units was proven to be cost-effective at several installations. At Langely AFB, a net savings of over \$100,000.00 was reported after the first year of operations, and the savings continued to increase. A Naval Base also reported savings for the first year of over \$1,000,000.

Studies and tests reveal that the jet-spray washing technique results in the following:

- X less hazardous waste production.
- X savings due to elimination of certain labor costs.

### **NAVY'S HAZARDOUS MATERIALS REDUCTION PROGRAMS**

The Navy via the Naval Supply Systems Command, has taken a major role in reducing or helping to eliminate DOD's environmentally harmful waste products through their Plastics Removal in Marine Environment (PRIME) and Hazardous Substance Management System (HSMS) programs. In addition, the Navy is complying with the International Convention for the Prevention of Pollution from Ships (MARPOL 73-78). Also, there are other United Nation's requirements for international shipments of hazardous materials by water for which Navy has direct responsibility. For additional information on pollution control, contact the following department:

Naval Inventory Control, Mechanicsburg  
P.O. Box 2020  
5450 Carlisle Pike  
Mechanicsburg PA 17055  
(717)790-5623

**ENVIRONMENTALLY SAFE SOLVENTS**

P-D-680 dry-cleaning solvent has been used for many years but is being eliminated because it is flammable, toxic, and becomes a hazardous waste. Therefore, Types I and II of P-D-680 are curtailed for use but Type III, with NSN 6850-01-221-3349 (5 gal) or NSN 6850-01-244-3207 (55 gal drum), is still approved for use but will eventually be “phased-out”.

An approved substitute for P-D-680 is **134 HI-SOLV**, NSN 6850-01-277-0595 (5 gal) and NSN 6850-01-244-3207 (55 gal drum).

Other approved solvents are listed below:

Product	NSN (5 Gal)	NSN (55 gal)
Breakthrough	6850-01-376-0679	6850-01-378-0666
Eelctron 296	6850-01-375-5553	6850-01-375-5555
Skysol 100	6850-01-381-4423	6850-01-381-4401
Skysol	3850-07-381-4420	6850-01-381-4404
PF	7930-01-328-4061	7930-01-328-4058

For details concerning the properties, action, and replacement of P-D-680, we recommend the reading of TARDEC Technical Reports Nos. 13630 (Oct 1996) and 13643 (Sept 1995) by In-sek Rhee, Carlos Velez, and Karen Von Bernewitz at the USA Tank Automotive RDE Center, TACOM Research, Development, and Engineering Center, Warren Michigan 48397-5000.



## Chapter 3

# Preservatives and Their Application

## BASIC PRINCIPLES OF PRESERVATIVES PROTECTION

### DETERIORATION OF MATERIALS (FIGURE 3-1)

The fact that items have been cleaned and dried does not insure that they will remain free from future contamination. In fact, cleaning may increase the possibility of damage to an item by leaving its surfaces exposed to the direct attack of destructive forces. Attacks by air, water, sunlight, living organisms, temperature changes, and aging occur everywhere. It is known that iron and steel rust; copper, zinc, and similar metals corrode; wood rots and decays; leather cracks and mildews; cork becomes brittle; paper and textiles fade and mildew; food molds and spoils; and other materials change in many ways to reduce their usefulness. This reduction in the usefulness of a material is deterioration. In most cases, deterioration is a chemical change, but it can also be a physical change such as the cold flow or plastic deformation of rubber. The deterioration of a material varies with its composition. Organic materials such as wood, leather, fabrics, rubber, and plastics are affected by micro-organisms, insects, heat, sunlight, and extremes of humidity. Inorganic materials such as metal, glass, quartz, graphite, and the like are attacked by chemical actions of gases, water, and sunlight.

### Corrosion of Metals

The most prevalent form of deterioration to which metal items are subjected is corrosion. In the presence of gases found in industrial areas, unprotected metal is attacked. With water absent, the rate of attack is extremely slow because the film forming on an exposed metal surface by an initial attack acts as a protective layer and inhibits further corrosion on the base metal. For example, oxygen is a protective agent for most metals, despite its attack on all metals at various rates. The action of oxygen on metal usually produces a thin, uniform oxide film that impedes further attack. Pure aluminum, for example, will last indefinitely when exposed to air, because it is protected by an adherent and continuous oxide coating that forms immediately on exposure. In the presence of free water and corrosive gases, these protective oxide films change into other less stable oxides, hydroxides, chlorides, and sulfates, which are soluble in water and are thus removed by rain, snow, and sleet, with the result that some of the metal is destroyed. The rate of destruction depends upon such factors as temperature, humidity, evaporation, and sunlight.

### Electrochemical Corrosion

Electrochemical corrosion takes place when two different metallic components are brought into contact with each other in the presence of water or another nonmetallic conductor (an electrolyte). The two metallic components plus the electrolyte make up the elements of an electrochemical cell (a battery) and an electrical current will flow accompanied by chemical action. This chemical action is corrosion. That is, one of the metals will dissolve while the other metal will be coated with reaction products. This is due to each metal possessing a different electromotive potential. Where two different metals such as aluminum and steel are coupled together, in the presence of an electrolyte, the potential difference is great enough to cause a flow of current. There is even sufficient potential difference between adjacent crystals of a single piece of impure metal for corrosion to occur when all the conditions are favorable.

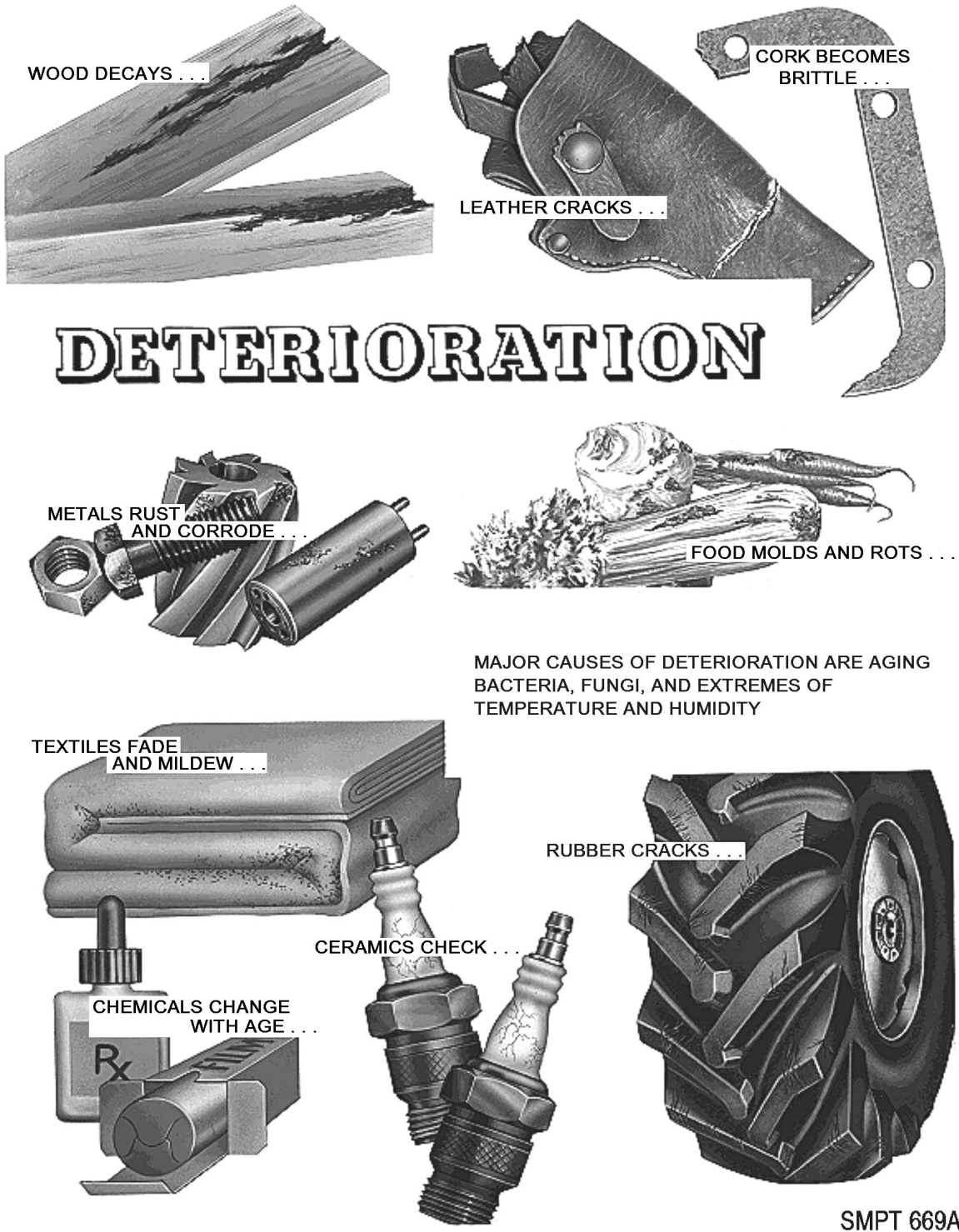


Figure 3-1. The causes and effects of deterioration.

**Galvanic Corrosion**

Galvanic corrosion occurs when electrical current flows between dissimilar metals that are in contact with each other or from one part of the surface of a piece of metal to another part of the surface. For this kind of corrosion to take place, an electrolyte such as water must be present. Table 3-1 lists an electrochemical series of metals ranging from the anodic or positive end to the cathodic or negative end of the series. Galvanic corrosion action is stronger when the metals are further apart in the series, such as when aluminum and copper are placed together. Metals closer to one another in the series, such as tin and steel (or iron) would have a lesser corrosion effect. The further apart any two metals are, the stronger the corroding effect on the higher one, toward the anodic end in the electrochemical series. So, for galvanic corrosion to occur in metals, there must be an electrolyte to allow current to flow between a metallic area or region with a negative charge in relation to a second area, and a second area positive in opposition to the first. The susceptibility to corrosion of iron and steel is of great concern because annual U.S. losses have been estimated at nearly \$70 billion.

**Table 3-1. Electrochemical Series.**

<u>Anodic (Positive) End</u>	+	
Lithium		
Rubidium		
Potassium		
Calcium		
Sodium		
Strontium		
Barium		
Magnesium		
Beryllium		
Aluminum		
Manganese		
Zinc		
Chromium		
Gadolinium		
Iron (Fe <sup>++</sup> )		
Cadmium		
Indium		
Tellurium		
Cobalt		
Nickel		
Tin		
Lead		
Iron (Fe...)		(neutral)
Hydrogen		
Antimony		
Bismuth		
Arsenic		
Copper		
Iodine		
Silver		
Palladium		
Mercury		
Platinum		
Gold	-	
<u>Cathodic (negative) End</u>		

## **Preservatives Defined**

Preservatives are materials that are applied to, or come in contact with, items to protect them from deterioration resulting from exposure to environmental conditions during shipment and storage. Some preservatives protect items by providing a barrier against moisture, air and other agents of corrosion. These are contact preservatives. Other preservatives protect items by releasing vapors which deposit an invisible protective film on the items. These materials are called volatile corrosion inhibitors (VCI).

## **PRESERVATIVE APPLICATION CRITERIA**

Preservatives should be applied whenever items require protection against deterioration. The composition of some items render them immune to corrosion under ordinary conditions. For example, the more resistant metals such as gold, platinum, palladium, and beryllium seldom require a preservative application. Items fabricated from graphite, clay, stone, glass, or ceramics require no preservative coating. Many items susceptible to corrosion can be made less subject to deterioration by the application, at the time of manufacture, of a protective coating which remains an integral part of the item during its useful life. Such coatings are permanent preservatives. Many items, however, because of close tolerances, operating characteristics such as rolling, sliding, or bearing surfaces, or other limiting factors cannot be protected with a permanent coating but must be protected during shipment and storage by temporary preservatives. These materials are applied after the item has been manufactured and must be removed before the item can be used.

## **CLASSIFICATION OF PRESERVATIVES**

Permanent and temporary preservatives are classified on the basis of the material to be preserved. There are preservatives for metals and for nonmetals. They are usually applied on the item at the time of manufacturer, however, they are also applied in the field. This is especially true of cordage, leather goods, and canvas materials. Preservatives for nonmetals are intended to protect items against deterioration by hardening, drying, aging, decaying, rotting, or decomposing.

## **PERMANENT PRESERVATIVES FOR METALS**

### **CORROSION-RESISTANT METALS**

The most effective means of giving permanent protection to items is to make them from metals which are highly resistant to corrosion. There are several metals and alloys available such as steel, copper, nickel, chromium, brass, bronze, and beryllium. Under normal conditions of usage, these metals are highly resistant to corrosion. However, the most resistant metals or alloys may be unacceptable because of technical or economic factors. The design engineer may be forced to compromise because of workability, mechanical properties, fabrication problems, availability, or cost. If corrosion resistance is the major design requirement, metals and alloys with superior corrosion resistance should be selected despite high cost and poor fabrication qualities. While the selection of the fabrication materials is not a direct responsibility of preservation personnel, a knowledge of the corrosion-resistant characteristics of items will assist in the choice of preservatives. For example, corrosion resistant steels quite often require added protection, especially when exposed to salt atmospheres.

## **METAL COATINGS**

When a corrosion-resistant metal cannot be employed in the fabrication of an item, the next best alternative is to provide a protective metal coating for the corrodible metal used. There are two types of metal coatings that can increase the corrosion resistance of the base metal. They are -

### **Resistant (Cathodic) Coating**

This coating furnishes complete protection of the base metal only if it is impervious to water. If any pores exist in the coating, corrosion of the base metal is accelerated.

To increase protection and reduce porosity, the thickness of the coating must be increased. Nearly all the electroplated metals, except zinc and cadmium, are in this category. Of the more resistant metal coatings, nickel plating is the most used to protect steel and iron. A preliminary copper coating is frequently applied, partly because the copper is more cheaply polished than the underlying steel or the superimposed nickel. Copper also produces better adhesion. Other frequently used coatings are chromium, gold, silver, and tin.

### **Sacrificial (Anodic) Coating**

Corrosion will attack this coating first. The coating is destroyed before the base metal is affected. Generally, the corrosion product of the coating provides further protection to the base metal. Some metals like zinc, aluminum, nickel, and copper, when exposed to the atmosphere, form a protective coating which retards further corrosion. Iron, however, continues to rust progressively after every exposure to water. The two sacrificial coatings most commonly used are zinc and cadmium.

## **CHEMICAL CONVERSION COATINGS**

Metals are frequently given corrosion protection by applying chemicals that react with the base metal to form a thin coating which prevents further attack on the metal. These chemicals provide oxide, phosphate, and chromate coatings.

### **OXIDE COATINGS**

There are several processes used to form oxide films on metals at a more rapid rate than would occur in nature. For ferrous metals, these films are produced by heating the metals in various atmospheres, depending on the color or character of the coating desired. In many applications, oxide coatings are more useful for their decorative value than for their corrosion resistance. Browning, bluing, and blackening (MIL-C-13924) are processes of this type. They color the metal more than they protect it and are seldom used without an oil or wax coating. For aluminum, the aluminum is rapidly oxidized in sulfuric or chromic acid to form permanent oxide coatings. This treatment is referred to as anodizing (MIL-A-8625).

### **PHOSPHATE COATINGS**

Where "heavy" coatings are required, MIL-P-16232 should be used. This specification covers two types of heavy phosphate coating for ferrous metals, applied by immersion. The coatings consist of a manganese phosphate or zinc phosphate base.

Light phosphate coatings used as a paint base are covered by other specifications, such as TT-C-490. However, heavy coatings may be used as a paint where required. In addition, TT-C-490 covers suitable cleaning processes for nonferrous surfaces.

### **CHROMATE COATINGS**

Chromate conversion coatings are applied to items plated with zinc, cadmium, aluminum, magnesium, and other metals. Several procedures are available by which a protective film of chromium salts is produced on the metal platings. The film is formed by simple immersion of the plated item in a chromate or chromic acid solution and sulfuric acid. These chromate coatings applied to zinc and cadmium plated items extend the useful life of such items considerably.

### **VITREOUS COATINGS**

Vitreous porcelain or glass enamel coatings consist of a thin layer of glass fused into the surface of the metal, generally iron. Obviously, these coatings have the properties of glass, and variations in their properties are due to the differences in the compositions and physical conditions of the glasses selected. These coatings have been long used for durable and sanitary finishes for iron cooking utensils, refrigerators, and plumbing fixtures.

### **ORGANIC COATINGS**

Organic coatings are widely used to protect surfaces from deterioration. Such coatings are applied as liquids but become solid after application. Included in this group are varnishes, paints, lacquers, and enamels. Organic coatings are essentially barriers and unless care in their application and maintenance is exercised, cracks, pinholes, or other breaks will render the barrier ineffective as a protective coating.

### **VARNISHES**

A varnish is a combination of drying oil and a fortifying resin, either natural or synthetic. The mixture is thinned with suitable solvents to brushing or spraying viscosity and employed as a clear composition. It dries by oxidation of the oil component.

### **PAINTS**

Originally, this term applied to mixtures of pigments (usually oxides of metals) with a drying oil such as linseed oil. Oil base paints are the oldest type of protective coatings in general use. The term "paint" has now come to mean any combination of pigmented-and-liquid-vehicle, such as rubber-base and water emulsions, that are adaptable to brushing, rolling, or spraying, and that dry to a tough, adherent coating.

### **Enamels**

An enamel is a pigmented varnish in its strictest sense. Actually, the wide use of fortifying resins in oilbase paints has resulted in the disappearance of any distinction, other than an arbitrary one, between paints and enamels. There is currently a tendency to term alkyd-resin-base finishes "quick-dry" enamels to differentiate them from the older, natural resin paints.

### **LAQUERS**

Originally, a lacquer consisted of one or more selected natural resin dissolved in a rapidly volatile solvent. These compositions were either clear or pigmented. They set to very hard, glossy, nontacky films by solvent evaporation only. Presently, the term is expanded to mean any air drying or ovenbaking type composition, usually, but not necessarily based on nitrocellulose or similar cellulose resins.

### **PLASTIC COATINGS**

Plastic protective coatings consist of solutions or dispersions of film-forming plastics in organic solvents. These coatings are satisfactory for continuous contact with mild corrosives such as fresh and salt water, some solvents, and some alkalies. Generally, they should be used only for exposure to splash and fumes in the presence of corrosive liquids. There are two basic types of plastic material employed for protective coatings.

## **THERMOPLASTIC COATINGS**

A number of thermoplastic coatings have proved useful in protecting metal surfaces in mildly corrosive atmospheres. Of these, polyethylene, styrene copolymers, vinyl resins, and polyvinylidene chloride (saran) are especially valuable.

### **Vinyl Resins**

Vinyl resins have been compounded to be highly resistant to alkalis, corrosive salts, certain solvents, and acids. They are used in the protection of metal against splash and fumes of corrosive chemicals, and for coating objects which are to be continuously immersed in fresh or salt water.

## **THERMOSETTING COATINGS**

Several of the thermosetting types of plastics are being used as corrosion-resistant coatings.

### **Polyesters**

Protective coatings consisting of polyesters blended with styrene can be compounded to yield good chemical resistance. Polyester coatings may be colored and may be applied by brushing, roller coating, or spraying.

### **Urea-melamine Resins**

These resins are used primarily as baked coatings. When applied as organic solutions and baked at temperatures between 200° and 350°F., hard, light colored, brittle films are produced.

### **Phenolic Coatings**

Phenolic coatings have been used for many years for preventing iron contamination to liquids stored in drums and tanks. They are applied as liquid resins dissolved in alcohol and dried and baked at temperatures near 300°F.

### **Epoxy Coatings**

Epoxy coatings are resistant to acids, alkalis, and some solvents. They adhere well to a wide variety of surfaces, and their impact resistance can be made superior to that of phenolic coatings by the addition of flexibilizers.

### **Rubber-Type Coatings**

A number of rubber-type coatings are employed as protective coatings.

### **Chlorinated Rubber**

Natural rubber treated with chlorine forms a plastic material which has excellent adhesion to many surfaces and is resistant to many corrosives. It has low resistance to heat and light. By blending it with other resins and plasticizers, its brittleness is overcome to a great extent.

### **Chlorosulfonated Polyethylene**

Exposure of polyethylene to chlorine and sulfur dioxide produces this material. This increases the solubility of polyethylene in several solvents. The dissolved polyethylene gives excellent adhesion characteristics. It has an excellent chemical resistance and can be pigmented to produce a wide choice of colors.

### **Chloroprene**

Also known as neoprene, this material can be dispersed in organic solvents and can then be applied by brush or spray. It has excellent resistance to oils, sunlight, heat and ozone and has high retention of resilience upon aging. This combination of properties makes it ideal for use as a heavy-duty protective coating. Chloroprene

coatings with high solid content yield heavy films which adhere well to chlorinated-rubber primed surfaces.

#### **FUSION-BONDED PLASTIC COATINGS (FIGURE 3-2)**

The fusion-bonding of powdered plastics to the surfaces of objects that can be heated to the melting point of the plastic is a technique for applying protective and decorative plastic coatings. Many plastics which have not been used previously because of their insolubility as protective coating materials can now be used to provide excellent protection against acids, alkalies, and corrosive liquids. Plastics such as polyethylenes, polyesters, epoxies, vinyls, nylons, and saran can now be obtained in finely divided-powdered form in many colors. The powdered plastic is placed in a fluidizer consisting of a tank having an upper and lower section divided by a porous plate. Air or gas forced up through the porous plate causes the powder to vibrate as if it were a boiling liquid. The coating process consists of dipping a preheated item for a few seconds in the fluidized powdered plastic. Upon coming in contact with the heated item, the powder is melted and forms a smooth plastic film over the surface of the item. The coated item is then placed in an oven for curing to set the film.

#### **PRESERVATIVES FOR NONMETALS**

Since the preservatives for nonmetals include a wide variety of materials, in most instances intended for specific applications, their use is limited to the instruction contained in contracts, specifications, or special processing directives and manuals. Examples of some of the common nonmetal preservatives are electrical circuit preservatives, leather preservatives, and textile preservatives.

#### **ELECTRICAL CIRCUIT PRESERVATIVES**

These compounds are used to protect electrical and electronic equipment against the effects of fungus and moisture. It is generally desirable to design equipment so that the use of the products is not necessary; however, when equipment is not so designed, these materials are suitable for providing the necessary protection.

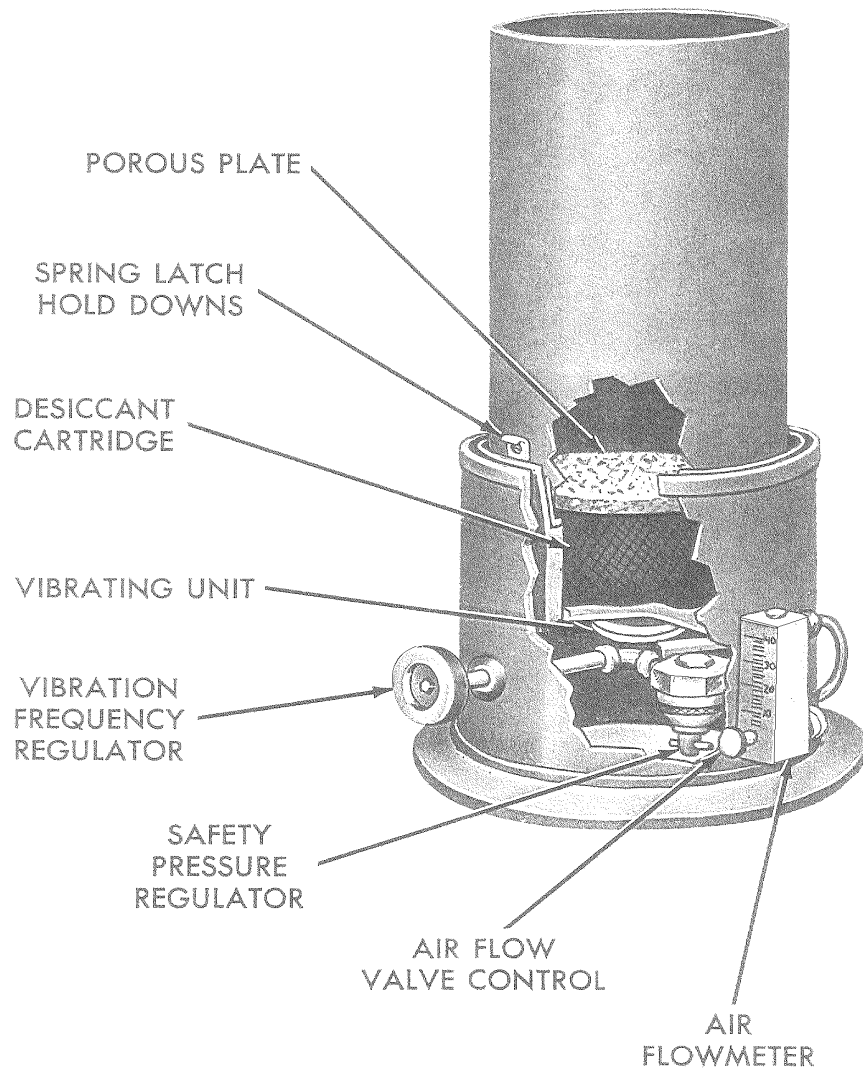
#### **MOISTURE AND FUNGUS RESISTANT VARNISH (MIL-V-173)**

Varnish conforming to this specification is used for the overall protection of communication and electronic equipment against the effect of moisture and fungus attack on the performance of the equipment. It may be applied by spraying, dipping, or brushing and must be used in conjunction with supplementary specifications stating the method of application of the varnish and the treatment of the equipment to receive it.

#### **WATERPROOFING, ELECTRICAL IGNITION VARNISH (MIL-V-13811)**

This material is a clear (unpigmented) compound intended primarily for use in protecting electrical circuits and engine parts of internal combustion engines used on military motor vehicles and other automotive equipment. This compound can be applied by spraying, dipping, or brushing. The resulting coating dries to a hard, flexible film in about 8 hours. The solvents used in this material have a low flashpoint (75°F), and safety precautions against fire must be taken. It must not be applied to heated surfaces. This compound should be stored in tightly sealed containers.





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Figure 3-2. Fusion-bonding fluidizer.

**LEATHER PRESERVATIVES**

These compounds are used on leather items to give them resistance to cracking, mildew growth, and water penetration. They are expected to preserve the original qualities of leather and improve the qualities of leather items that have been in use.

**SOLVENT TYPE MILDEW PREVENTATIVE (O-L-164)**

This type of compound is used as received with no dilution necessary. Items must be cleaned in warm (not over 100°F) soapy water, rinsed and drained for about 5 minutes. The items are then immersed in the compound for about 2 minutes. The treated leather must be allowed to dry thoroughly in the open air before wearing.

**Handling**

These compounds must be handled with due regard to health. Application of these materials must be made in a well ventilated area. Skin contact and the breathing of the fumes should be avoided. The hands must be washed thoroughly in cool water and soap after application. Treated materials must be thoroughly aired and dried before allowing them to come in close contact with the skin. These compounds should not be used on leather products which will come in prolonged contact with the skin. When boots and shoes are treated, socks must be worn.

**TEXTILE PRESERVATIVES**

These consist of several complex chemical treatments which are intended to give a high degree of mildew resistance to fabrics, wool felt, rope, thread, twine, and other natural fibers. The chemical agents used in these treatments are capable of limiting the growth of mildew and fungus. Most of these processes should not be applied to materials which will come in frequent and close contact with a person's skin during use. They should not be used on materials which will be coated with, or come in contact with natural rubber. They will cause an undesirable reaction with the rubber. In preparing colored materials, allowance must be made for the effects the process may have on the colors. Many textiles are also protected by the use of vapor type preservatives such as naphthalene or paradichlorobenzene (A-A-52287) which repel insect attack, principally by the cloths moth.

**LINSEED OIL (ASTM D 234 OR ASTM D 260)**

Linseed oil can be obtained raw (ASTM D 234) or kettle boiled (ASTM D 260). Aside from its use in the manufacture of and thinning of paints and varnishes, linseed oil is used to preserve wooden gun stocks and similar wooden items and to treat the inner surfaces of chests and lockers in hot, humid, or dry areas. For gun stocks, it is prepared by mixing 1 gallon of volatile mineral spirits paint thinner with 6 gallons of raw linseed oil (kettle boiled if faster drying is desired) and 2 percent of fungicide. Any wiping cloths used while applying linseed oil should be disposed of immediately after use to avoid fire by spontaneous combustion.

**CASTER OIL, TECHNICAL (ASTM D 960)**

Caster oil is used as a preservative on hydraulic brake systems and as a leather dressing.

**CONTACT PRESERVATIVES FOR METALS**

Many finished metal items require a preservative coating that is easily removed and yet will not rub off or abrade. Attempts were made to use lubricating oils for this purpose, since oil and water do not normally mix. It was found that lubricating oils, being lighter than water, and with less attraction to the metal surface, were soon displaced by water. A number of protective, removable petroleum base compounds have been developed with characteristics for specific preservation needs. By adding ingredients with water displacing compounds and inhibiting qualities to lubricating oils, greases, and hydraulic fluids, several temporary preservatives have been developed. These compounds have different consistencies and require different methods of application.

**CONTACT PRESERVATIVE GROUPS (TABLE 3-2)**

For convenience, the preservatives listed in MIL-STD-2073-1C, Appendix A, Table A.III, Contact Preservative Category Code Determination, may be placed into four groups, according to their composition and application requirements, as follows:

- X thin film, solvent cutback, cold application;
- X petrolatum base, hot application;
- X rust inhibiting oils, cold application; and
- X special purpose, cold application.

**Group 1**

The contact preservatives in Group 1 are as follows:

- X Code 01, MIL-PRF-16173, Grade 1, corrosion preventative, solvent cutback, cold application, hard film;
- X Code 02, MIL-PRF-16173, Grade 2, corrosion preventive, solvent cutback, cold application, soft film;
- X Code 03, MIL-PRF-16173, Grade 3, corrosion preventive, solvent cutback, cold application, water displacing soft film;
- X Code 19, MIL-PRF-16173, Grade 4, corrosion preventive, solvent cutback, cold application, transparent, not-tacky; and
- X Code 21, MIL-PRF-16173, Grade 5, corrosion preventive, solvent cutback, water displacing soft film, low pressure steam removable.

The thin film solvent cutback, cold application preservatives contain 40 to 60 percent petroleum solvent, which evaporates, leaving a thin protective film. Code 01 is black in color. Asphaltic preservative Codes 02 and 03 are amber in color and are intended for short-term outdoor and long-term indoor exposures. Code 02 is oil miscible and Code 03 is water displacing. Code 19 is a transparent nontacky film. Code 21 is the same as Code 03 but with the additional requirement that it is removable with hot water or low pressure steam.

Table 3-2. Contact Preservatives for Metal Items\*

GROUP 1	GROUP 2	GROUP 3	GROUP 4
THIN FILM, SOLVENT CUT-BACK, COLD APPLICATION	PETROLATUM BASE, HOT APPLICATION	OILS, RUST-INHIBITING, COLD APPLICATION	SPECIAL PURPOSE, COLD APPLICATION
Code 01 02 03 19 21	Code 06	Code 07, 09 10, 15 17	Code 11 20

\*Contact preservative material codes are found in Table J.III, Appendix J, MIL-STD-2073-1C.

**Group 2**

The contact preservative in Group 2 is Code 06, MIL-C-11796, Class 3, light preservative compound, soft film, hot application. Only one petrolatum base, hot application preservative is currently in use by the military. Code 06 consists of petroleum plus inhibitors. It is made by adding oils of high viscosity to the petrolatum base. As the consistency decreases, the ease of application increases, but the degree of protection decreases. It is applied by brushing or swabbing at room temperature or by dipping in the molten state. It is used for preservation of antifriction bearings and for use on machined surfaces for which a protective material that is brushable and easily removable at room temperature is required.

### Group 3

The contact preservatives in Group 3 are as follows:

- X Code 07, MIL-PRF-3150, medium preservative oil, cold application;
- X Code 09, VV-L-800, very light preservative oil, water displacing, cold application;
- X Code 10, MIL-L-21260, preservative and break-in lubrication oil, internal combustion engine, Grade 10, 30, or 50.
- X Code 15, MIL-H-46170, hydraulic fluid, synthetic, rust inhibited, fire resistant; and
- X Code 17, MIL-PRF-6085, lubricating oil, instrument, aircraft, low volatility.

Rust inhibiting oils, cold application, consist of petroleum oils to which rust inhibitors have been added. These oils are used where the petrolatum base types are unsuitable or difficult to apply, for example, in oil lubricated bearings, hydraulic systems, turbines, and gearcases. These oils drain off or are removed by wick action; thus greaseproof wraps must be used to keep the oils within the package. Examples of these oils are Code 07, Code 09, Code 10, Code 15, and Code 17. Code 09 is also water displacing.

### Group 4

The contact preservatives in Group 4 are Code 11, MIL-G-23827, grease, aircraft and instrument, gear and actuator screw, and Code 20, MIL-P-46002, preservative oil, contact and volatile corrosion inhibited. Special purpose, cold application compounds are made for specific use and should be applied to those items for which they are intended.

#### CONTACT METAL PRESERVATIVES AND THEIR USE

The description, characteristics, physical properties, uses, application, and removal of the contact preservatives are presented in table 3-3 at the end of this chapter. The flashpoints are included to indicate possible fire hazards, and the pour point indicates possible climatic problems.

#### LUBRICANTS AND TEMPORARY PRESERVATIVES OTHER THAN CONTACT PRESERVATIVES

There are a number of preservatives for temporary use not listed in MIL-STD-2073-1C, some of which have been developed for specific uses. These preservative or corrosion preventing materials are listed in table 3-4 located at the end of this chapter. The flashpoint and flow point values, where available, have been listed to indicate possible fire hazards and usage in cold climate situations.

#### APPLICATION PRINCIPLE

Most temporary preservatives are oily or greasy in nature and vary greatly in chemical composition and consistency. Therefore, they cannot be used indiscriminately on all kinds of materials. They may even destroy the usefulness of an item due to the difficulty of removal. An example is the application of a hard-drying contact preservative to a typewriter. A preservative may penetrate into unwanted areas and cause swelling or decomposition of the material, or it may reduce its electrical conductivity. The criteria for preservative application have been established with some exception for specific situations.

#### BASIC APPLICATION REQUIREMENTS

Petroleum or contact preservatives are applied to those metal surfaces on which corrosion in any form, such as oxides, sulfides, and verdigris, would impair the usefulness of the item or assembly, except under the conditions discussed below. The type of preservative is usually specified in procurement documents or processing

specifications. In the absence of specific instructions, the choice of preservatives is made from those listed in MIL-STD-2073-1C as shown in table 3-3 at the end of this chapter. Care must be taken that the preservative selected will not damage the mechanism, structure, or function of the item, either when applied, in use, or during removal.

#### **EXCEPTIONS TO BASIC APPLICATION REQUIREMENTS**

Contact preservatives are not applied to surfaces which are protected with solid film lubricants, vitreous, plastic, prime, or paint coatings. They are not normally used on noncritical metal surfaces that are inherently resistant to corrosion, brass, bronze, or other corrosion resistant metals and alloys. Contact preservatives are not applied to noncritical items that have been chromium, silver, nickel, cadmium, zinc, or tin plated or coated. Cadmium plated or coated items packaged in nonventilated containers together with organic coated items or insulated electrical items require application of a preservative. Oily type preservatives are not applied to items that are vulnerable to damage by the petroleum ingredients, such as those fabricated from textiles, cordage, plastics, mica, rubber, paper, felts, leather and leather products, or prelubricated bushings. These preservatives are not applied to certain types of electrical and electronic components, distributor rotors, circuit breakers, switches, resistors, and rectifiers. Finally, contact preservatives are not applied to any items which would suffer damage to the mechanism or structure, or where malfunction or unsafe operational conditions would result from the application or removal of the preservative.

#### **PRESERVATIVE SELECTION CRITERIA (FIGURE 3-3)**

To choose the type of preservative to be applied to a specific item, a number of factors must be considered. First is the characteristics of the item. The composition, surface finish, complexity of construction, size, and shape must all be evaluated before a preservative is applied. Second is the characteristics of the preservative. Some preservatives are hard-drying and difficult to remove. Some are thin and drain off too rapidly under high temperatures. Some require heating for application, while others can be applied cold. Third is the extent of protection desired. If the item is to be used within a relatively short period of time, only a light, temporary preservative is necessary, but, if the item is to be shipped overseas or must remain in storage for several years, then a more persistent protective coating is demanded. Finally, the requirements of the user must be considered. If it is necessary to spend hours in the field attempting to remove hard-drying and hard-setting preservatives, without adequate cleaning equipment, the outcome of a military engagement may be influenced by such delay. A light preservative in combination with a waterproof or watervaporproof pack may be preferred for certain items, rather than using a hard film preservative such as Code 01 or Code 19.

#### **Item Composition**

The composition of an item determines whether it can be preserved and, if so, what kind of preservative is used. Generally, metal items are preserved with any of the contact preservative compounds. The exceptions are when there is a possibility of chemical reaction between the metal and certain additives in the preservative. For instance, some highly finished copper or brass, or cadmium or zinc plated items, have been stained by preservatives containing sulfur or phosphorous ingredients. Usually, contact preservatives are not applied to nonmetal items made of glass, rubber, leather, cork, paper, fabrics, or plastics, unless they are combined in an assemble with corrodible metals. In this event, the preservative must be applied in such a manner to ensure the coating will not come into contact with the nonmetal portion or component of the item.

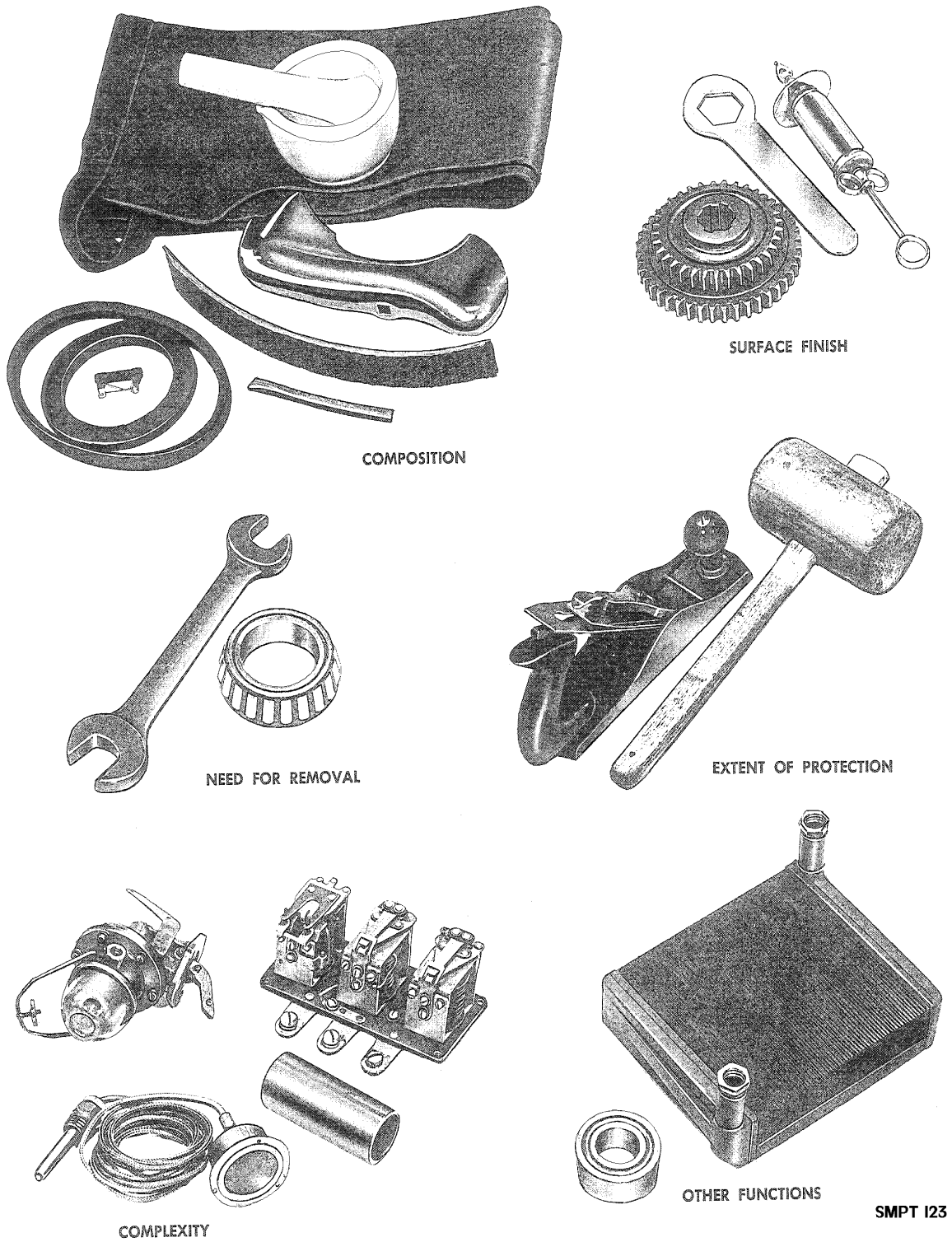


Figure 3-3. Preservative selection criteria.

### **Surface Finish**

If the item is forged, stamped, rough cast, rough ground, or rough machined, and has nonprecision uses, it may be protected by almost any of the petroleum type preservatives. On the other hand, items of precision use with surfaces held to close tolerances require an easily removed preservative, or one which may be left in place without interfering with the functioning of the item. Oil and light grease-type preservatives are preferred for these items. Small fragile items require light oil-type preservatives. Heavier preservatives are unsuitable because they may interfere with future operation or their removal may result in damage to the item.

### **Complexity of Construction**

Items should be cleaned, dried, and preserved in as simple unit state as possible. Disassembled items with close tolerances should not be coated with heavy greases or hard-drying types of preservatives which may interfere with or prevent later reassembly. If disassembly is not practical or the item is highly irregular with blind holes, crevices, and the like, heavy preservatives may be difficult to apply and impossible to remove. Molten grease types, carelessly applied, may result in some portions of complex items receiving no coating. This is true where air may be trapped in small, blind holes or crevices.

### **Extent of Protection Required**

The hazards to which the item may be subjected and the atmospheric conditions and time limits expected for the items must be considered. In most instances where time limits and severity of hazards are unknown, the best possible type of preservative should be used. If these time limits are short and the weather conditions to be encountered are mild, then work and expense may be saved by using light, temporary oil-type preservatives.

### **Ease or Need for Removal**

The user of the item must be kept in mind when choosing a preservative. The time required for removal, equipment available in the field, and whether removal is necessary should all be considered before applying a preservative. Items shipped to a battle area which require time-consuming and elaborate removal equipment, might make a major difference in the outcome of a campaign. If complete or partial removal of the preservative is necessary in order for the item to function properly, a light, readily removable, oil-type preservative should be employed.

### **OTHER FUNCTIONS OF PRESERVATIVES**

In some instances, the characteristics of the item or assembly require that the preservative act also as a lubricating oil or hydraulic fluid. For example, engines require Code 10 and hydraulic systems require Code 15. In such cases, lubricating oil requirements for engines and hydraulic system requirements must be met first; the preservative properties are secondary. Dual purpose preservatives, therefore, should be used only where their dual function is required and where it is known that the degree of preservation they offer will be sufficient. Generally, dual purpose types do not give the extent of protection given by those types which are primarily corrosion preventatives. Whenever severe corrosion conditions will be encountered and the degree of protection offered by the dual material becomes insufficient, a material should be chosen definitely for its preservative qualities. The proper lubricant, hydraulic fluid, and the like should be introduced at the place of use.

### **PACKING APPLIED OVER PRESERVATIVES**

It is necessary to know if and how the items coated with the preservatives are to be packed before a particular type of corrosion preventive is selected. Unless both the preservative and the method of preservation are considered, full protection cannot be expected. For example, if the preservative compound has no impact or abrasion

resistance, then the packing and wrapping must be selected which will protect the preservative. If the characteristics and size of the item are such that physical limitations are encountered when designing the pack it may be necessary to select a preservative with good impact and abrasion resistance to prevent mechanical damage to the preservative coating. If the packed items may be exposed to rain, salt water, high temperatures, and other hazardous situations, it is necessary to correlate the type of preservative with the method preservation in order to offset the shortcomings of one or the other.

#### **AVAILABILITY OF MATERIAL**

If the proper and necessary preservative material is unavailable, then the best possible substitute should be used rather than omit using any preservative at all. However, when proper preservatives do exist, inconvenience or difficulty in obtaining them should not influence the choice. Damage through corrosion will far outweigh any special effort and expense necessary to obtain the most satisfactory material.

#### **DIFFICULTIES OF APPLICATION**

Corrosion preventive materials should not be chosen merely because they are easy to apply. This should be a governing factor only when all other previous requirements have been met. It is possible to find a suitable means of applying all approved materials.

### **METHODS OF APPLYING PRESERVATIVES TO METAL ITEMS**

#### **DIPPING (FIGURE 3-4)**

This is done by the complete submersion of the item in a bath of the preservatives. This procedure is preferred whenever the size, shape, and nature of the item will permit its being used.

#### **Loading Items for Dipping**

Cleaned and dried items must be held on hooks, in baskets, by metal tongs, on wax-coated cord, or by gloved hands, in such a way that a complete coating and thorough drainage of excess material will result. Wire baskets, used for many small items in large quantity, should be loaded only one item deep to permit the formation of a continuous, even coating around each item. Groups of fine, small items can be tied together with moisture free, wax-coated cord.

#### **Dipping Items Into Preservatives**

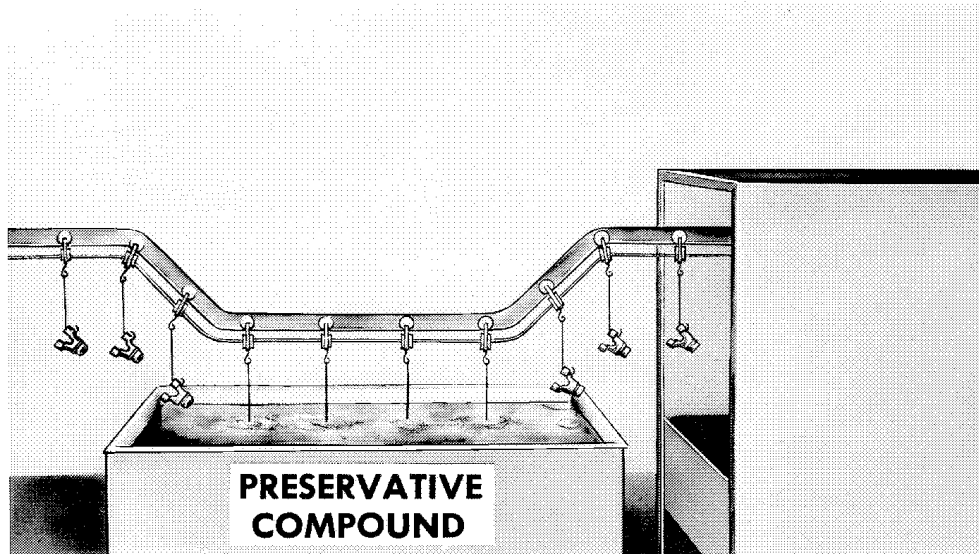
When items are dipped into the tank by hand or by conveyor, care must be taken that air bubbles are not caught on any of the surfaces of the item. Completely immerse items below the preservative level. Move them slowly beneath the surface to eliminate any air which may have been trapped inside. Keep them at the proper angle for coverage and draining. Trials should be conducted to determine the best temperature and length of time necessary for a suitable coating.

#### **Removing Items From Tank**

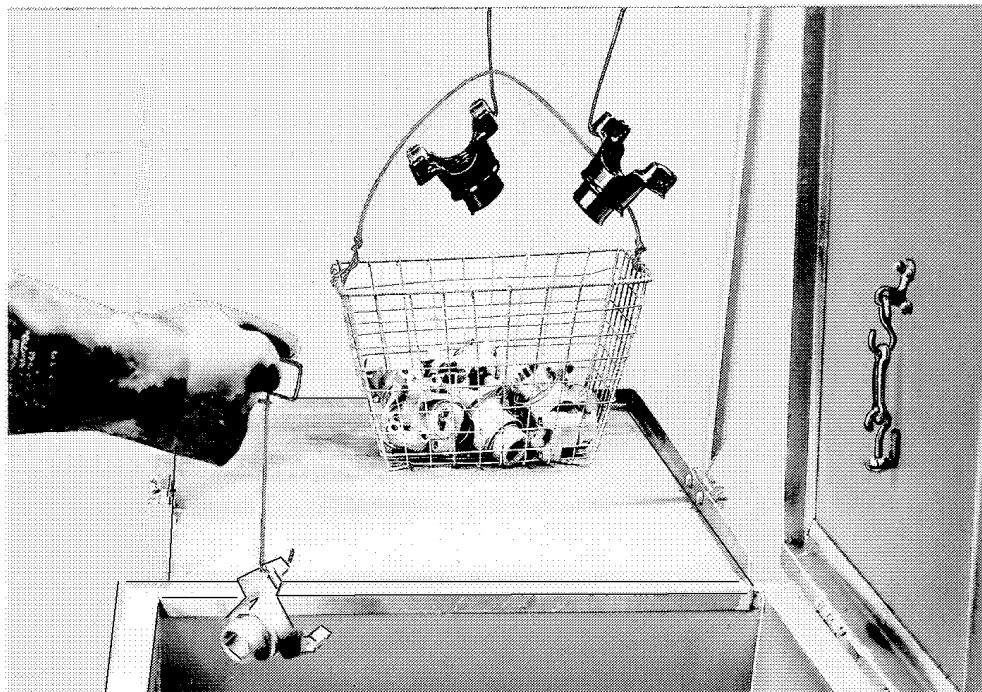
When removing items from the tank, allow excess compound to drain from all surfaces so that pools of material do not collect in corners and pockets. Items individually handled should be hung on hoods, rings, rods, or racks until preservative has set or dried. Items dipped in baskets are left in the baskets until the preservative film sets. Just before wrapping, any marks left by hook or hanger should be touched up by applying more preservative with a brush. Bare spots can be avoided somewhat by predipping hooks or baskets before dipping the item. After the preservative has dried or set, the item should be placed on a precut piece of



greaseproof barrier material. This should be the initial wrap for the packing operation. If items cannot be wrapped or packed immediately, they should be placed in baskets or trays and protected from dust and dirt with a suitable cover. Cleaned items left overnight should be carefully inspected for signs of corrosion before continuing with the application of preservatives.



**CONVEYORIZED DIPPING**



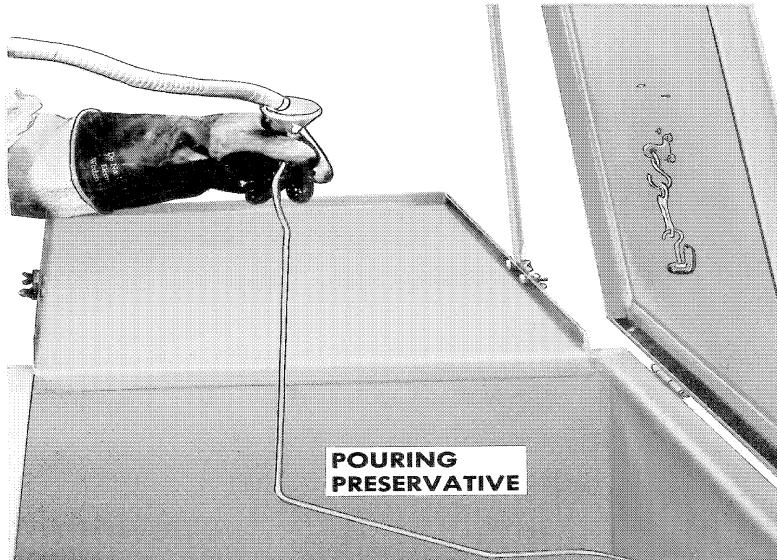
**HAND DIPPING**

**SMPT 718A**

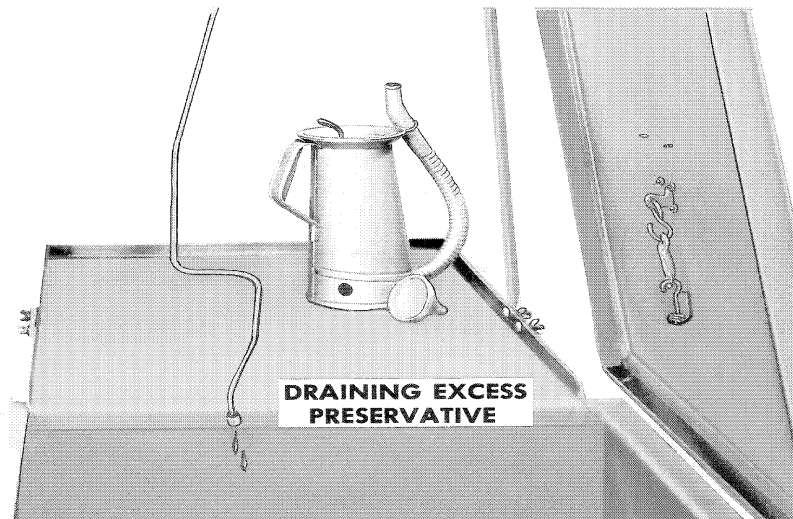
Figure 3-4. Application of preservative by dipping.

**FLOW-COATING (FIGURE 3-5)**

This procedure is accomplished by coating the surfaces of the item by pouring the preservatives on the item or portions of the item. This procedure is generally used for items too large to dip or on limited areas of items of a complex nature which cannot be completely covered without injury to some of the materials of which they are made.



**NOTE. POUR PRESERVATIVE INTO TUBE ALLOWING IT TO FLOW THROUGH TUBE AND COVER INTERIOR SURFACES.**



**NOTE. DRAIN EXCESS PRESERVATIVE FROM TUBE BY HOLDING TUBE OVER PRESERVATIVE TANK ALLOWING PRESERVATIVE TO DRAIN INTO TANK.**

**SMPT 719A**

Figure 3-5. Application of preservative by flow-coating.

### **Positioning Items for Flow-Coating**

Items are to be placed in such a manner, before coating, as to prevent pocketing of the preservative in blind holes or cavities. Tilt them to an angle that will permit free flow of the preservative and drainage by gravity.

### **Pouring Preservative on Items**

Use oil type preservatives and pour slowly over surfaces to be coated. Flow on sufficient preservative to completely cover the desired areas and permit the excess to drain off by gravity. Avoid any unnecessary handling until after preservative has set. Do not handle items with bare hands or dirty gloves while applying the preservative.

### **SLUSHING (FIGURE 3-6)**

This procedure is performed by pouring the preservative into the item to be preserved and rotating, agitating, or slanting the item to insure complete coverage of all internal surfaces. The item is then drained of excess preservative. This procedure is most often used to coat inside surfaces of chambers, tubing, oil coolers, metal tanks, and their cavities not accessible by other procedures of application. For this reason, oils and soft thin film preservatives should be used. If properly selected, the preservatives do not normally require removal from the item before using. If removal should be required, they are easily flushed out.

### **Inserting the Preservative**

Pour a sufficient quantity of the preservative into the interior of the item to cover all surfaces when the item is rotated. If available, a small pump with a flexible outlet hose may be used to pump the preservative inside the item.

### **Slushing the Item**

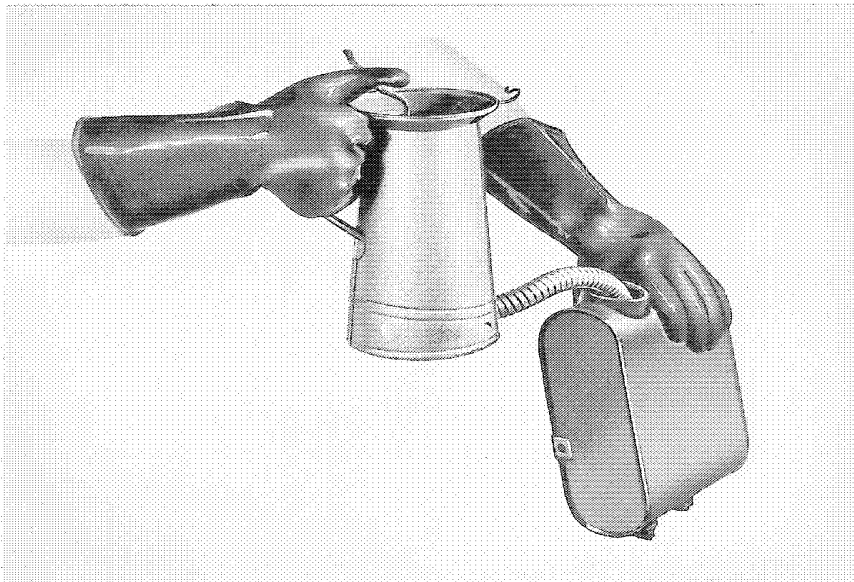
Shake, rotate, agitate, or slant the item in all directions to insure complete coverage of all interior surfaces. Never mix two different compounds for slushing, as this may cause a lumping of the ingredients.

### **Draining Off the Preservative**

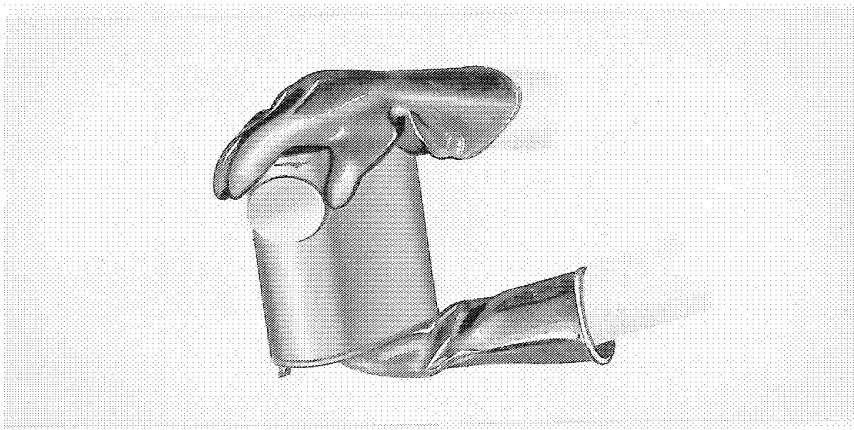
Drain off excess compound by rotating the item, if necessary, to prevent the collection of preservative in blind holes and crevices. It is always desirable that care be taken to prevent spilling the preservative thus avoiding safety or fire hazard. Equipment and methods of operation should insure economy through the reuse of slushing oils.

### **Closing the Item**

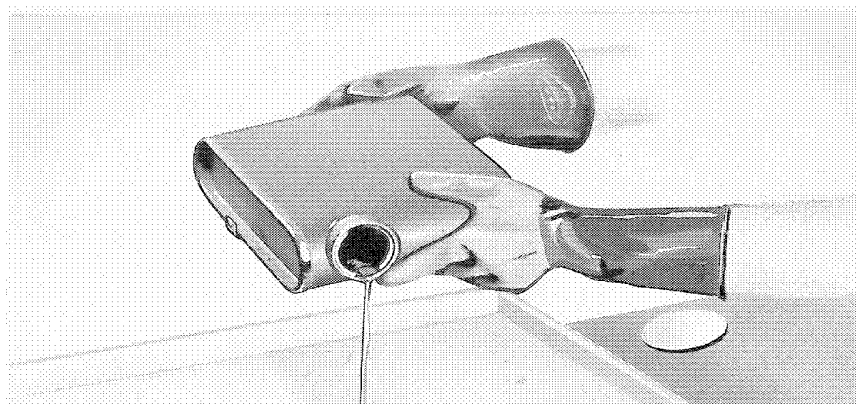
After draining, close all openings of the item to keep out dirt and other foreign matter. Plastic plugs are most satisfactory for sealing openings. Male and female types are available for various kinds of openings. Never use wooden plugs as closures, since splinters from the wood are difficult to remove and may clog fuel or oil lines and cause serious damage.



**A -INSERTING PRESERVATIVE**



**B -ROTATING OR SLUSHING ITEM**



**C -DRAINING EXCESS PRESERVATIVE REPLACE CAP AFTER DRAINING  
SMPT 717**

Figure 3-6. Application of preservative by slushing.

**Brushing (figure 3-7)**

Brushing is performed by using a brush to coat the item or limited surfaces of the item with a preservative. This procedure is used when no other procedure is available or suitable. Brushing is used extensively where only one part of an assembly requires the coating, such as against hinge fittings, inside surfaces of bushings, or bare metal surfaces next to fabric or rubber materials that must not be coated with preservative compounds.

**Applying the Coating**

Make sure the item is clean and dry before brushing. Use only clean brushes for applying the coating. Apply an even and continuous coating. Do not handle items with bare hands or dirty gloves.

**Checking the Coating**

Inspect item to be sure that areas not readily visible are not left uncoated. It may be necessary for more than one brush application to provide an unbroken, continuous coating.

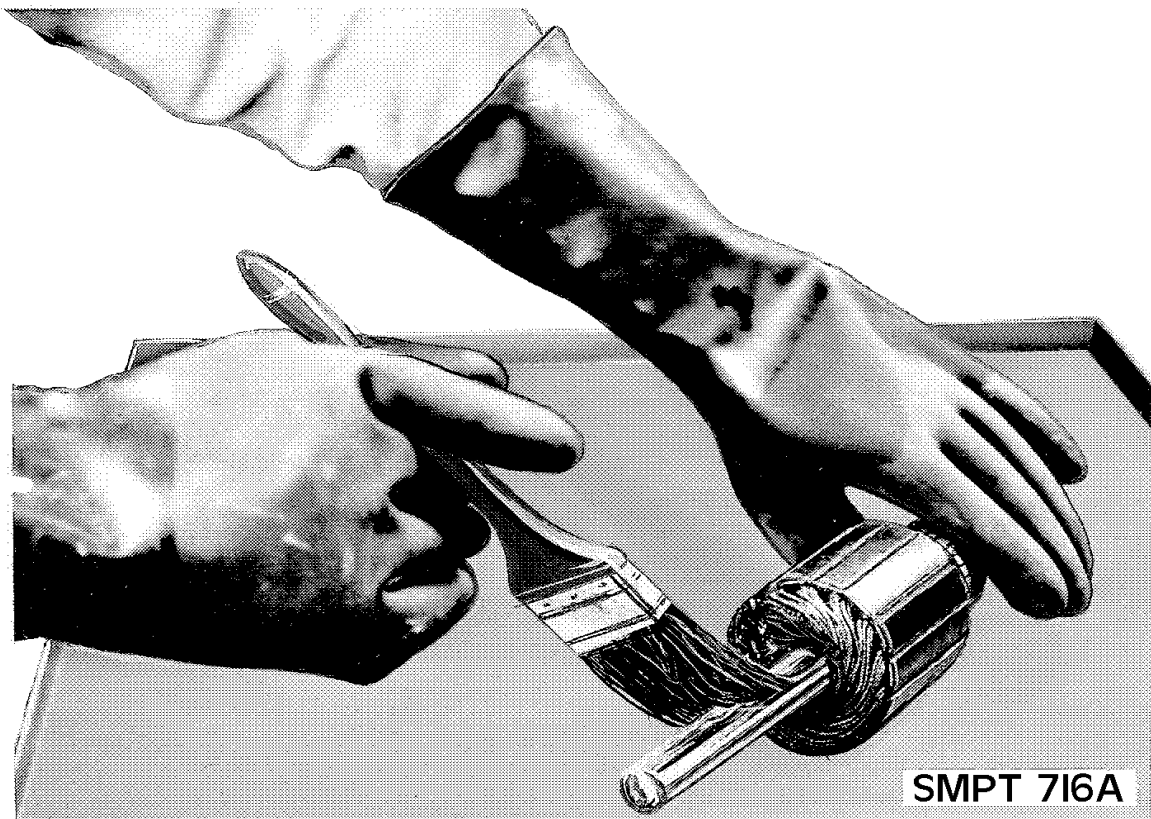


Figure 3-7. Application of preservative by brushing.

**FILLING OR FLUSHING (FIGURE 3-8)**

This procedure is accomplished by completely filling the items with preservative until all interior surfaces are satisfactorily coated.

**Filling Item**

Insure coverage of all interior surfaces by completely filling the item with preservative. Care should be taken so that entrapped air will not prevent complete coverage of the interior surface. Oils or easily removed thin film preservatives are to be used for filling.

**Draining Preservative**

Drain off the preservative oil and close up the openings. If oil is not to be drained, space must be allowed for thermal expansion. Close all openings and make sure they are sealed to prevent any leakage. Wipe up any spilled oil to avoid possible fire hazards.

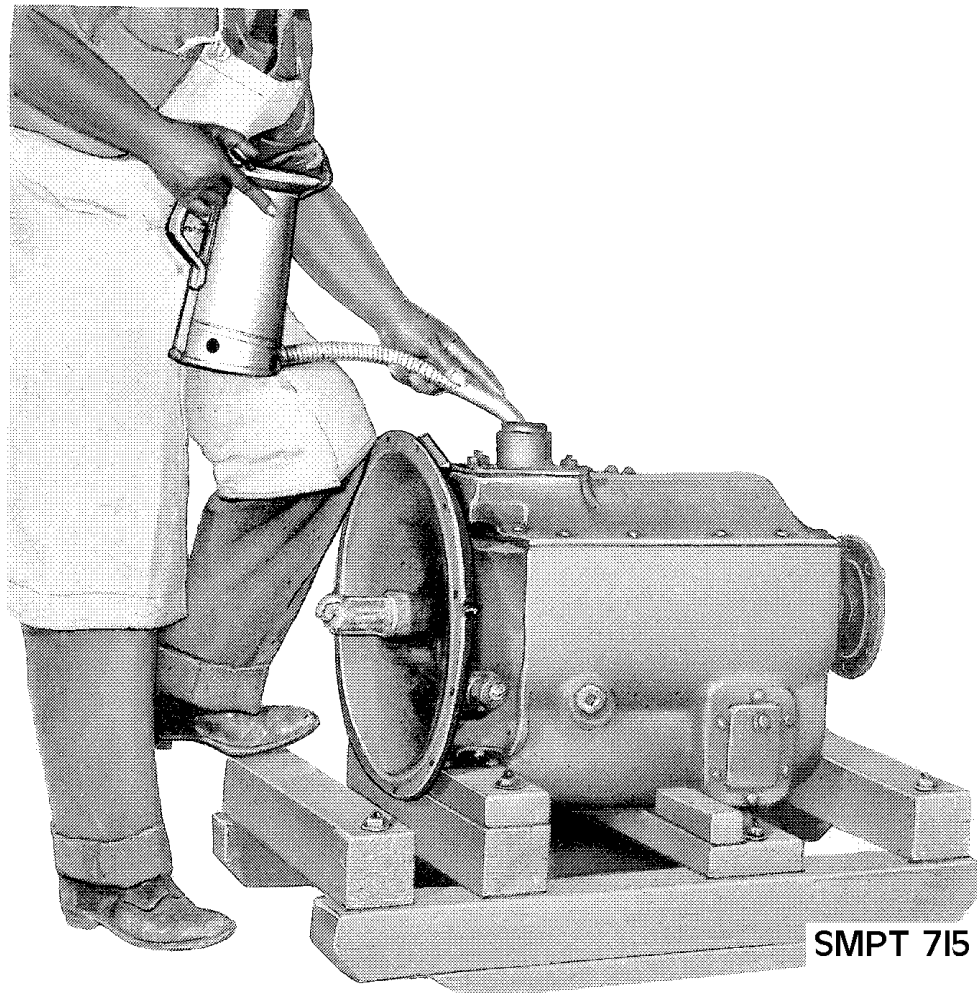


Figure 3-8. Application of preservative by filling or flushing.

### **Fogging (figure 3-9)**

This procedure is accomplished by coating interior surfaces of items, such as tanks and chambers, with preservatives injected as a cloud or mist from an air atomizing gun until the inclosed atmosphere is saturated.

### **Preparing Fogging Gun**

Fill the gun container with a light preservative oil and attach the flow of preservative fluid by turning the base of the handle grip. Press thumb valve or finger trigger, allowing fluid to run. Adjust the flow of preservative fluid by turning the nozzle to the left to increase and to the right to decrease the flow of preservative.

Tighten the locknut on the nozzle after the flow has been adjusted and keep the air vent located on the left side of the container open. Be sure the air is dry.

### **Fogging Interior of the Item**

Insert the nozzle through the opening of the item and fog until atomized mist begins to come out around the nozzle. If more than one opening is available on the item, repeat the process at these openings to insure complete fogging of the interior. For extra large tanks or chambers, extensions are available to attach to the nozzle to reach into otherwise inaccessible corners and pockets.

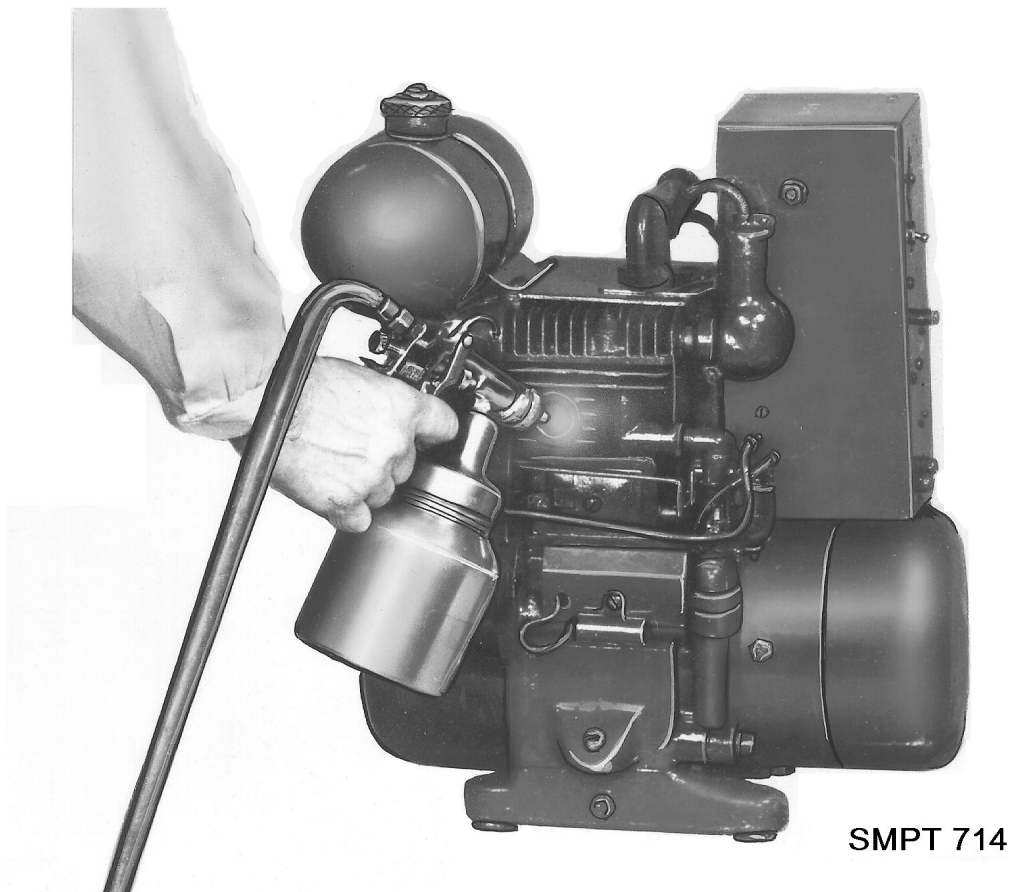


Figure 3-9. Application of preservative by fogging.

### **Spraying (figure 3-10)**

This application is done by coating surfaces (interior or exterior, as applicable) of the items with preservative applied as a spray. Spraying is especially useful for preservation of large and heavy items that cannot be dipped or assemblies requiring a preservative only on certain portions of their surfaces. Thin film or oil-type preservatives usually are used in spraying.

### **Preparing Item for Spraying**

Mask all surfaces that are not to be coated, including such parts as fiber looms, electrical wiring, receptacles, rubber and fabric components. Suitable materials for masking are kraft paper and pressure-sensitive tape. Code 01 preservatives and oils will not damage paints or primers on metal surfaces and are not usually marked as such.

### **Spraying the Item**

Spraying must be done in a well ventilated area. Wear protective clothing, masks, gloves, etc. Fill spray gun with the selected oil or thin film preservative. If contact preservative is to be used, it may be necessary to dilute it with petroleum solvent until it will spray effectively. Adjust spray gun and apply an even, continuous, and unbroken film around each item surface. Use normal spray painting technique for applying the coating. Allow preservative coating to thoroughly dry or set before further handling.



Figure 3-10. Application of preservative by spraying.



## **VOLATILE CORROSION INHIBITORS (VCI)**

### **CONCEPT OF VCI**

#### **Development of VCI**

Chemists have known for some time that chemicals such as camphor and moth balls give off vapors. Some of these chemicals are known to inhibit corrosion and neutralize the effects of moisture laden air within a package. These chemicals are called Volatile Corrosion Inhibitors or VCI. They are available for packaging applications in several forms.

#### **Description of VCI**

VCI compounds are white crystalline powders similar in appearance to a fine talc. While the crystals are used in some instances, for preserving interiors of engines and other applications, the most widely used forms of the material are coated and impregnated papers. As a coating, the chemical is mixed with casein which acts as a bond or adhesive to stick the crystals to the paper surface. In impregnated papers, the process consists of soaking the paper in a solution containing a concentration of the inhibitor. The solution evaporates and leaves the crystals impregnated in the fibers and the surface of the paper.

#### **How VCI Prevents Corrosion (figure 3-11)**

When used as a wrap around an item, the crystals in the paper slowly vaporize. This vapor moves from the paper and fills the entire volume within the pack. When the vapor concentration reaches a certain level, an equilibrium is established, provided the pack is airtight, so that crystals will condense on the surface of the item as rapidly as they vaporize from the paper. The vapor forms on all surfaces of the item, including all cracks and crevices, and forms an invisible, adhering, protective film which resists the corrosive action of water vapor. Corrosion is prevented as long as the chemical remains active and this will depend on the effectiveness of the pack in keeping the vapors concentrated inside.

### **USE AND LIMITATIONS OF VCI**

#### **Use**

VCI offers effective protection to iron and steel. This protection is equal to or better than that provided by the more commonly used contact preservative compounds. VCI provides good protection to areas of an item where it would be impossible or impractical to apply a grease or oil type preservative. Such areas as small holes, blind holes, cups, cavities, or threads are also protected by the vapors of VCI. VCI offers a choice in the degree of protection given to military supplies and equipment. This may vary from temporary protection given to items during processing operations, through protection for shipment and immediate use, to complete protection for long-term storage or overseas shipment. VCI provides for savings through the simplicity and ease of its application. It reduces labor and time in the complicated preserving and cleaning operations normally associated with the use of grease and oil type preservatives. VCI offers a strategic advantage by allowing many essential stored items to be ready for immediate use. Weapons need little or no disassembly or cleaning and reassembly prior to use. Production equipment and machine tools may be stored in convenient areas where little time would be required to put them into use.

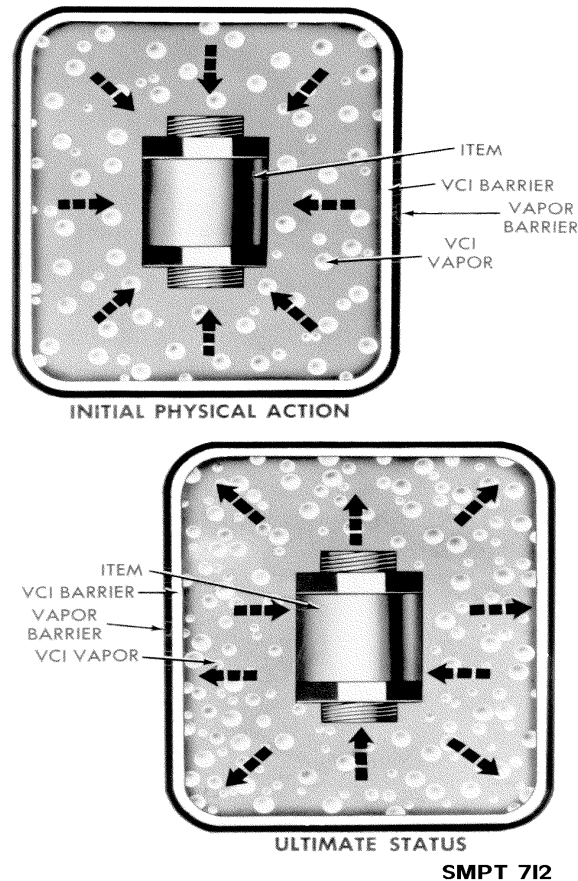


Figure 3-11. Action of VCI.

### Limitations

VCI materials will not protect all metals from corrosion. In fact, they appear to increase the rate of corrosion in certain metals. VCI materials must not be used to protect any assemblies containing optical systems or precision moving parts which have been coated with a preservative or lubricant, unless otherwise specified. Items protected with bonded films, such as molybdenum (a dry lubricant), are not included in this category. VCI materials are affected by heat and light. They lose their effectiveness as the temperature increases and they decompose if exposed to direct sunlight for extended periods. They also decompose in the presence of acids or strong alkalis. Precautions must be taken when VCI is used with items, assemblies and subassemblies containing zinc plate, cadmium, zinc-base alloys, magnesium-base alloys, lead-base alloys, and alloys of other metals including solders and brazing alloys. If such items contain more than 30 percent of zinc or 9 percent of lead, they must not be preserved with VCI. In all cases, direct contact of VCI with nonferrous metals except aluminum and aluminum-base alloys should be avoided unless specific permission had been granted. Care should also be taken with assemblies containing plastics, painted parts, or components of natural or synthetic rubber. Assemblies containing parts made of these materials should not be packed with VCI until proof is established that they have passed the compatibility test required by MIL-I-8574.

**FORMS OF VCI**

These materials are covered in several specifications and are available in the forms of treated kraft paper, barriers, paperboard wrapping, cushioning, oils, crystalline powder, and others.

**Packaging Materials (Wraps, Barriers and Bags)*****MIL-PRF-3420, Packaging Materials, Volatile Corrosion Inhibitor Treated, Opaque***

This specification establishes the requirements for materials (kraft paper, barriers, or paperboard wrapping and cushioning) which are treated with a corrosion inhibitor. The treated materials come in two forms, three classes, and seven styles. Form "a" and Form "b" represent a carrier's material which has been coated or impregnated respectively with corrosion inhibitors. The three classes relate to the strength of the material and the seven styles to the composition of the material. Styles A and B consist of kraft paper; styles C and G are constructed using waterproof-greaseproof barriers; style H may be either single ply or laminated kraft with a cohesive coating; and styles J and K are made from paperboard conforming to PPP-P-291, type III, style 1. Styles J and K are alike except that style J has a cohesive coating on one side. Refer to table 3-3 for information on the use of these VCI materials. Table 3-3 is located at the end of this chapter.

***MIL-PRF-22019, Barrier Materials, Transparent, Flexible, Sealable, Volatile Corrosion Inhibitor Treated***

This VCI material is available in two types. Type I material is intended for use where a heat-sealable, VCI treated barrier material is required. Type II material is for use where either production processing or custom hand processing requires a cold-sealable, VCI treated barrier material. Refer to table 3-3 for information on the intended use and other characteristics of this material.

***MIL-B-22020, Bags, Transparent, Flexible, Sealable, Volatile Corrosion Inhibitor Treated***

The bags are intended for use in the packaging of items requiring protection by volatile corrosion inhibitors. The bags come in two classes. Class 1 bags are intended for use where heat-sealable, transparent, VCI-treated bags are required. Class 1 bags are made from barrier material qualified under Type I material of MIL-PRF-22019. Class 2 bags are intended for use where pressure cold-sealable, transparent, VCI-treated bags are required and are fabricated from Type II material of MIL-PRF-22019. These bags are available in eleven sizes from as small as 2-1/2 X 3 inches to as large as 10 x 13 inches (length x width).

**Powders and Oils*****MIL-I-22110, Inhibitors, Corrosion, Volatile, Crystalline Powder***

The VCI crystals provide corrosion protection for most metals under specific conditions. Table 3-3 at the end of this chapter provides information on the use and limitations of this crystalline powder form.

***MIL-P-46002, Preservative Oil, Contact And Volatile Corrosion Inhibited***

This VCI lubricating oil is intended for use in the preservation of enclosed systems where the volatile components will provide protection above the preservative. This material is not to be used in the preservation of any engine fuel tank or fuel storage tank. Refer to table 3-3 for information on how to apply this VCI. Table 3-3 is located at the end of this chapter.

### **Other Forms of VCI**

Although specifications have not yet been issued covering items, there are other forms of VCI available to industry which may be used if permitted by the military activity concerned. Volatile corrosion inhibitors are now available in tablet form. The tablets can be used in automated packaging of small items such as bolts, pins, dowels, screws, drills, taps and dies, etc., where a hopper feed machine can form a bag, drop in the item and a pellet in the bag, and seal the bag in a single operation. Also available are VCI crystals compounded with a noncaking agent and supplied in 2-ounce cotton bags; VCI-treated papers fabricated into bore tubes for small arms preservation; envelopes of VCI-treated kraft; spirally-wound fiber cans (MIL-C-3955) and fiberboard boxes coated with VCI; and aerosol containers with VCI dissolved in alcohol.

### **HANDLING AND APPLICATION OF VCI MATERIALS**

Application and use criteria of volatile corrosion inhibitors will be in accordance with the procedures given in MIL-I-8574.

### **Storage Requirements**

#### ***Sheets and Rolls***

VCI materials must be stored in a cool, dry location. Original packages must not be opened until shortly (not more than 24 hours) before use. During use operations, the material must be protected from excessive heat, direct sunlight, moisture, strong drafts, and excessive dust. At the close of each working day, VCI-treated materials should be replaced in their original containers or completely wrapped or covered with aluminum foil, QQ-A-1876, greaseproof barrier material MIL-B-121, (Grade C), or water-vaporproof barrier material MIL-PRF-131. Should any material be subjected to damaging or adverse conditions, its effectiveness can be determined by the appropriate test found in the applicable material specification.

#### ***Lined Barrier Bags***

Barrier bags lined with VCI-treated materials are self-protected, except for the unsealed ends which can be folded over to retain the vapors. Punctured or otherwise damaged bags should be discarded. When feasible, the lines should be stored separately from the bags until ready for use.

#### ***Bore Tubes***

VCI-treated bore tubes must be kept in a closed, barrier-type container. The container should be opened only for withdrawal of tubes for immediate use.

### **Safety Precautions**

VCI materials may include ingredients irritating to the eyes and skin of some people. Do not rub or wipe eyes while handling VCI-treated materials. After handling, wash hands thoroughly with soap and water.

### **HOW TO APPLY VCI**

#### **Cleaning and Drying**

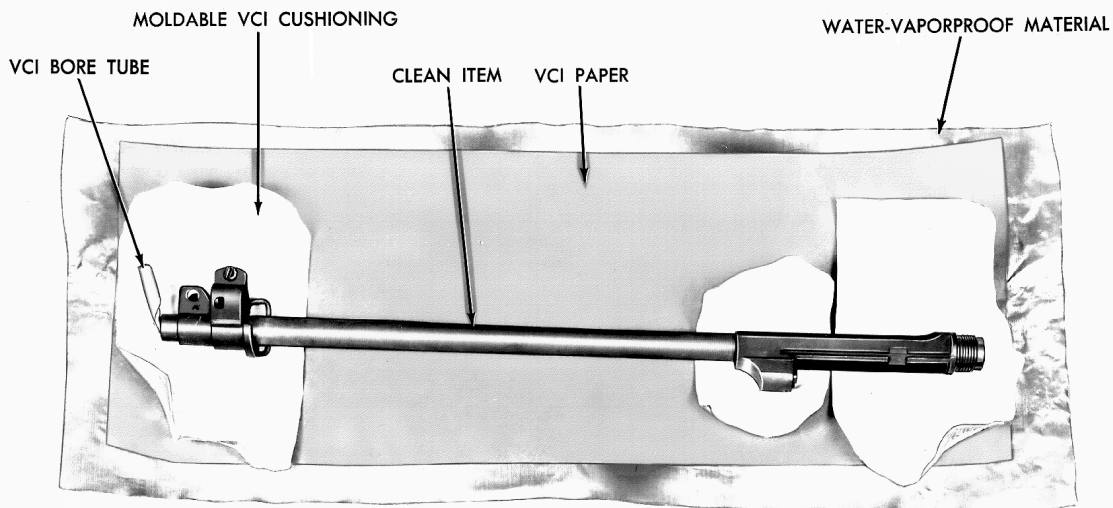
Metal items to be protected with VCI must be cleaned and dried in accordance with requirements of MIL-STD-2073-1C. If a vapor degreaser is used, operation and control instructions furnished by the manufacture of the degreaser must be strictly followed to prevent the possibility of acid residues being left on the item which would render the VCI ineffective and promote corrosion.

### Use of VCI With Operational Lubricants

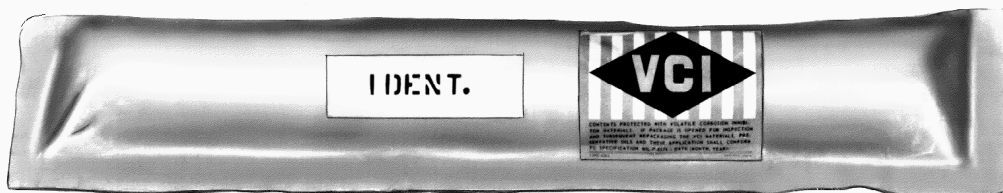
When VCI materials are used on assemblies containing operational lubricants, it is necessary to establish the fact that the specific VCI and the lubricants being used are compatible. Prior to the application of the VCI to the assemblies, the excess oil must be drained off. This is not required in the case of items protected with bonded films.

### Application of packaging materials (wraps, barriers, and bags)

VCI-treated materials must completely enclose the item, or the item may be wrapped with strips of material without any other material between the item and the wrapping. Complete wrapping, where feasible, is preferred. The treated face of the material must be placed toward the item being wrapped. The wraps should be applied in such a manner that any air entering the pack will pass through or over the surface of the VCI before reaching the item. The VCI-treated materials should not be more than 12 inches away from any surfaces to be protected (see figure 3-12). Whenever possible, the opening of the VCI-treated, transparent bags, MIL-B-22020, should be heat sealed.



**PRESERVATIVE, CUSHIONING AND VCI WRAPPING AS REQUIRED**



**WATER-VAPORPROOF BAG, SEALED**

SMPT 132

Figure 3-12. Application of packaging with VCI-treated materials.

### **Application of Crystalline Powder, MIL-I-22110.**

These materials are sprayed, atomized, or dusted over the entire surface of the item. If feasible, the VCI should also be sprayed, dusted, or atomized into the container immediately before sealing.

### **Material in tiers or layers**

When items are packaged in tiers or layers, the VCI should be placed between the tiers. Where VCI-treated materials are used in a box containing separators, all faces of the separators must be lined with VCI-treated material, in addition to lining the inside of the box.

### **Amount of VCI Required**

When used as a complete overwrap, the amount of VCI-treated barrier, MIL-PRF-3420, and barrier, MIL-PRF-22019, should at least equal 3/8 of the surface area of the container. When not used as an overwrap, the amount of VCI-treated material must be at least equal to the surface area of the container. VCI crystalline, MIL-I-22110, should equal 1 gram per cubic foot of volume of the enclosing container.

### **Packaging Components With Closed Spaces and Blind End Cavities**

Assemblies with enclosed portions, such as gear boxes, must be protected with strips of VCI material placed inside and the opening sealed. Open end voids, where the opening is small in relation to the void, should be treated likewise. Open end voids of a depth greater than 6 inches, such as gun barrels or bolt holes in castings, should have an inserted strip or tube of VCI-treated material slightly longer than the depth involved. The protruding portion of the bore tube or strip should be bent over and held in place with tape or other material to aid in its removal whenever an enclosed area of an assembly is not used prior to the application of the proper lubricant.

### **Use of Cushioning and Dunnage**

Projections or sharp corners and edges of the item shall be cushioned with moldable VCI-treated materials to prevent damage either to the item or the barrier. Where dunnage is required next to, or around the item, a facing of VCI-treated material must be placed between the item and the dunnage. When the dunnage or other nonmetallic materials used in the package are hygroscopic or may give off corrosive vapors, the item and the VCI must be isolated by the use of aluminum foil or other suitable barrier material.

### **Use of Greaseproof Barriers**

When VCI-treated items, coated with operational oils, are packed with outer packing materials that are not greaseproof, a greaseproof barrier must be used to separate the packed items from the outer materials. Styles C and G of MIL-PRF-3420 VCI-treated barrier materials may be used for this purpose since both styles incorporate a greaseproof barrier in their composition.

### **Marking of VCI Packs**

Unit and intermediate packs shall be marked for identification in accordance with MIL-STD-129. An example of these unit pack markings are shown in figure 4-46 at the end of chapter 4.

## Chapter 4

### Methods of Preservation (Unit Protection)

#### GENERAL PRINCIPLES AND REQUIREMENTS

Preservation is the application or use of adequate protective measures to prevent deterioration resulting from exposure to atmospheric conditions during shipment and storage. Such protective measures, applied to military supplies and equipment, include, as applicable, the use of appropriate -

- X Cleaning processes.
- X Drying procedures.
- X Preservative application.
- X Wraps, barrier materials, and containers when necessary.

Methods of preservation (unit protection) are therefore those protective measures which have been developed, grouped together, tested, and are presently approved for the prevention of deterioration of military supplies and equipment. The methods of preservation are established by MIL-STD-2073-1C, and consist of the five following basic methods:

- X Method 10 - Physical protection.
- X Method 20 - Preservative coating only (with greaseproof wrap, as required).
- X Method 30 - Waterproof or waterproof-greaseproof protection (with preservative, as required).
- X Method 40 - Watervaporproof protection (with preservative, as required).
- X Method 50 - Watervaporproof protection with desiccant.

This chapter contains information that will enable you to construct unit packs using standard methods of preservation. However, there are several areas that you need to become familiar with before actually getting into the steps and techniques of unit pack construction. These areas include sources of packaging requirements; information on packaging materials such as adhesives, bags, sacks, tubing, envelopes, barriers, wraps, cushioning, tapes, and labels; information on the use of desiccants, desiccant formulas, humidity indicators, inspection windows; and the use of heat sealing machines. Finally, information is provided on the construction of all methods of preservation. The chapter ends with information concerning quality assurance provisions which will help you to determine if your unit packs will pass the tests and inspections required by MIL-STD-2073-1C.

The basic concept of military preservation hinges upon the ability of a particular method to provide the following protective measures, as needed:

- X Mechanical and physical protection.
- X Greaseproof protection.
- X Waterproof protection.
- X Watervaporproof protection.

Figure 4-1 depicts the five basic methods of military preservation which are applied to military items or materiel.

## SOURCES OF PACKAGING REQUIREMENTS

MIL-STD-2073-1C provides the standards for military packaging when items are expected to enter the military packaging distribution system. It, also, provides a system for codification of packaging materials and processes used in military packaging. Packaging codes are particularly useful for procurement and contract administration purposes.

MIL-STD-2073-1C recommends the use of commercial packaging to the maximum extent possible. It provides a “decision chart” and lists several non-Government specifications, including ASTMs, to advance the DOD’s policy for the use of commercial packaging.

Packaging simplification has been achieved in MIL-STD-2073-1C because it has incorporated the following documents and eliminated the need for them as separate documents:

- X MIL-P-116
- X MIL-STD-2073-2
- X MIL-STD-1510

Some military/Federal specifications and standards were replaced with non-Government standards. Over 400 seldom or unused packaging codes were eliminated.

MIL-STD-2073-1C provides criteria for control and development of all military packaging requirements based upon the item's physical-chemical characteristics, fragility, dimensions and weight. It establishes and defines codes used in describing materials and techniques for these requirements.

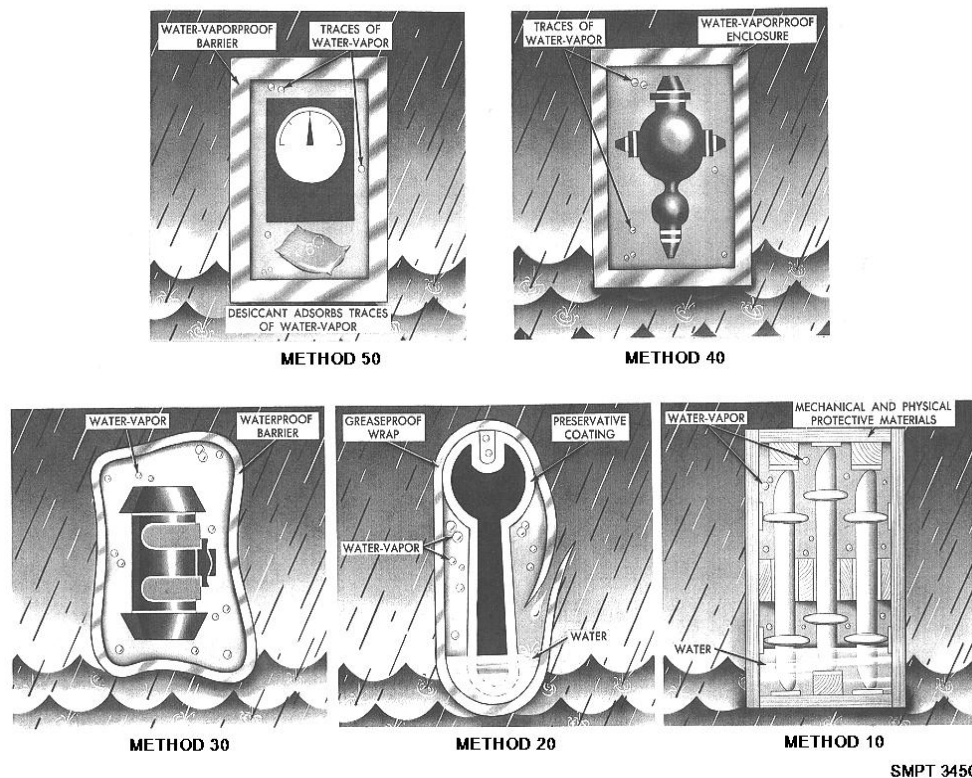


Figure 4-1. Concepts of the basic methods of military preservation.



**TYPES OF ITEMS OR CLASSIFICATION IN ACCORDANCE WITH MIL-STD-2073-1C**

All material to be packaged can be classified into one of three groups of items:

- X common,
- X selective, and
- X special.

**Common Items**

Items for which complete packaging details can be specified by predetermined coding are classified as common items. First, a four digit category code must be determined by chemical, physical, and other characteristics of the item using tables from MIL-STD-2073-1C. These tables are also used to reveal the packaging information such as cleaning procedure, wraps, cushioning thickness and the like. Table 4-1, which is identical to figure A.1 in MIL-STD-2073-1C, shows a packaging code of 42100EALCCED. In this example, the table shows that digit position 10 (which corresponds to a "C" in the coded packaging data) indicates a cushioning thickness of 3/4 inch.

**Selective Items**

Items are called selective if they cannot appropriately use predetermined packaging data and yet do not require a drawing, sketch, illustration or narrative type instruction to specify packaging details. However these packaging details can be found in tables A.I, A.II, A.III, and A.IV of MIL-STD-2073-1C.

**Special Items**

Items assigned to this special group have peculiar characteristics such as mass (weight), configuration, complexity, fragility, or other considerations that preclude their being grouped as common or selective. An item is considered special if drawings, sketches, illustrations, or narrative type instructions or a reusable container are required to specify packaging details.

**Table 4-1. Format for interpretation of packaging code sequence**

DIGIT POSITION	1	2	3	4	5	6	7	8	9	10	11	12
CORRESPONDING TABLES IN APPENDIX J	J. I & J. Ia		J. II	J. III	J. IV	J. V	J. VI	J. VI	J. VI	J. VI	J. VII	
SEE TABLES IN APPENDIX J	METHODS OF PRESERVATION		CLEANING PROCEDURES	PRESERVATIVE MATERIAL	WRAPPING MATERIAL	CUSHIONING AND DUNNAGE	CUSHIONING THICKNESS	CUSHIONING THICKNESS	CUSHIONING THICKNESS	CUSHIONING THICKNESS	UNIT CONTAINER	
EXAMPLE: METHOD 42	42		1	ØØ	EA	LC	C	C	C	C	ED	
ANY APPLICABLE PROCESS IN ACCORDANCE WITH 5.2.1	NO REQUIREMENT		NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	NO REQUIREMENT	
MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER		MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	MIL-P-17667, CHEMICALLY NEUTRAL WRAPPING PAPER	ASTM-D5118, TYPE CF; CLASS WEATHER-RESISTANT FIBERBOARD BOX	
PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING		PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	PPP-C-795, CLASS 1, CELLULAR PLASTIC FILM CUSHIONING	3/4 INCH CUSHIONING	

SMPT 916D

### Other Packaging Information

In addition, MIL-STD-2073-1C provides formulas for packaging material weight and size calculations; exterior shipping containers - weight of contents (lbs., max.) and levels of protection; quantity per unit pack determination formula; guidance for establishing number of unit packs per intermediate container; fiberboard container size list (including NSNs); and other packaging information.

## PACKAGING MATERIALS

Among the most commonly used packaging materials are adhesives, bags, sacks, and envelopes, barrier and wrapping materials (opaque and transparent), cushioning materials, desiccant, humidity indicators, inspection windows, labels, and tapes. A general knowledge of the composition, characteristics, intended uses, and methods of application of these materials is very important from both an engineering standpoint and the performance standards required of military packs. Unauthorized use of these materials should be discouraged at all times. Their procurement and distribution should be based on requirements contained in Government and/or DoD adopted non-government specifications and on the needs emanating from official mission assignments. A brief discussion of the materials listed above is contained in the following paragraphs and tables. Unit containers such as fiberboard, setup, folding and metal-stayed boxes and cartons, cans, drums, etc., are described in chapters 6 and 7.

### ADHESIVES

Adhesives include such materials as cement, glue, mucilage, paste, thermoplastic adhesives, etc. These are generally fluid or semifluid materials used to bond two surfaces together by forming a solid or semisolid interface between the two contacting surfaces. The term *adhesive* may be modified by adjectives which describe its physical state, e.g., *liquid adhesive*, *tape adhesives*; its chemical type, e.g., *silicate adhesive*, *resin adhesive*; the materials bonded together, e.g., *paper adhesive*, *can-label adhesive*; or the condition of use, e.g., *hot-setting adhesive*, *thermoplastic adhesive*. Adhesives may be procured through the General Services Administration. Adhesives must be stored indoors at temperatures ranging from 45°F. to 75°F. Exposure to freezing temperatures reduces their adhesive properties. Length of storage should not exceed the manufacturer's recommendations and/or length of storage criteria provided in the material specification. Information concerning specification symbols, nomenclature, uses, and methods of application of the most commonly used adhesives is provided in table 4-2.

### BAGS, SACKS, AND ENVELOPES

The containers are especially adaptable for the packing of small, lightweight items. The fact that they can be manufactured from transparent stock; can be made waterproof, watervaporproof, and greaseproof; can be lined or treated with corrosion inhibiting materials; and can be provided with cushioning effects broadens their application to a large number of items of various types and characteristics. Bags, sacks, and envelopes are generally procured prefabricated and can be stored in a minimum of space. For specific sizes and properties required, the pertinent specifications should be consulted. Basic information concerning the most commonly used bags, sacks, and envelopes can be found in table 4-3.

### Bags, Sleeves and Tubing (MIL-B-117)

Bags used for interior packs, when required by a method of preservation, must be made in accordance with MIL-B-117. Types, classes, and styles of MIL-B-117 bags are shown in table 4-4 and also in the left three columns of table 4-5.

Table 4-2. Adhesives Used in Military Packaging.

Specification	Title	Uses	Method
MMM-A-250	Adhesives, water-resistant (for closure of fiberboard boxes).	For closure of fiberboard boxes, cartons, and cases. Type I - For application by automatic box closing equipment. Type II - For hand application by brushing. Type III - For hand application, form pressurized container.	Type I - Machine. Type II - Brush.  Type III - Aerosol.
MMM-A-260	Adhesive, water-resistant (for sealing waterproofed paper).	For application to seams in the manufacture and closure of waterproof bags, wraps and case liners. Type I - For application by machine. Type II - For hand application. Class 1 - Solvent-base adhesive. Class 2 - Water-emulsion adhesive. Class 3 - Hot-melt adhesive.	Type I - Machine. Type II - Brush.
MMM-A-105	Adhesive, paper label, water resistant.	Type I - For attaching printed paper labels to shipping containers, also coating the top of labels to make them water resistant. Type II - For repairing and mending articles of glass, metals, leather, china, etc.	Brushing.  Brushing.
MMM-A-178	Adhesive, paper label, water resistant.	One type, all purpose for application of paper labels to soft wood, fiberboard, black iron, galvanized iron, glass, tin, enamel painted metal, and rubber surfaces.	Brush application. Room temperature.

Table 4-3. Bags, Sacks, Envelopes Used in Military Packaging

Specification	Title	Type, grade, or class	Uses
MIL-B-22020	Bags, transparent, flexible, sealable, volatile corrosion inhibitor treated.	Class 1 - Heat sealable Class 2 - Pressure (cold) sealable Note: Class 1 bags are made from type I material of MIL-B-22019. Class 2 bags are made from type II material of MIL-B-22019	For use in packaging of items that are adaptable to protection by volatile corrosion inhibitor treated materials. Bags shall be used in accordance with Specification MIL-I-8574.
A-A-302	Sack, shipping, paper (cushioned).	None	For shipment of publications and small parts where a light cushioning effect and water resistance are required. The maximum weight limit is 10 lbs.
A-A-1588	Sack, shipping, paper (cushioned with closed cell plastic film).	None	For interior packaging of fragile items such as bottled liquids, testing and laboratory equipment. The maximum weight limit is 10 lbs.
MIL-E-6060	Envelopes, packaging, watervaporproof, flexible.	One type only	Generally - For packaging of items required maximum watervaporproofing protection under Methods 40 & 50. Specifically - For floating bag application (methods 43 & 53); for containers having two dimensions over 36"; or for packages containing inspection windows.
MIL-B-81997	Pouches, cushioned, flexible, electrostatic-free reclosable, transparent.	Type I - Three-Ply Wall; Two Outerplies - Barrier Electrostatic-Free transparent; Inner Ply-Cushioning, Electrostatic-Free Transparent; Type II - Single Ply; Cushioning-Electrostatic-Free Transparent.	For packaging and storing static-sensitive electronic devices.

Table 4-4. MIL-B-117 types, classes and styles.

TYPES CLASSES STYLES	DESCRIPTION
Type I Type II Type III	Heavy duty Medium duty Light duty
Class A Class B Class C Class E Class F  Class G Class H	Waterproof, electrostatic protective, static dissipative Waterproof Waterproof, greaseproof Watervaporproof, greaseproof Watervaporproof, electrostatic protective, electrostatic and electomagnetic shielding  Watervaporproof, greaseproof, flame resistant Waterproof, electrostatic protective, electrostatic shielding
Style 1 Style 2 Style 3	Opaque Transparent One side opaque, other side transparent

**Materials (table 4-5)**

Materials shall conform to the specification numbers shown in the center column of table 4-5. The material's type, grade, and class are shown in the three right columns of the table. For example, a bag conforming to MIL-B-117, Type I, Class C, Style 2, would be constructed from material conforming to MIL-PRF-22191, Type II.

**Intended use of bags**

Bags are used as containers to provide various degrees of protection to the contents. Transparent bags are used where transparency is desired to facilitate visual inspection of the enclosed product. Common stock sizes are listed in table 4-6. According to the class designations shown in table 4-4, the bags are used as follows:

- X Class A bags are designed for critical items that require protection against the buildup or retention of electrostatic potential in addition to protection against water penetration and are equivalent to the protection offered by Method 31.
- X Class B bags are designed as unit packages for items requiring waterproof protection and are equivalent to the protection offered by Method 31.
- X Class C bags are designed as unit packages for items that require greaseproof protection in addition to waterproof protection and are equivalent to the protection offered by Method 33.
- X Class E bags are designed as unit packages for critical items that require general protection against watervapor penetration in addition to waterproof and greaseproof protection and are equivalent to the protection offered by Methods 41 and 51.
- X Class F bags are designed for critical items that require protection against the buildup or retention of electrostatic potential in addition to protection against water and water vapor and are equivalent to the protection offered by Method 41.

- X Class G bags are designed for critical items that require flame resistance in addition to protection against water, water vapor, and grease penetration and are equivalent to the protection offered by Methods 41 and 51.

Table 4-5. Classification of Materials (MIL-B-117)

Classification (MIL-B-117)				Classification (material specification)		
Type	Class	Style	Specification	Type	Grade	Class
I	A	2	MIL-PRF-81705	II	-	1 or 2
I	B	1	MIL-B-121	I	A	1
II	B	1	MIL-B-121	II	A	1
III	B	1	MIL-B-121	II	A	1
I	B	2	MIL-PRF-22191 A-A-3174 <u>1/</u>	III I OR II	- A	- 1 <u>2/</u>
I	B	3	MIL-B-121 MIL-PRF-22191	I III	A -	1 -
I	C	1	MIL-B-121	I	A	1
II	C	1	MIL-B-121	II	A	1
I	C	2	MIL-PRF-22191	II	-	-
I	C	3	MIL-B-121 MIL-PRF-22191	I II	A -	1 -
I	E	1	MIL-PRF-131	I	-	1
I	E	2	MIL-PRF-22191	I	-	-
II	E	1	MIL-PRF-131	I	-	3
III	E	1	MIL-PRF-131	I	-	2
I	E	3	MIL-PRF-131 MIL-PRF-22191	I I	- -	1 -
I	E	3	MIL-PRF-131 MIL-PRF-22191	I I	- -	3 -
I	F	1	MIL-PRF-81705	I	-	1 or 2
I	G	1	MIL-PRF-131	II	-	-
I	H	1 or 2	MIL-PRF-81705	III	-	1 or 2

1/ Unless otherwise specified, nominal thickness shall be 0.004 inches.

2/ Finish shall be No. 2 (treated).

Table 4-6. Common Stock Sizes

Size Designation	Inside dimensions in inches
1	2-1/2 x 3
2	2-1/2 x 6
3	3 x 5
4	4 x 6
5	4 x 8
6	4 x 12
7	6 x 6
8	6 x 8
9	8 x 12
10	10 x 10
11	10 x 13
12	10 x 12
13	12 x 12

Dimensions are expressed in inches and fractions, width first and length second, as follows:  
 4" x 6" is a bag that is 4"wide and 6" long.

**Dimensions and Tolerances For Bags**

The bag length and width tolerances and maximum heat seal width depend on the area of the bag. See table 4-7 for these values.

**SIZE AND WEIGHT LIMITATIONS**

**Size Limitations**

Size of bags is unrestricted with the following exceptions:

- X Type III, class E, style 1 - 450 square inches; maximum product of inside width times inside depth.
- X Type II, class C, style 1 - 50 square inches; maximum product of inside width times inside depth.

**Weight Limitations**

Net weight of contents shall not exceed 10 pounds when bag is used without additional packaging/packing. No weight restrictions are imposed if the filled bag is packed in a supporting container. There are no weight restrictions for bags shown in table 4-8.

Table 4-7. Heat Seal Width.

Area of bag (one side)	Heat seal width maximum	Tolerance - width and length of bag
25 sq. in. or less	3/8"	-1/16 + 1/8
26 thru 200 sq. in.	1/2"	-1/8 + 1/4
201 thru 500 sq. in.	5/8"	-1/4 + 3/8
501 sq. in. or over	5/8"	-1/4 + 1/2

Seams fabricated by the dielectric, impulse or ultrasonic process shall have a minimum 1/32 inch heat seal. Seams of bags fabricated from unsupported plastic sheet (i.e. polyethylene, polyolefin) shall be required to meet the seam strength test specified in para. 3.4 of MIL-B-117 with no minimum seam width required.

Table 4-8. No Weight Restrictions

Type	Class	Style
I	B	2*
I	C	2
I	E	1,2,3
I	F	1
I	G	1

\*when using A-A-3174 the following applies:

Nominal Thickness	Weight Limitation
.004	up to 5 pounds
.006	over 5 pounds

**Envelopes, Packaging, Watervaporproof, Flexible (MIL-E-6060)**

For large sizes of watervaporproof bags, those conforming to MIL-E-6060, Envelopes, Packaging, Watervaporproof, Flexible, shall be used. The Air Force provides specification sheets for fabricating bags for Power Plants. These are shown in table 4-9.

**BARRIER AND WRAPPING MATERIALS**

A barrier material is a paper like or film material designed to withstand, to a given degree, the penetration of water, water vapor, grease, or certain gases. Barrier materials may serve to exclude or retain such elements within or outside the pack. A wrap is simply a sheet of flexible material, usually fed from roll stock, and formed around the item or pack to exclude dirt and facilitate handling, marking, or labeling. Barrier and wrapping materials may be divided into two general categories: opaque (nontransparent) and transparent. Opaque barrier materials are especially manufactured made to resist puncture or tear in shipping and handling. They must be flexible, waterproof, watervaporproof, greaseproof, or gasproof, or be resistant to flame, tarnish, or mold, if so specified. Some must prevent corrosion, provide protection against penetration by insects, or be nontoxic, odorless, and tasteless. Practically all must be capable of accepting markings for identification and some must be heat sealable. Transparent films are unsupported, nonfibrous, thin, flexible, organic plastic materials that are highly desirable in preservation-packaging operations due to their clear and protective characteristics. Examples of these materials are polyethylene, cellulose acetate, polyester, polystyrene,

rubber hydrochloride, vinyl chloride, and chlorotrifluoroethylene. Correct handling of barrier and wrapping materials is a great factor in avoiding inefficient wrapping operations. It is extremely important to receive, store, and handle barrier and wrapping roll stock according to recommended practices. Rolls should be stored on end, and flat cuts should be stored on their flat surfaces. Temperatures of 45° to 75°F., and a relative humidity of 40 percent to 50 percent are recommended for the storage of most barrier and wrapping materials. The use of dispenser units and automatic splicing equipment will contribute greatly to economy in the use of barrier and wrapping materials. It will also help to maintain a uniform and constant flow of work through the packaging line. Specification symbols, nomenclature, available types, grades, and classes, and intended uses of the most common barrier and wrapping materials are given in table 4-10.

Table 4-9. Specification Sheets.

MIL-E-6060/1A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-986 and R-1340 Engines)
MIL-E-6060/2A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-1820, R-1830 and R-2000 Engines)
MIL-E-6060/3A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-2800 Engine)
MIL-E-6060/4A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (5 KW Aircraft Power Plant)
MIL-E-6060/5A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (J-33 Engine)
MIL-E-6060/6A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (O-435 Engine)
MIL-E-6060/7A(USAF)	Envelope, Packaging, Watervaporproof, Flexible (R-4360 Engine)



Table 4-10. Barrier and Wrapping and Materials Used in Military Packaging

Specification	Title	Type, grade, or class	Uses
MIL-B-121	Barrier Material, Grease-Proofed, Waterproofed, Flexible.	<p><i>Type I - Heavy Duty</i>                      Grade A - Greaseproofed, waterproofed, and non-corrosive.                      Class 1 - Heat sealable, nonstretchable.                      Class 2 - Nonheat sealable, stretchable.                      Grade C - Greaseproofed, waterproofed noncorrosive moldable and self-adhering.                      Class 1 - Self-adhering coating applied on nongreaseproof side only.                      Class 2 - Self-adhering coating applied on both sides.</p> <p><i>Type II - Medium Duty</i>                      Grade A - Greaseproofed, waterproofed, and noncorrosive.                      Class 1 - Heat sealable, nonstretchable.                      Class 2 - Nonheat sealable stretchable.</p>	<p><i>General</i>- This material is used for protection of military supplies and equipment during transportation and storage under all types of climatic conditions.</p> <p><i>Grade A material</i> - Grade A, class 1 material is primarily used in the fabrication of greaseproofed, water-proofed packaging bags and also as an intimate wrap instead of Grade A, Class 2 material. Grade A, class 2 material is essentially used as an intimate wrap to maintain and protect coatings of oily or soft preservatives in contact with metal surfaces to which applied. It is also used where it necessary to insulate the metal surface of packaged items from hygroscopic or corrosive elements of the pack where contact of required outer wraps of other barrier materials would contaminate the metal surfaces of the packaged item; or where other more protective barrier materials are not required.</p> <p><i>Grade C material</i> - Grade C material is used primarily as an outer wrap of boxed or unboxed preserved material and usually sealed by a waxdip coating over the closed wrap. Grade C, class 1 material only may be used as an intimate wrap for critical items preserved with oily or soft preservatives since the surface of the wrap in contact with critical surfaces is noncorrosive and free of transferrable. material.</p>
MIL-P-130	Paper, Wrapping, Laminated And Creped.	<p>Type - Heavy.                      Type II - Medium duty.                      Type III - Light duty.</p>	<p>As a protective cover or wrap over Grades A and C, MIL-B-121, barrier material; as an intimate wrap on nonprecision parts where greaseproofness is not required; a wrap on parts or articles where a carton would waste shipping space; as a protective band around the outer surface of cylinders on completed radial-type engines; and as a complete cover for in-line-type engines. Not intended for use as a substitute for waterproof barrier materials.</p>
MIL-PRF-131	Barrier Materials; Watervaporproof, Greaseproof, Flexible, Heat Sealable.	<p>Class 1 - Plastic and non-woven backing.                      Class 2 - Kraft backing (limited use)</p>	<p><i>Class 1</i> - For use in packaging operations where heat-sealable, flexible, water-vaporproof barrier materials are required.</p> <p><i>Class 2</i> - Suitable for use in packages where the combined weights inside the barrier does not exceed 10 pounds. For all practical purposes, class 2 materials should be limited to use in bags whose inside length plus width does not exceed 42 inches. Class 2 materials should not be used in floating bag applications, in packaging operations under low temperature conditions (below 32EF) where fabrication or manipulation of the material is required, or where a double seam junction is fabricated.</p>
MIL-P-17667	Paper, Wrapping, Chemically Neutral (Noncorrosive).	<p>Type 1 - Flat.                      Type II - Creped (furnished in the following classes);                      Class 1 - Creped in one direction.                      Class 2 - Creped in two directions, or creped in one direction and corrugated in the other.</p>	<p>Intended for use as an initial wrap on items requiring a noncorrosive, dust protective wrap applied prior to, or as a part of unit packaging, where a greaseproof wrap is not required.</p> <p><i>Note</i>. Not intended as an antitarnish paper for silver and magnesium.</p>
MIL-PRF-22019	Barrier Materials, Transparent, Flexible, Sealable, Volatile Corrosion Inhibitor	<p>Type I - Heat sealable.                      Type II - Pressure (cold) sealable.</p>	<p>The VCI treated materials are mainly for interior packs where transparency is desired. The Type II material lends itself to custom hand processing in bag sealing operations.</p>

Table 4-10. Barrier and Wrapping and Materials Used in Military Packaging (continued)

Specification	Title	Type, grade, or class	Uses
MIL-PRF-22191	Barrier Material, Transparent, Flexible, Heat Sealable.	Type I - Waterproof, greaseproof, watervaporproof. Type II - Waterproof, greaseproof. Type III - Waterproof Note. All three types come in Class 1 (unlimited use) and Class 2 (automated bag making machines only).	Type I - Used in packaging applications requiring watervaporproof and greaseproof barriers. Type II - Used in packaging applications required waterproof and greaseproof barriers. Type III - Used in packaging applications requiring waterproof barriers.
MIL-PRF-81705	Barrier Materials, Flexible, Electrostatic Protective, Heat Sealable.	Type I - Watervaporproof, electrostatic protective, electrostatic and electromagnetic shielding. Type II - Transparent, waterproof, electrostatic protective, static dissipative. Type III - Transparent, waterproof, Note. All three types come in Class 1 for unlimited use and Class 2 for automated bag making machines only.	Type I - Used for the watervaporproof, electrostatic and electromagnetic protection of electrostatic discharge sensitive items. Type II - Used where transparency and static dissipation is required. Type III - Used where a transparent, waterproof, electrostatic field protective barrier is required. Note. Type II or III must be used in conjunction with Type I material to provide level A protection.
A-A-3174	Plastic Sheet And Strip, Thin Gauge, Polyolefin.	Type I - Normal impact strength polyethylene. Type II - High impact strength polyethylene. Type III - Polypropylene. Type IV - Heat shrinkable polyethylene. Class 1 - For nonfood contact application. Class 2 - For use in contact with food. Class 3 - Biaxially oriented. Class 4 - Preferentially oriented.	Intended for use in general purpose packaging applications where high degree of water resistance, moderate moisture vapor resistance, and dust protection are desired. It is not intended for use in special packaging applications where special grease or oil resistance properties may be required.
QQ -A-1876	Aluminum Foil.	Type I - Rolls. Type II - Interfold flat sheets. Class 1 - Flat sheets 12 x 10-3/4 inches. Class 2 - Flat sheets, 9 x 10-3/4 inches. Type III - Single-ply flat cuts (size to be specified in the contract or order). Grade A - For food handling and processing application. Grade B - For application other than food handling or processing.	As a noncorrosive barrier between surfaces which have been coated with preservative compounds and wood or dunnage, or between treated surfaces which would cause action. <i>Caution.</i> Direct contact with metals other than cadmium, aluminum, magnesium, or zinc should be avoided in application which may be exposed to water, to prevent galvanic action.
A-A-203 A-A-1894 (Formerly UU-P-268)	Paper, Kraft, Untreated Paper, Kraft, Treated (Fire Resistant)	Type I - Untreated. Grade A - No. 1 commercial designation. Grade B - No. 2 commercial designation. Type II - Fire resistant treated. Grade C - Heavy duty. Grade D - Light duty.	For general use in the overwrapping of packages where a chemically neutral or greaseproof, waterproof, or vaporproof barrier is not required. Types I and II are not intended for use as a wrapping material for food items.
A-A-1249 (Formerly UU-P-553)	Paper, Wrapping, Tissue	Type I - Regular. Class 1 - Bleached. Class 2 - Unbleached. Type 2 - Neutral (antitarnish). Class 1 - Bleached. Class 2 - Unbleached.	Type I is used as an initial wrap to protect items from breaking, scratching, and dusting during shipment and storage. Type II, in addition to the use requirements of type I, is used to prevent tarnishing.
PPP-B-1055	Barrier Material, Waterproofed, Flexible.	Classes: B-1 - Baling and interior wraps. B-2 - Baling and interior wraps. B-3 - Baling and interior wraps. C-1 - Interior wraps. C-2(a) - Crate liners and interior wraps. E-1 - Interior wraps and crate liners. E-2 - Interior wraps, crate liners, shrouds, and baling. H-2 - Case liners. H-3 (a) - Case liners. H-4 - Case liners. H-5 - Case liners, shrouds, and crate liners. L-2(b) - Case liners and crate liners. L-4 - Temporary tarpaulins. M-1 - Case liners, shrouds, and crate liners.	Baling - Classes B-1, B-2, -3 and E-2. Interior wraps - Classes C-1, C-2(a), E-1, and E-2. Case liners - Classes H-1, H-2, H-3(a), H-4, H-5, L-2(b), and M-1 Crate liners - Classes C-2(a), E-1, E-2, H-5, L-2(b), and M-1. Shrouds - Classes E-2, H-1, H-5, and M-1. Ammunition containers - Class P-1.

**Desiccants (Activated)**

Desiccants are used in connection with Method 50 preservation and must conform to the requirements of specification MIL-D-3464. Desiccants are available in three types - type I-General Purpose, type II - Nondusting, type III-for specific conditions (8 and 16 units only). The type II is intended for use in critical packing application where dusting cannot be tolerated. The Type II is intended for use where a danger exists of accidental flooding by water. The durability of the bag material and seams should be sufficient to prevent contamination of a system by accidental dispersal of desiccant material. Desiccants are furnished in bags of unit size 1, fractional sizes of 1/6, 1/3, and 1/2 of a unit, and multiple sizes of 2, 4, 8, and 16 units. A unit size is that quantity of desiccant which will adsorb at equilibrium with the air and at 77°F. temperature at least the following quantity of water vapor: 3.00 grams at 20 percent relative humidity and 6.00 grams at 40 percent relative humidity. Desiccant bags shall be secured to prevent movement, possible rupture of bags or barriers, or damage to the item. Securing may be accomplished by tying, storage in specially provided baskets, taping, or other approved means. Desiccant bags should be located uniformly throughout the pack and in such a manner that all voids are exposed to the dehydrating action of the material. It is recommended that the total amount of desiccant be in as small unit bag sizes as possible without increasing the cube of the pack. Desiccant bags will not be placed on or permitted to come in contact with critical surfaces of the packed item. If it becomes necessary to place bagged desiccant in contact with a preservative coated part, the bags shall be isolated by wrapping the coated part with MIL-B-121, Grade A barrier material. The minimum quantity of desiccant for use per pack is determined in accordance with Formula I or Formula II of table 4-11, as applicable. Removal of the desiccant from its storage container and its insertion into the unit pack shall be the last action prior to sealing the bag or container.

**HUMIDITY INDICATORS (FIGURE 4-2)**

Humidity indicators shall be used in Method 50 packs, unless otherwise specified. As applicable, the indicator shall be located behind inspection windows or immediately within the closing edge, face or cover of the barrier and as far as practicable from the nearest unit of desiccant. Humidity indicators used within sealed packs shall conform to military standard MIL-I-8835 (formerly MS 20003-2), Indicator, Humidity, Card, Three-Spot Impregnated Areas (figure 4-2). This indicator is a three-spot paper card type, 2x4 inches in size. The spots indicate relative humidities of 50 percent, 40 percent, and 30 percent, top to bottom, by changing color from blue to pink. The indicator is accurate within 5 percent of the aforementioned relative humidities. Desiccant type humidity indicators will be subject to approval of the procuring agency. Externally mounted indicating elements or devices such as the plug type, when specified, shall be installed in place of, or when required, in addition to, the humidity indicators conforming to military standard MIL-I-8835 (formerly MS 20003-2). Externally mounted color change indicators, unless otherwise specified, will conform to MIL-I-26860 (Indicator, Humidity, Plug, Color Change). This is a metal plug type indicator which is permanently calibrated, reacts quickly to humidity changes, and is used for determining relative humidity within rigid containers and flexible watervaporproof barriers. Plug type indicators change from blue to pink at 40 percent relative humidity. When used with pressure or vacuum containers, they will hold up to 20 pounds per square inch differential air pressure. Advancements in plug type indicators have produced one that provides positive and permanent indication of early moisture entry before corrosion takes place. These "Irreversible Relative Humidity Indicators" trip (stain) at a set relative humidity (usually 55%) and are not reset by temperature or sunlight.

Table 4-11. Minimum Quantity of Desiccant per Unit Pack.

Formula I - To find units of desiccant for use within barrier other than sealed rigid metal barrier:

$$U = CA + X_{(1)} D + X_{(2)} D + X_{(3)} D + X_{(4)} D$$

Formula II - To find units of desiccant for use within sealed rigid metal barrier:  $U = KV + X_{(1)} D +$

$$X_{(2)} D + X_{(3)} D + X_{(4)} D$$

In the above formulas:

U = Number of units of desiccant to be used.

C = 0.011 when area of barrier is given in square inches.

C = 1.6 when area of barrier is given in square feet.

A = Area of barrier in square inches or square feet.

K = 0.0007 when volume is given in cubic inches.

K = 1.2 when volume is given in cubic feet.

V = Volume within barrier in cubic inches or cubic feet.

D = Pounds of dunnage (other than metal) within barrier.

$X_{(1)}$  = 8 for hair felt, cellulosic material (including wood) and other material not categorized below.

$X_{(2)}$  = 3.6 for bond fibers (animal hair, synthetic fiber and vegetable fiber bound with rubber).

$X_{(3)}$  = 2 for glass fiber.

$X_{(4)}$  = 0.5 for synthetic foams and rubber.

Note - Use only the X factors for material used in fabrication of the unit pack being considered.

Formula II may be used to determine units of desiccant required for sealed rigid containers (other than all-metal) when the sealed barrier provides a MVTR not exceeding 0.001 grams per 24 hours per 100 square inches, as established by Government specification or when tested in accordance with ASTM D1008.

Area (A) = L x W

L = Length of barrier material to be used to fabricate pack.

W = Width of barrier material to be used to fabricate pack.

Volume (V) =  $\pi r^2 h$

$$\pi = 3.1416$$

r = Radius of can (2 distance across top)

h - Height or length of can

## INSPECTION WINDOW

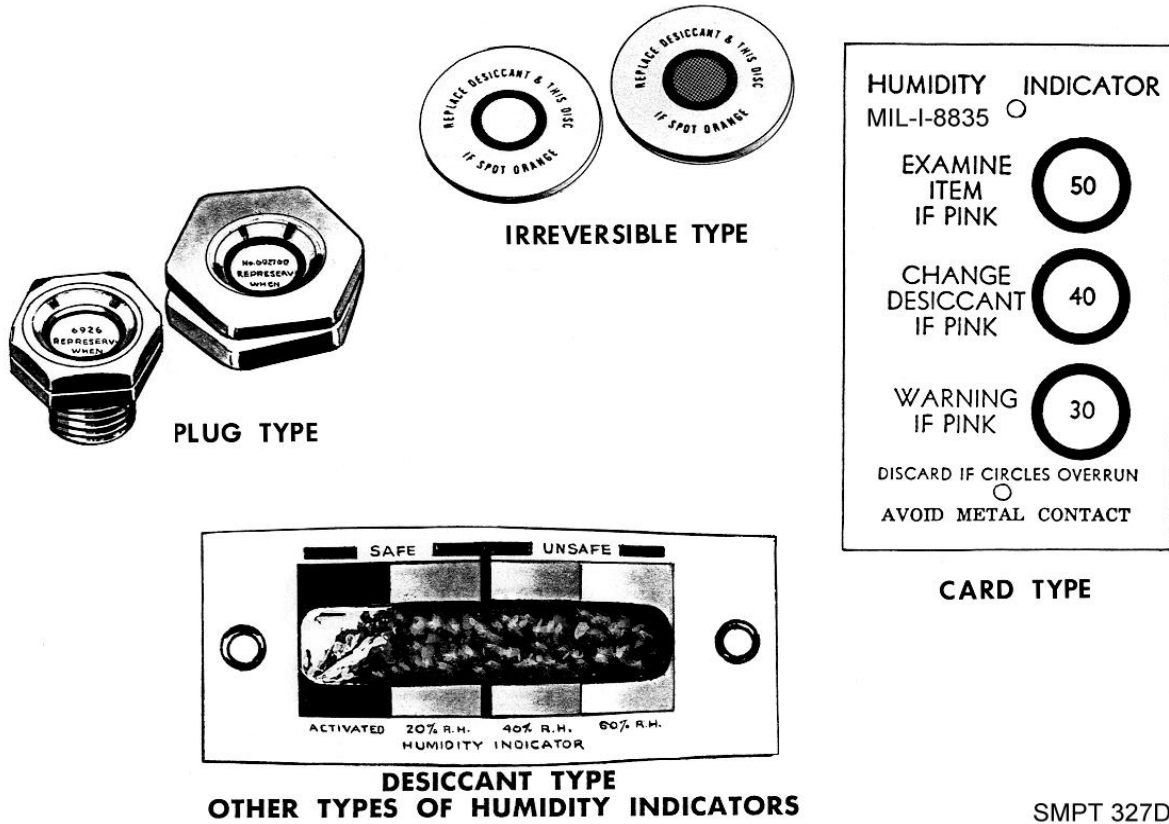
When specified in the contract or order, a window of material conforming to MIL-PRF-22191, Type I shall be provided in the bag in accordance with MIL-E-6060 procedures for Method 53 packs 15 cubic feet or larger. See figure 4-2 for "humidity indicators" and figure 4-3 for "inspection window".

## Window Dimensions

Unless otherwise specified, the window will be 4 inches by 8 inches.

## Method of Mounting Window

The inspection window shall normally be mounted by means of heat sealing. If heat sealing cannot be accomplished, the window may be secured to the inside of the bag by means of a suitable water-resistant adhesive, and cloth-backed tape conforming to ASTM D 5486. After adhesively mounting the window to the inside of the bag, the edges of the window shall be completely taped from the inside, using 2-inch strips (minimum width) of ASTM D 5486 tape.



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Figure 4-2. Humidity Indicators.

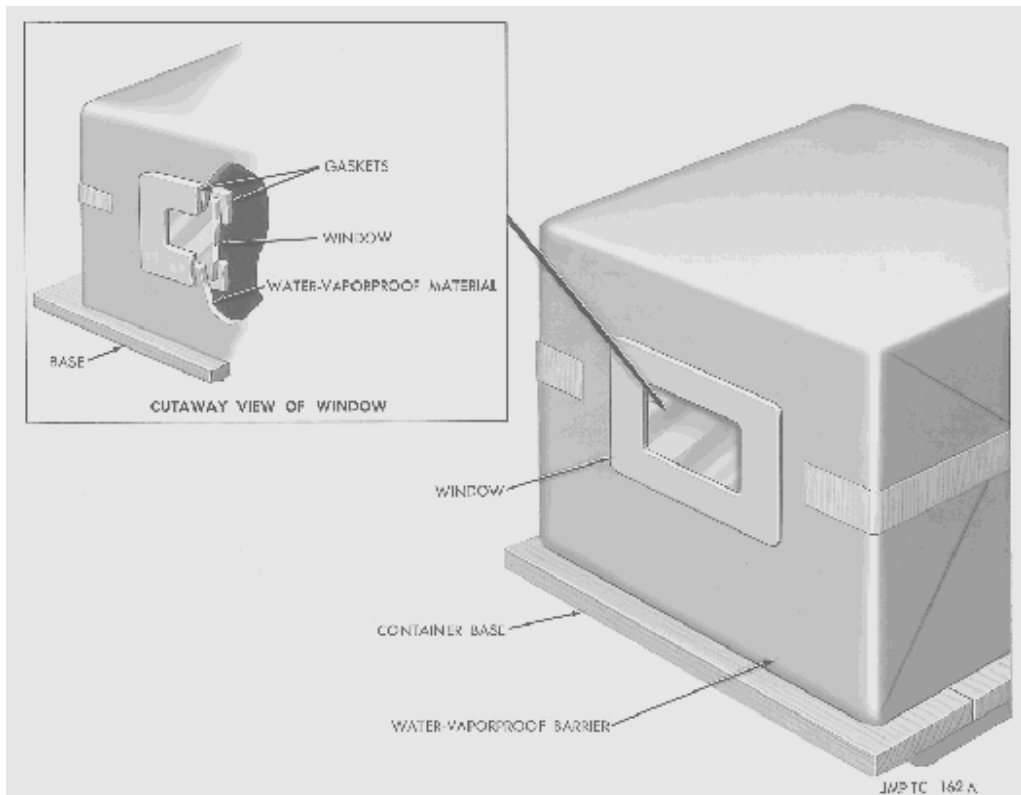


Figure 4-3. MIL-E-6060 inspection window.

### **Unit and Intermediate Pack Labels**

When labels are used for marking identification and contract data, the following applies:

- X Labels shall be machine printed, typed, stamped, or reproduced.
- X The label used to mark a unit pack shall be no larger than any side of the unit pack.
- X Paper labels that are other than pressure-sensitive shall be securely affixed with a water-resistant label adhesive that is applied on the complete underside of the label. An alternate method is to place ASTM D 5486 transparent tape over the entire surface of the label.
- X Pressure sensitive labels shall be of a water-resistant grade of paper, film, fabric, or plastic and shall be coated on one side with a pressure-sensitive, permanent adhesive. The adhesive shall adhere to metal, plastic, or fiberboard surfaces under high or low temperatures.

### **TAPES**

A tape is an adhering strip or band of paper, textile, plastic, etc., which has several applications in military packaging, among them the closing and sealing of containers. On the basis of the nature of the adhesive applied to the backing material of tapes, those used predominantly by the military fall into two major categories: pressure-sensitive tapes and water-activated tapes (gummed tapes). Pressure-sensitive tapes are those which in the dry (solvent-free) form are highly and permanently tacky at room temperature and firmly adhere to the surface upon mere contact and without the need of more than slight finger or hand pressure. Water-activated tapes are those which require activation of the adhesive holding power. Tapes should be stored in clean, dry places. Storage temperatures of 70° to 75°F. are recommended. Tapes should be stored in their original containers, and purchases should be adjusted to avoid storage for more than 6 months. All tapes, especially pressure-sensitive tapes, should be stored so that the pressure is exerted against the edge of the tape. Tapes which have been stored for over 1 year should be examined carefully before use, and, if there is any evidence of deterioration such as separation of layers within the roll, tape adherence to its own backing, or stringy appearing adhesive when the tape is unrolled, the tape should be replaced. Specification symbols, nomenclature, available types, grades, and classes, and intended uses of the most common tapes are given in table 4-12.

## **CUSHIONING MATERIALS AND THEIR APPLICATION**

### **CONCEPT AND FUNCTIONS OF CUSHIONING**

#### **Concept of Cushioning**

Cushioning is the protection from physical and mechanical damage afforded an item by means of compressible and resilient materials, known as cushioning materials, designed to absorb the energy of shocks and vibration caused by external forces.

The following paragraphs provide engineering principles involved in the use of various cushioning materials. MIL-HDBK-304, "Package Cushioning Design," is one of the best documents to understand the characteristics and functions of cushioning materials and how these factors may affect the protection of the item within the package.

Table 4-12. Tapes used in Military Packaging

Specification	Title	Type, grade, or class	Uses
L-T-99	Tape, Pressure-sensitive, Adhesive, Identification.	Type I - Interior labeling and identification. Type II - Edging. Type III - Exterior labeling and identification	Type I. For interior use as an identification medium. In the printed form it may be used for labeling application including files, containers of all types, charts, etc. Colored tape, with or without printing can be used for identifying the metal in metal shapes, color coding, etc. It is not recommended for edging purposes. Type II. For edging of documents; maps, charts, etc. to protect the edges from tearing or other damage during handling and storage. Type III. For both interior and exterior identification applications such as Air Mail Tape and other special markings required in packaging. Office use and similar applications. It is not recommended for edging purposes.
A-A-883	Tape, Pressure-sensitive, Adhesive, Masking.	Type I - Creped. Type II - Flat.	For light duty bundling, holding, and packaging applications such as bundling small parts to be overpacked, holding small parts to larger assemblies, and for temporary closing of chipboard and fiberboard boxes that are <i>not</i> to be shipped.
A-A-1492 A-A-1671  (Formerly PPP-T-45)	Tape Gummed, Paper, Reinforced and Plain, for Sealing and Securing.	A-A-1671 Type I - Asphalt lamination Type II - Nonasphalt laminated Class 1 – Strippable Class 2 – Nonstrippable Style A - 2 way reinforcement Style B - 3 way reinforcement A-A-1492 Grade A - Light duty Grade B - Medium duty Grade C - Heavy duty	A-A-1671 Intended for closure of fiberboard boxes. For domestic shipment and storage and securing wrapping of packages  A-A-1492 Use for general sealing of cartons and fiberboard boxes, wrapping of packs, and banding of paper and paper products.
ASTM D 5486 (Formerly PPP-T-60 and PPP-T-76)	Pressure-sensitive Tape for Packaging, Box Closure, and Sealing.	Type I – Waterproof, weather-resistant; polyester-backed. Class 1 - Colored. Class 2 - Transparent. Type II Water-resistant, polyester backed. Class 1 – Tan. Class 2 – Transparent. Type III – Water-resistant, polypropylene. Type IV – Water-resistant, woven, cloth backed. Type V – Weather-resistant, paper backed.	These tapes are used when packaging and sealing performance against water penetration and low temperatures are desired. Type I is used for box closure and sealing where strength and resistance to sunlight, rain, and other deteriorating elements are required. Type I, Class 2 can also be used for label attachment and covering applications where weather resistance is needed. Type II is used for box closure where strength and water-resistance are required. Type II, Class 2 is also used for label attachment and covering application where water-resistance is desired. Type III is used for box closure where a general purpose water-resistant tape is desired. Type IV is used for less critical packaging applications where a cloth-backed tape is desired. Type V is used for box closure and sealing where weather-resistance and water-resistance are required.

Table 4-12. Continued.

Specification	Title	Type, grade, or class	Uses
A-A-1689 (Formerly PPP-T-66)	Tape, Packaging ,Vinyl Plastic Film.	Type I - General Purpose. Class 1 - Transparent. Class 2 - Colored. Type II - Printable.	Both Types I and II are intended for uses such as sealing out moisture and applications requiring the flexibility, toughness, and conformability normally possessed by a plasticized vinyl film.
ASTM D 5330 (Formerly PPP-T-97)	Pressure-sensitive Tape for Packaging, Filament-Reinforced.	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.	Type I – For strip reinforcement of Containers and anchoring moving parts. Type II – For closures. Type III – For bundling and other forms Type IV – Where weather resistance is required.
A-A-113	Tape, Pressure-sensitive Adhesive.	Type I - Glossy finish. Class A - Transparent, cellophane, or other material. Class B - Colored, cellophane, or other material. Type II - Matte finish. Class A - Transparency, cellulose acetate backing. Class B - Cellulose acetate, transparent, glossy backed.	Type I, Class A tape is for temporary mending and attaching. Type I, Class B tape is for temporary identification, charting, and decorating. Type II, Class A tape is virtually invisible. Type II, Class A - For permanent mending of paper, documents, blueprints, maps, etc. Type II, Class B - For permanent applications such as light holding, covering, shielding, and sealing.
MIL-T-22085	Tape, Pressure-sensitive, Adhesive, (For Exterior Preservation and Sealing of Military Vehicles, Aircraft, and Related Equipment)	Type II - For use with or without overcoating. Type IV - For use without overcoating for extended time periods.	Type II - For use in the preservation and sealing of military vehicles, airplanes, missiles, and other related equipment where long term exterior exposure is anticipated. Overcoating is required when unprotected outdoor storage is anticipated. Type IV - For the same application as Type II. Type IV shall be used where extended periods of unprotected outdoor storage are expected. Type IV tape may be used without overcoating for the sealing of equipment that may have shed or indoor storage.
MIL-T-43036	Tape, Pressure-sensitive Adhesive, Plastic Film (For Sealing Fiber Containers and Cans).	Type I - Reinforced polyester film. Type II - Non-reinforced polyester film.	For sealing fiber containers and cans meeting MIL-C-2439 and MIL-C-3955 and for slip cover metal containers. It may be used in other applications where waterproof, watervaporproof, medium tensile strength tape possessing good low temperature removal properties is required.



## **Cushioning Vs Dunnage**

According to MIL-HDBK-304 “Cushioning Design” there is a profound difference between cushioning material and dunnage. Cushioning an item is an engineering application of a specific material thickness and bearing area to protect against known forces. Usually this involves testing the bare item for fragility, designing the cushioning system and testing the resulting design for complete item protection from shock and vibration forces.

Dunnage is the application of unspecific material to fill voids, protect the finish from scratches or abrasions, or prevent load shifting during transport. Dunnage use does not apply the engineering design and test process to ensure specific shock and vibration protection. Until recently, military packagers used loose-fill dunnage materials extensively. Many problems surfaced with the use of this dunnage material. This material is forbidden for use by most of the military services and DLA. One problem with loose fill was the shifting of the item within the package so that no item protection was available. Also, foreign object debris (F.O.D.) on the flight line was a problem. For example, polystyrene peanuts may find their way into the aircraft engine causing costly damage upon engine start-up.

Many dunnage wrap materials such as polyethylene, polyurethane, and polypropylene foams, flexible cellular plastic films and thin-sheet cellulose material are all acceptable for void fill. Dunnage types include PPP-C-795, A-A-3129, PPP-C-1797, A-A-59135, A-A-1051, and A-A-1898. The packer simply wads up several sheets and forces them into the void.

Cushioning materials can be used as dunnage, but the cost is excessive. Unless the packer has excess or scrap cushioning materials available that can not be otherwise used for an engineering purpose, it is best to only use the cheaper dunnage materials for void fill.

## **Functions of Cushioning**

In order to properly utilize the many cushioning materials available in the military supply system, it is necessary to understand the functions of cushioning. Among these functions, as shown in figure 4-4, the most important functions are as follows:

- X Control item movement. Cushioning, when properly applied, controls the movement of the item within the barrier or container and mitigates the effects of shock and vibration.
- X Protect fragile or delicate components. When fragile or delicate components form a part of an otherwise rugged item, they may be disassembled and packed separately. If disassembly is not permitted and they must be left in place, cushioning is applied to give them protection.
- X Prevent rupture of barriers and containers. Many items have sharp corners or projections which could puncture the barriers or containers in which they are packed, resulting in the entry of moisture or water. Cushioning is applied to these projections or corners to insure that waterproof or watervaporproof barriers are not rendered useless by such damage.
- X Distribute forces. Cushioning materials reduce the effects of impact shock to an item by distributing the damaging forces over a large area, thus lowering the energy concentration at any one point on the surface of the item.
- X Prevent abrasion. Items with highly finished surfaces which may be marred by blocking, strapping, or contact with other items in the container must be protected against abrasion by cushioning. Usually, lesser amounts and

thicknesses of cushioning materials are employed to accomplish this cushioning function.

- X Absorb shocks. Perhaps the most frequent and important use of cushioning is to absorb the energy resulting when a container is subjected to impact. This shock energy is absorbed as the cushioning material is compressed by the item.

**MULTIPURPOSE CUSHIONING**

Although the foregoing functions of cushioning are described separately, in practical application most materials used for cushioning serve more than one function. A material selected to protect an item from damage by impact shock may also prevent abrasion, protect barrier materials and cover sharp projections. Another material may serve to distribute shock forces as well as limit movement. Some materials serve as rigid blocking with limited shocks and as flexible cushioning with more severe shocks. Cushioning materials may also be required to absorb liquids, in case the inner container becomes damaged and leaks. This is particularly required for liquids which are corrosive or otherwise dangerous.

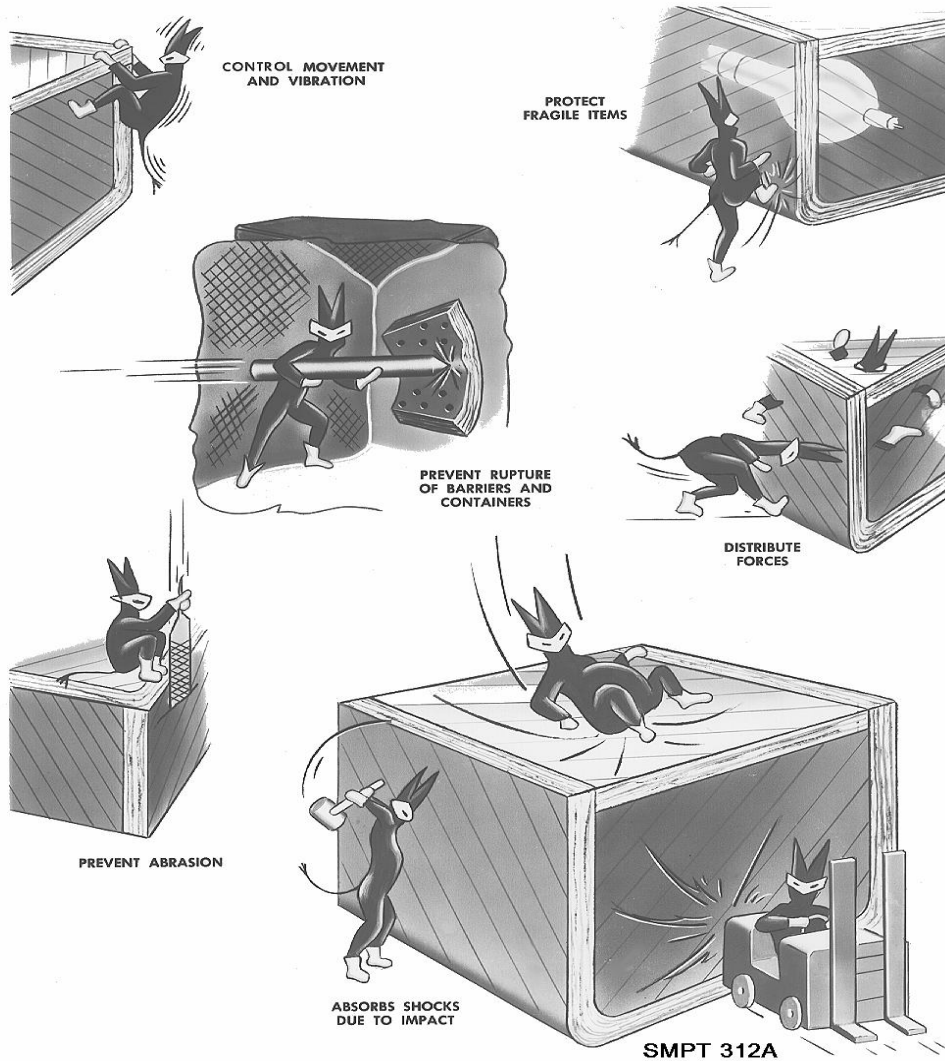


Figure 4-4. Functions of cushioning.

**REQUIREMENTS FOR THE USE OF CUSHIONING MATERIALS**

In addition to the requirements established in cushioning specifications which control material quality, construction, and performance, three important requirements must be met when cushioning materials are used within waterproof or watervaporproof barriers. MIL-STD-2073-1C requires the following:

- X Cushioning be as dry as practicable.
- X Cushioning must be noncorrosive.
- X If the item is coated with a preservative, the preserved item must first be wrapped in a greaseproof barrier conforming to Grade A or C of MIL-B-121, QQ-A-1876, or Type II of MIL-PRF-22191. In addition, material conforming to Type III of MIL-PRF-22191 may also be used as cushioning and dunnage when bags are made of material conforming to Grade A of MIL-B-121, MIL-PRF-131, or Type II of MIL-PRF-22191.

**CUSHIONING SELECTION FACTORS**

There are several factors that must be considered in selecting the appropriate cushioning material for a given application. The nature and physical limitations of the item, the favorable and unfavorable characteristics of the cushioning material, the destination of the packs, and the means of transportation must all be taken into consideration before an item can be properly cushioned.

**CHARACTERISTICS OF THE ITEM (FIGURE 4-5)**

In planning to cushion an item, the nature and physical limitations of the item must first be considered. The shock resistance, size, weight, shape, surface finish, and the degree of disassembly permitted will influence the way an item is to be cushioned. Design data such as specifications and/or drawings are excellent sources for this information.

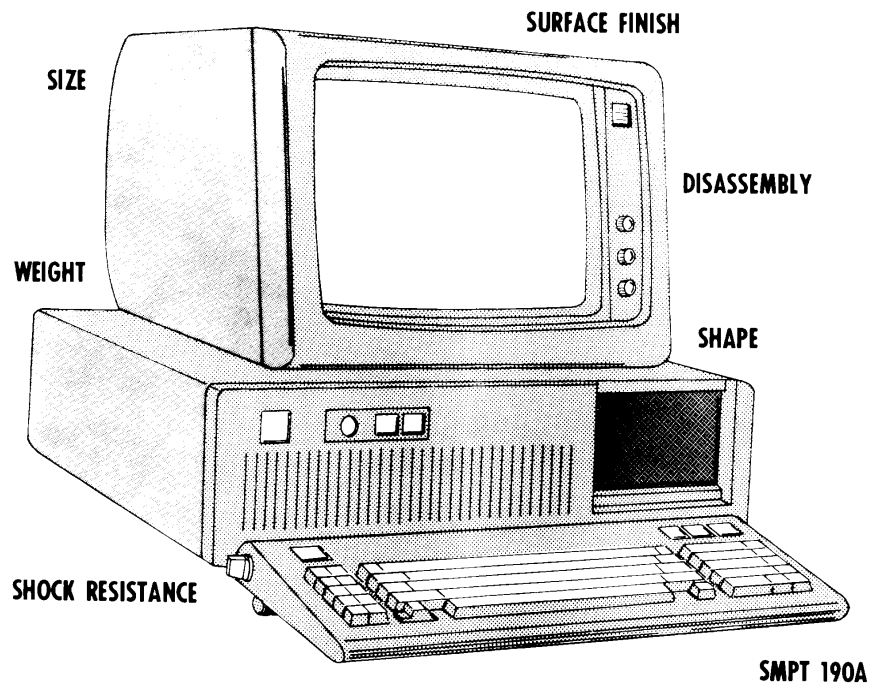


Figure 4-5. Item characteristics which determine the selection of cushioning material.

**Shock Resistance or Fragility**

Fragility cannot be determined by eye alone. The tendency is to over-cushion seemingly fragile items and to under-cushion seemingly sturdy items. Fragility, the greatest amount of energy an item can withstand without destruction, can be measured with scientific instruments. The term "G-factor" has been accepted as indicating the shock resistance of an item. This resistance is determined by fragility testing in which an item is subjected to impact shocks of increasing severity. The minimum deceleration of the item at which damage or malfunction occurs divided by the acceleration due to gravity is called the "G-factor" for that item. This is expressed as:

$$\text{G-Factor} = \frac{\text{Acceleration}}{\text{Gravity}}$$

The G-factors of many military items are being determined. In the absence of known G-factor values, the determination of the right cushioning must be based on the history of previous shipments and, whenever practicable, on actual drop testing of the completed pack.

**Size**

A large item may require a thinner layer of cushioning than a smaller item of the same weight because there is less load per square inch applied to the cushioning. This should be kept in mind when an item is irregular in shape - more cushioning may be required at the small end than at the large end.

**Weight**

Weight in motion results in force, and force can cause damage. Thus, the weight of an item controls the thickness, quantity, and firmness of the cushioning material to be used. Generally, the heavier the item, the firmer the cushioning must be.

**Shape**

A regular-shaped item will ordinarily fit snugly into a container with a minimum of cushioning, while an irregular-shaped one may require a complicated arrangement of pads and cells or foamed-in-place cushioning to bring it up to a more regular shape. Light, small items which are irregular in shape can be made regular and at the same time positioned and held in the container merely by a wrap of cushioning material. Large, irregular items may make it impractical to use cushioning materials to make them regular. Blocking and bracing in conjunction with cushioning will have to be employed to protect such items.

**Static Stress**

Tables of cushioning performance factors usually present data based on static stress (the weight per unit area). This is determined by dividing the weight in pounds by the area of the weight bearing surface in contact with the cushioning.

**Surface Finish**

An otherwise sturdy item may have highly finished surfaces which could be damaged by the rubbing action of harsh abrasive cushioning material, or the surface may be corroded and pitted by chemical action due to the presence of moisture and acidic or basic elements in the cushioning material.

**Disassembly**

The disassembly of a highly irregular item may allow a reduction in its cube and permit simpler cushioning to give the necessary protection. Before disassembly,

however, competent advice should be obtained as to the feasibility of reassembly and calibration, if necessary, in the field.

#### **CHARACTERISTICS OF CUSHIONING MATERIALS**

The chemical and physical properties of cushioning materials are many and display both desirable and undesirable characteristics. These characteristics vary in importance for different applications. What might be a highly desirable characteristic in one application, may be detrimental in another. The hygroscopic characteristic of some materials is to absorb water from the atmosphere. High moisture absorbency is required for packing liquids but is not desirable when packing corrodible metal items.

#### **Compression Set (Figure 4-6)**

This is the difference between the original thickness of a cushioning material and the thickness of the same material after having been released from compression. Compression set is undesirable as it creates free-moving space in the container.

#### **Resilience (Figure 4-6)**

Resilience is the ability of a material to absorb a series of shocks and return to its original shape and thickness after each shock. Few materials are completely resilient and this quality is often greatly altered by changes in temperature. Rubber, for instance, is highly resilient in temperate zones, but loses its resilience under extreme cold conditions, unless altered by additives.

#### **Rate of Recovery (Figure 4-6)**

This is the time it takes for a cushioning material to return to its original shape after compression. This is important because some materials have too rapid a rate of recovery and "spring back" so quickly that damage to the item may result.

#### **Dustiness (Figure 4-7)**

A breakdown and disintegration of certain materials used for cushioning allows small particles to become detached and work into crevices and critical working surfaces of the cushioned item.

#### **Corrosiveness (Figure 4-7)**

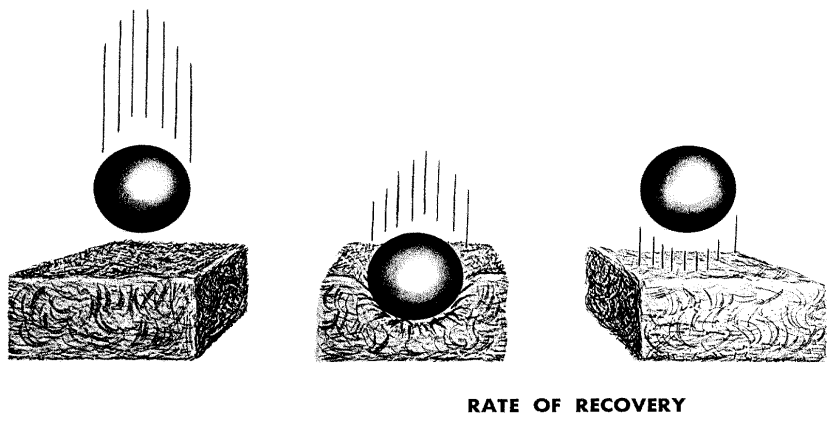
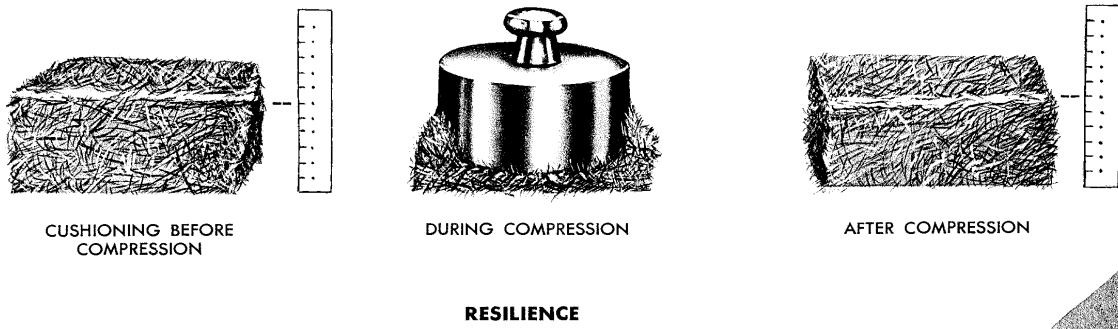
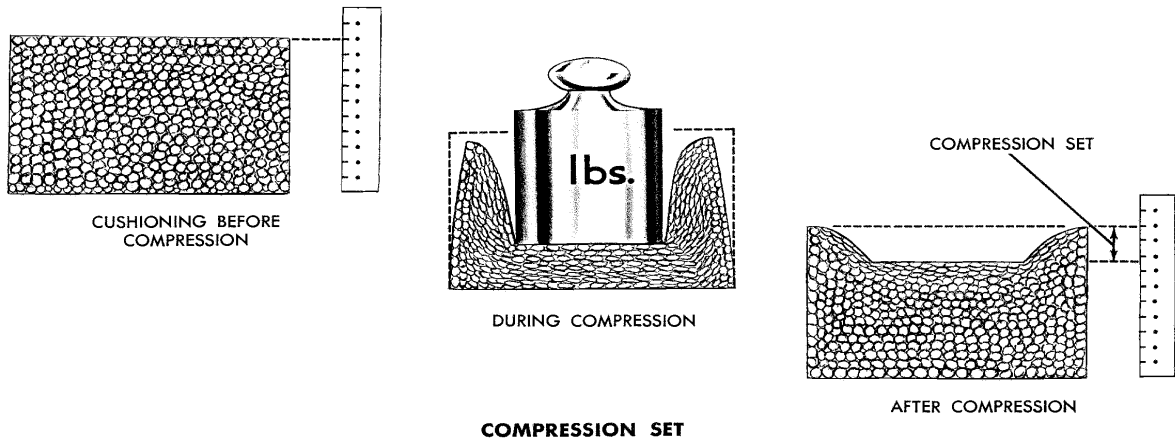
The corrosive effect of some cushioning materials is undesirable when packing items with critical surfaces. When this cannot be avoided, the item must be shielded from such materials by a neutral wrap or liner. Cushioning materials with a high acidic or alkaline content must not be enclosed within waterproof or watervaporproof barriers.

#### **Fungus Resistance (Figure 4-7)**

Some cushioning materials have a low fungus resistance and will allow the growth of mold, mildew, and other fungi. Many materials can be treated to inhibit such growth. However, such treated materials are often very corrosive to metal surfaces and must be isolated from them.

#### **Abrasiveness (Figure 4-8)**

The abrasive characteristics of some materials are factors which must be considered when protecting precision surfaces such as the lenses of optical instruments. Some cushioning materials are soft-textured and generally can be placed in contact with easily marred surfaces. Coarse-textured materials should not be used on such surfaces.



RATE OF RECOVERY

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Figure 4-6. Characteristics of cushioning materials-compression set, resilience, and rate of recovery.

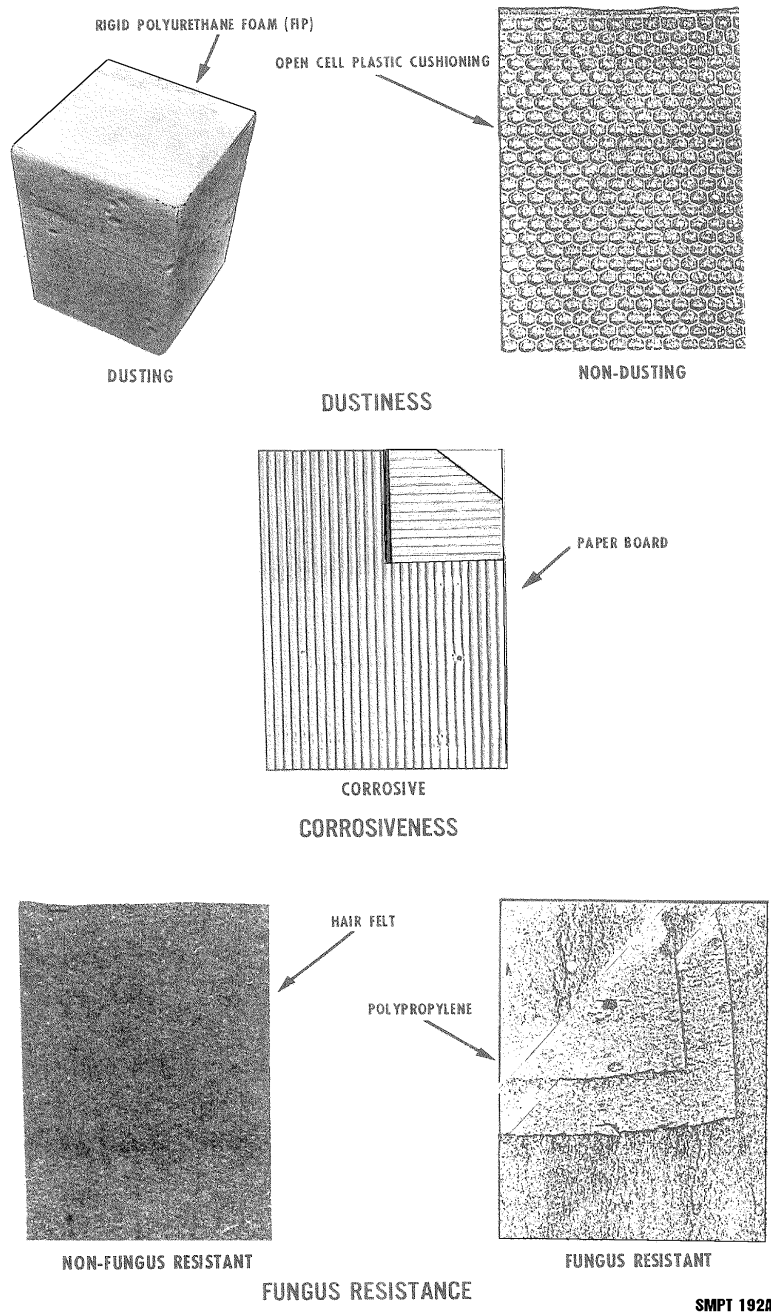


Figure 4-7. Characteristics of cushioning materials-dustiness, corrosiveness, and fungus resistance.

**Temperature Performance (Figure 4-8)**

Low temperature performance of certain cushioning materials makes them suitable for use in high altitude transport and in shipments to cold regions because they remain relatively soft and resilient.

**Other Characteristics**

Fire resistance or flammability (see figure 4-8) should not be overlooked in choosing cushioning materials. Also, be aware that certain cushioning materials may cause skin irritation to personnel who come in contact with it.

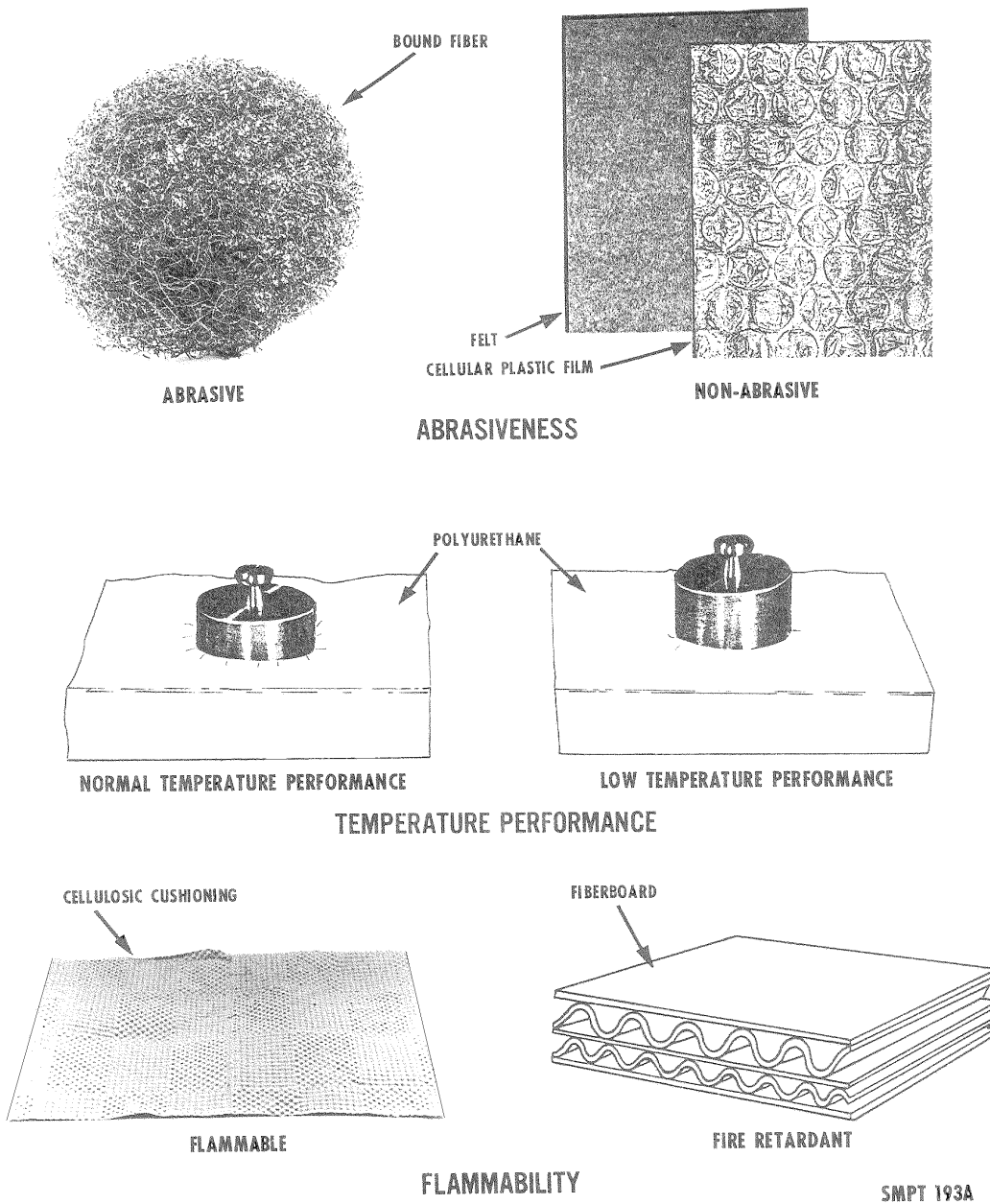


Figure 4-8. Characteristics of cushioning materials-abrasiveness, temperature performance, and flammability.

**DESTINATION OF THE ITEM**

The destination of the item is a factor in cushioning. Many cushioning materials change their characteristics under extreme climatic conditions. Some materials become so rigid or brittle at extremely low temperatures that they become useless as cushioning materials. In tropical climates, some materials soften and lose their cushioning qualities. In jungles or rainy locations, some materials will pick up excessive moisture which will result in the loss of resilience and will lead to growth of fungus and accelerated corrosion.



### **MEANS OF TRANSPORTATION**

The means of transportation must not be overlooked. Hazards and handling situations vary greatly between air, motor, rail, and ship. For example, there may be considerable difference between the amount of handling an item being transhipped from truck, to rail, to ship might receive than one being shipped by air freight. Likewise, an item to be delivered by air drop would require different protection from one that would be delivered by truck.

### **REPRESENTATIVE CUSHIONING MATERIALS**

#### **Bound Fiber (PPP-C-1120)**

These materials may consist of any suitable natural hair, vegetable fiber, or synthetic fiber bound with an elastic material. Horsehair, sisal, and cactus fibers sprayed with latex are common examples. The materials are furnished in four types and two classes. Class A is water-resistant, natural hair. Class B, common class, is not necessarily water-resistant. The four types are classified according to firmness, from soft to firm (capable of supporting loads up to 0.5 pound per square inch). They may be supplied as noncompressed flat sheets for general cushioning applications, or in molded forms shaped to fit the contours of the item. The materials have a high degree of resilience, low compression set, fair damping quality, and do not disintegrate easily. They are neutral and have a low water-soluble acidity so that their corrosive effects are slight. Moisture content and moisture absorption are both low; however, the materials may need to be treated for fungus resistance. Their performance is reduced at low temperature. They are intended to protect items against vibrational and impact shocks where resilient and water-resistant cushions are required.

#### **Cellulosic (A-A-1898)**

The General Services Administration has authorized the use of this Commercial Item Description (CID) in preference to PPP-C-843, which has been canceled.

This material may be made of any kind of cellulosic matter which will result in a product meeting the CID. The cellulosic matter used may be cotton, bonded fibers, natural fibers, or creped wadding. The material is furnished in three grades and three classes. They are -

- X Grade I - water absorbent.
- X Grade II - water resistant.
- X Grade III - fire retardant, water resistant.
- X Class A - low tensile strength
- X Class B - medium tensile strength
- X Class C - high tensile strength

Cellulosic cushioning material is readily moldable and fairly resilient. Its compression set is high, its damping ability excellent, but dusting is great enough to require an excluding wrap around items susceptible to dust damage. Its performance in cold temperature is good. This material is intended for use in packing lightweight, fragile items; as a protection against abrasion; and grade I, specifically, for absorbing liquids from containers broken in transit.

**Low Density Polypropylene Foam Cushioning Material (PPP-C-1797)**

This material, in rolls, tear-perforated rolls, or flat cuts, is a low density, resilient, unicellular (closed cell) polypropylene foam material for use in cushioning and packing applications. It is useful throughout a temperature range from -65°F (-54°C) to 160°F (71°C). Type I is used for general cushioning applications while Type II is used for electrostatic protective cushioning applications. For high density items, it can be used for protection of surfaces from abrasion. It is nondusting and nonlinting. Typical packaging applications would be surface protection for optical lenses, equipment with critical surfaces, electrical and electronic equipment, glassware, ceramics, and magnetic tape rolls.

**Pad, Energy Dissipator (MIL-PRF-9884)**

Kraft fibers are constructed into sheets of paper board that resemble honeycomb. This material is primarily used as an energy dissipating medium for landing shock to which air dropped objects are subjected. It may also be used for special packing requirements.

**Felt Sheet Hair and Felt Roll Hair (ANSI/BHMA A156.17)**

This specification covers cattle hair felt as manufactured by the felted and fulled process in sheet and roll form. The felt is used for cushioning, packing, padding, crating, and shock mounts for long-term operation. One variety of this material is designed for shielding where high strength and abrasion resistance are required.

**Solid and Corrugated Fiberboard**

MIL-B-3106, Board, Composition, Water-resistant, Solid (For Filler or Cushioning Pads), and ASTM D4727/D4727M, Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade).

Both solid and corrugated fiberboard are used in cushioning, but corrugated is more frequently used because it has greater cushioning value. The most common forms of fiberboard applications are die-cuts, open end cells, trays, pleated pads, and flat pads. See figure 4-9 for examples of these. Generally, cells and trays should be held in shape with tape. Those surfaces of the cell or tray which are perpendicular to the contacting surface of the item are called bracing supports and are the load-bearing members. To utilize all of the strength of these bracing supports, they should bear directly on the item. Pleated pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than on bracing supports. Therefore, they should be used to cushion heavier loads (up to 2 pounds per square inch). Flat pads are used to block shallow projections, to level off projecting screw heads, and to separate items within a container. They can be slotted to form partitions or may be die-cut or punched to fit articles of irregular shape. Application of fiberboard cells, trays, and pads is illustrated in figure 4-10.

**Solid Fiberboard (MIL-F-26862)**

This fiberboard is made from cane, wood or other vegetable fiber by a felting or molding process which incorporates a sizing agent to form uniform solid sheets, blocks, or special fabricated shapes. The board is made in two types - single-ply and laminated multiple-ply. The single-ply is furnished in 1/2 inch and 3/4 inch thickness. The material is available in a density of between 14 and 19 pounds per cubic foot. It has an average resilience, low compression set, low damping quality, and performs fair in cold weather. Its dusting qualities are low. The fiberboard is intended for use in packaging where a non-corrosive, fungus resistant material is needed to afford protection against vibration and impact damage during shipment and handling.

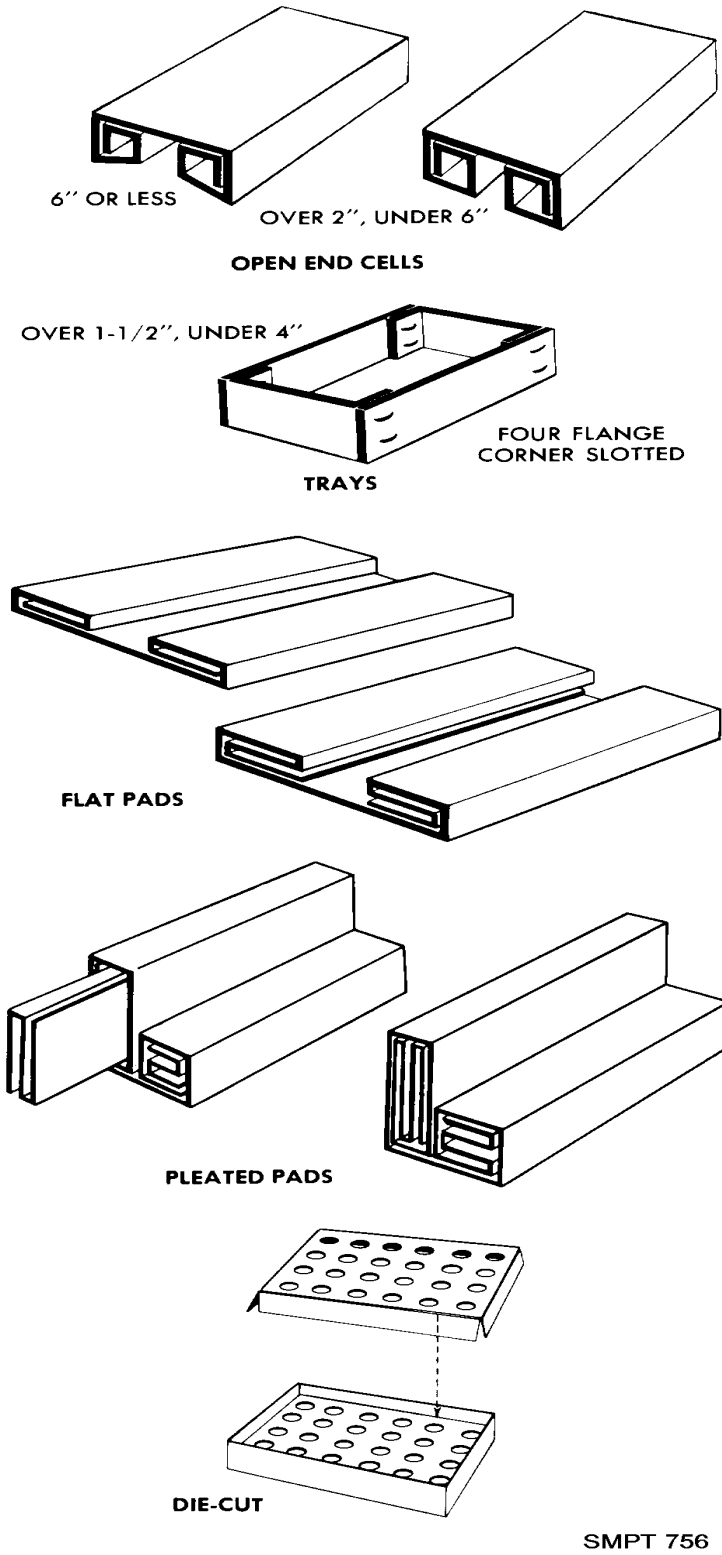
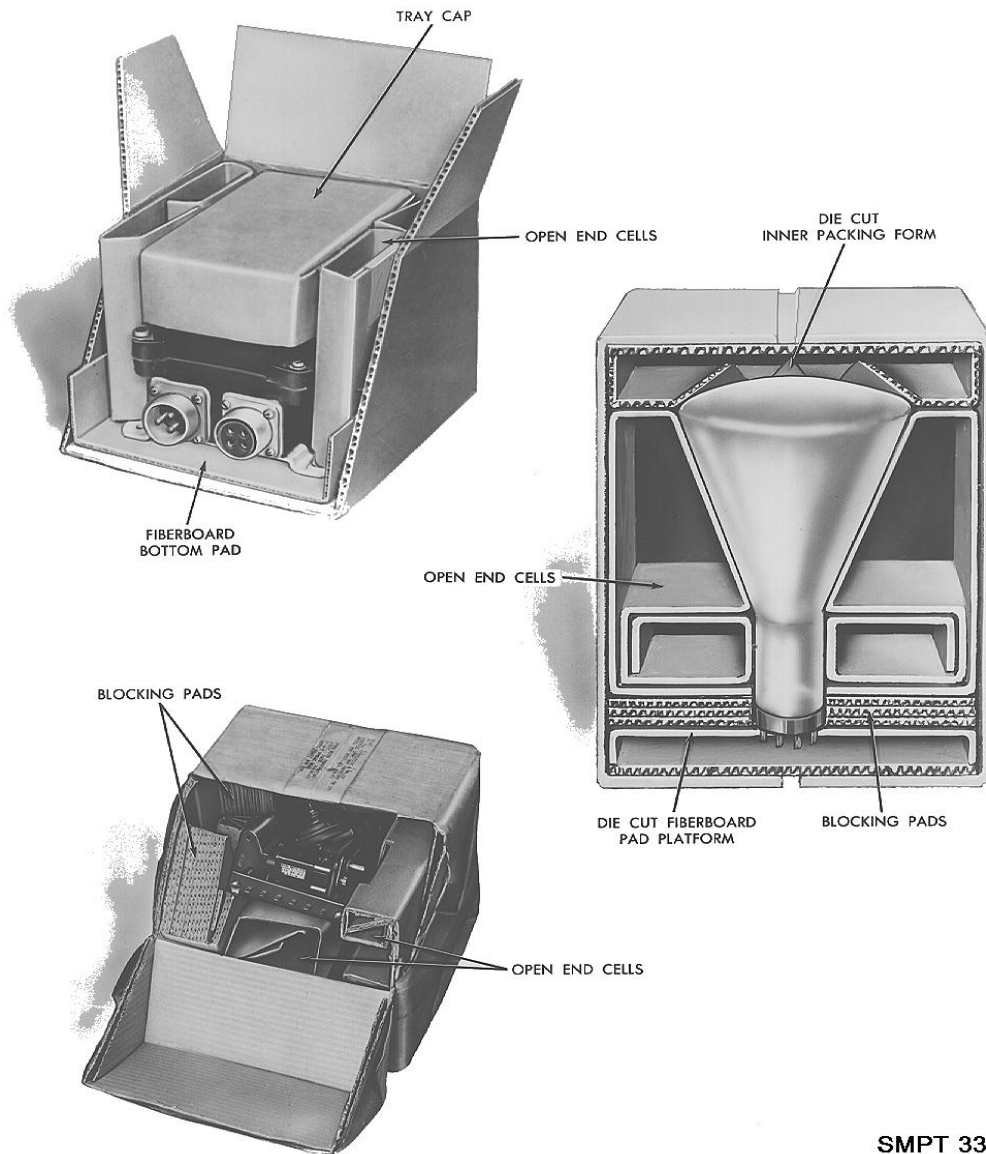


Figure 4-9. Examples of fiberboard die-cuts, open end cells, trays, and pads.



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Figure 4-10. Application of fiberboard die-cuts, open end cells, trays, and pads.

### Wrapping Paperboard (A-A-1051)

This is a paperboard composed of a corrugated sheet or a solid method pulp sheet firmly cemented to a backing flat sheet of unbleached sulfate fiber paper. The paperboard is furnished in two types - light and heavy duty, and in two styles, style 1 - backing sheet, mandatory, and style 2 - backing sheet, optional. It is furnished in sheets or rolls, as desired. This material has high compression, low resilience, excellent damping, and some dusting. The moisture content and moisture absorption are high. The material is not neutral and hence has a high corrosion effect. Its performance in cold weather is poor, and it is neither fungus nor flame-resistant. Critical metal items must first be wrapped in a chemically neutral or greaseproof barrier.

**Cushioning Material, Flexible Open Cell Plastic Film (A-A-3129)**

This material, available in sheets and rolls, is intended for use within packages. Transparent materials are especially suitable for use in inserts within transparent bags and envelopes to permit inspection of the contents. The materials are also used as bags, wraps, dunnage and as filler. Maximum transparency is obtained when use is limited to one thickness. Material may be ordered in two types, two styles, two classes, and three grades. Grade B of this material is static dissipative.

**Cushioning Material, Polystyrene Expanded, Resilient (PPP-C-850)**

This is a resilient cushioning material of expanded polymer of copolymers of styrene for use in cushioning and packaging applications. It is available in two types: type I - sheet form, classed as soft, medium, firm, and extra firm, and type II - roll form, with the same classes as type I. The material is nonabrasive and fungus- and mold-resistant. It is used as a cushioning material within packs to protect items from damage due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited to packing problems where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning and to packing problems in which the cushioning material must perform at extremely low temperatures. Resilient polystyrene cushioning material may be furnished in special converted forms, sizes, and shapes, such as with paper backing, paperboard backing, cloth backing, pressure-sensitive adhesive surface, die-cut holes or in the form of corner pads of special shapes. This material has a high compression set.

**Cushioning Material, Closed Cell Foam Plank (A-A-59136), Polyethylene And Other Polyolefin Cushioning Materials**

This specification establishes requirements for flexible closed cell foam plank material. These materials are intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, contamination and abrasions during transit. The Class 1 Polyethylene plank is inert to most chemical products and stable across a wide variation of temperature ranges. This type (formerly know as PPP-C-1752) has been widely applied to protect many types of military products for worldwide shipment and unknown storage conditions. Reliable and stable in the plank form, it is a very cost-effective selection for a wide range or products. The other classes available are intended to provide the use with options in procurement of other closed cell plank cushioning materials. Refer to MIL-HDBK-304 for specific application guidance.

**Rigid or Flexible Polyurethane Foam (MIL-PRF-26514)**

This material, furnished in rolls, sheets, or molded shapes, is available in two types, two classes, and three grades per type as follows:

Type I - Standard Foam	Type III - Anti-static Foam
Class 1 - Rigid	Class 1 - Rigid
Class 2 - Flexible	Class 2 - Flexible
Grade A - Blue	Grade A - Yellow
Grade B - Green	Grade B - Red
Grade C - Charcoal	Grade C - Brown

Materials covered by this specification (see figure 4-11) are intended for use as cushioning and blocking/bracing in packages to protect equipment and items from damage by shocks or impacts incurred during shipment and handling. Unless otherwise specified (when ordering the material), the compression set of class 2 material shall not be more than 10 percent of the original thickness.



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Figure 4-11. Polyurethane foam.

**Cushioning Material, Packaging (Flexible Closed Cell Plastic Film for Long Shipping Cycle Applications) (PPP-C-795)**

This specification establishes requirements for flexible closed cell, heat-sealable, non-corrosive, plastic film for use in cushioning and packaging applications. The cellular materials are intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, contamination, and abrasion during handling and shipment. The transparent class 1 material and class 2 material permit inspection of the contents, without opening the package, for condition of humidity indicators. The flexibility of the material permits it to be used as pads, bags, wrap, dunnage, or filler. When maximum transparency is desired, the use of class 1 or class 2 material should be limited to one thickness. Class 2 materials are used to protect electronic devices which are sensitive to static charges. Class 3 material is used where fire retardant cushioning material is required.

**METHODS OF CUSHIONING**

Cushioning is usually accomplished by any of four methods or a combination thereof. The methods are known as floated item, floated pack, corner pads and side pads, and shock mounts.

**Floated Item (figure 4-12)**

The item is floated in cushioning material and placed within a unit container. This is perhaps the method most commonly used for cushioning small, lightweight, fragile items against shock, vibration, and abrasion. Cushioning materials must be secured about the item. Loose cushioning may result in either the displacement of the material when the pack is subjected to shock, its disintegration under repeated vibration, or the production of dust or loose particles which will be entrapped within the pack. Since a container may be dropped on any one of its faces, edges or corners, the cushioning material must be designed to withstand the full impact of the entire weight of the item in any direction.



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Figure 4-12. Methods of cushioning - floated item.

**Floated Pack (figure 4-13)**

The item is packed in an interior container which in turn is floated in cushioning material. This method is generally used in connection with semi-fragile items of medium size and weight. The item is initially packed (which may include cushioning or blocking) in an interior container, then floated in cushioning, and placed into an exterior container. In this method, the noncorrosiveness and moisture content of the cushioning materials are not critical since the materials will not come in contact with the item. The use of absorbent cushioning materials, when used in this method, should be governed as follows:

- X When both the interior and exterior containers are water-resistant, the cushioning material may be simply placed between the two containers.
- X When either container is nonwater-resistant, the cushioning material must be placed in the form of pads wrapped in a water-resistant barrier material. Alternately, provide the interior container with a sealed water-resistant wrap and the exterior container with a sealed liner. The cushioning material is then placed between the two barriers.

**Corner Pads and Side Pads**

In cases where a full floated item or pack is not justified either because of weight and size or fragility of the item, corner blocks or side pads may be utilized. Corner blocks are used where a minimum amount of material is required to cushion the item. The total surface area of cushioning material for a side is determined, then divided by four. This gives the amount of material for each corner. This is done in turn for all six surfaces. Corner pads are also used where the only requirement of the cushioning is separation of the item from the container.

When the amount of the cushioning material required is too great for proper utilization of corner pads, the use of side pads is indicated. The amount of material per side must be of sufficient quantity as to preclude buckling.

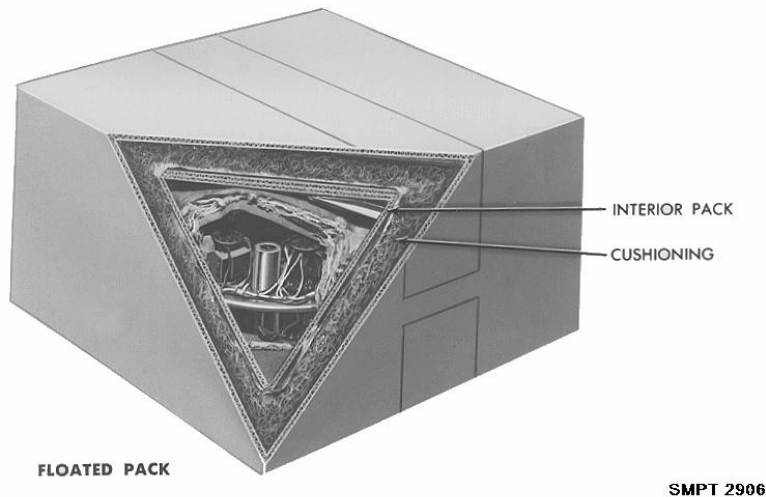


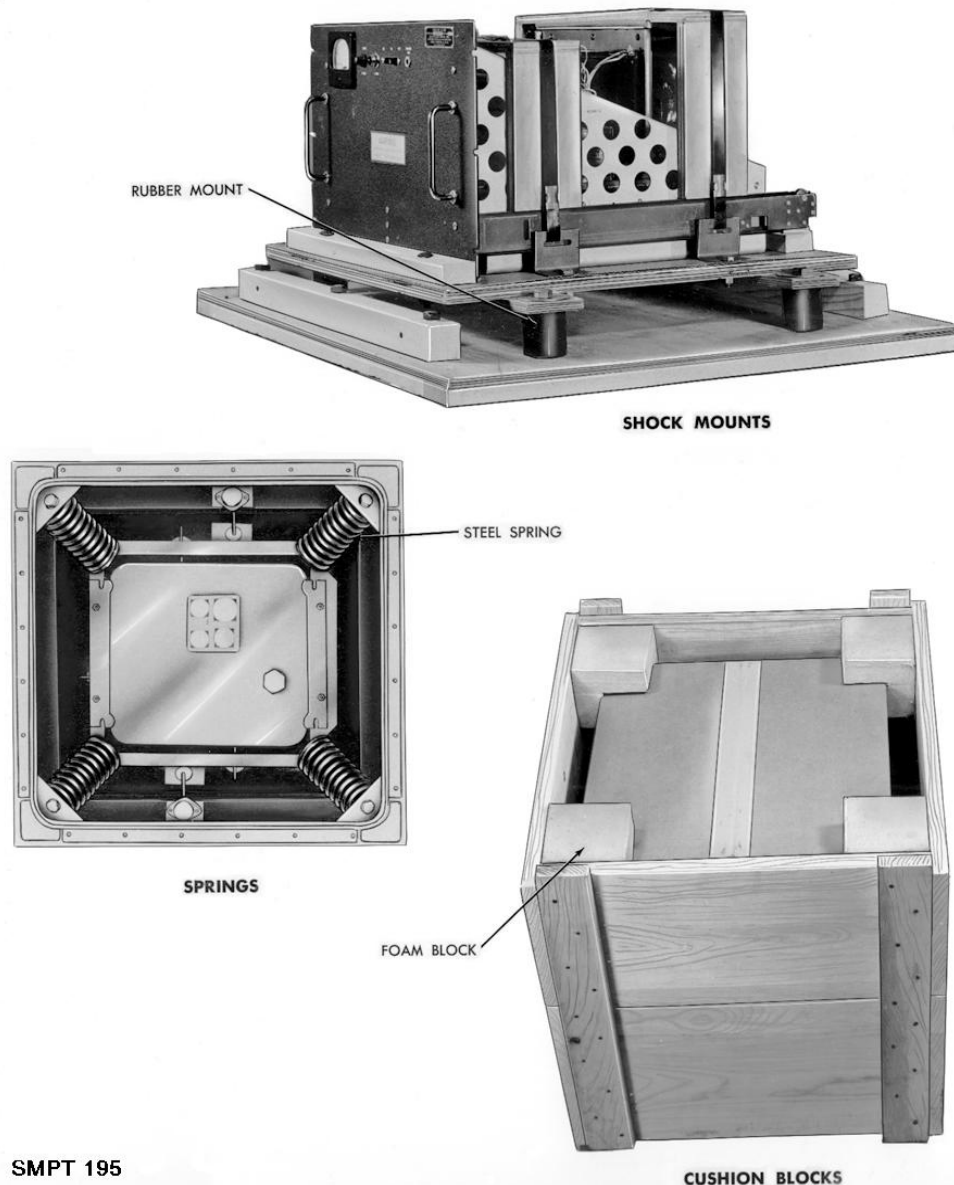
Figure 4-13. Methods of cushioning - floated pack.



**Shock Mounts (figure 4-14)**

The item is cushioned by means of shock mounts. This method is used to cushion fragile items and sensitive instruments or mechanisms that can be damaged by shock and vibration. The weight and size of the item may vary from light and small to heavy and large. The shock mounts may consist of metal springs with damping, shear mounts, or corner blocks. This method of cushioning may be accomplished in four main ways -

- X The item may be suspended directly by the means of shock mounts.
- X The item may be blocked in a cradle and the cradle suspended by means of shock mounts.
- X The item may be boxed in a unit container and the unit container suspended by means of shock mounts.
- X The item may be boxed in an intermediate container and the intermediate container suspended by means of shock mounts.



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Figure 4-14. Methods of cushioning - shock isolators.

## HEAT SEALING

### IMPORTANCE OF HEAT SEALING

Since World War II, the development of flexible heat sealable barrier materials for military purposes has proceeded at a rapid pace. Scores of barrier materials have been produced for packaging everything from small instruments to jet airplane engines. These barrier materials have been designed to insure long term storage of military supplies under all climatic conditions. They have been constructed to keep preservative oils and greases in contact with metal surfaces and to keep water and water vapor out of the interior of packs. Regardless of how good the barrier material may be, if the pack is not adequately closed and sealed, the contents may arrive at their destination in an unusable condition. One of the problems confronting personnel engaged in military packaging operation is to obtain good heat seals when using heat sealable barrier materials. In the following paragraphs, the basic requirements, methods, and equipment necessary to obtain good heat seals will be discussed.

### MILITARY REQUIREMENTS FOR HEAT SEALING

All heat seals performed on heat sealable barrier materials must meet the following three basic requirements:

- X The heat seal must not leak.
- X The heat seal must give the same degree of waterproofness, vaporproofness, or greaseproofness as required of the barrier material itself.
- X The seal must pass the test described later in this chapter.

### HEAT SEALABLE BARRIER MATERIALS

#### Construction (figure 4-15)

To understand the factors essential to proper heat sealing and the equipment needed to produce acceptable heat seals, a general knowledge of the construction of the materials involved is helpful. Most of the heat sealable barrier materials used by the military are composed of several layers or plies of unlike materials laminated together to form a multi-ply or built-up sheet. The general structure of such a built-up sheet or barrier is a heat sealable face, an impervious ply, and a backing ply.

#### The Heat Sealable Face

This face may be a ply (film) or a coating. This is a thermoplastic material which has the ability to become semi-fluid and flow upon the application of heat. After cooling, the plastic returns to a normal, solid, flexible state. This facing material is made from polyethylene, vinyl chloride, or other plastics. Besides providing a heat sealable face, this material also serves to fill tiny pin holes in the underlying plies to aid in making the barrier resistant to water, grease, or vapor.

#### The Impervious Ply

This is composed of a metal foil (aluminum) or plastic film (polyethylene, cellulose-acetate, etc.). It gives the whole barrier its greaseproof, waterproof, or watervaporproof properties. This ply may also serve as a heat sealable ply in some types of barrier materials.

#### The Backing Ply

Usually, this ply is made of cotton cloth (scrim), other fabric, or kraft paper. This ply may be reinforced with glass fibers or other materials. The purpose of this ply is to increase the resistance to abrasion, wear, and puncture, and to improve the tensile strength of the whole sheet.

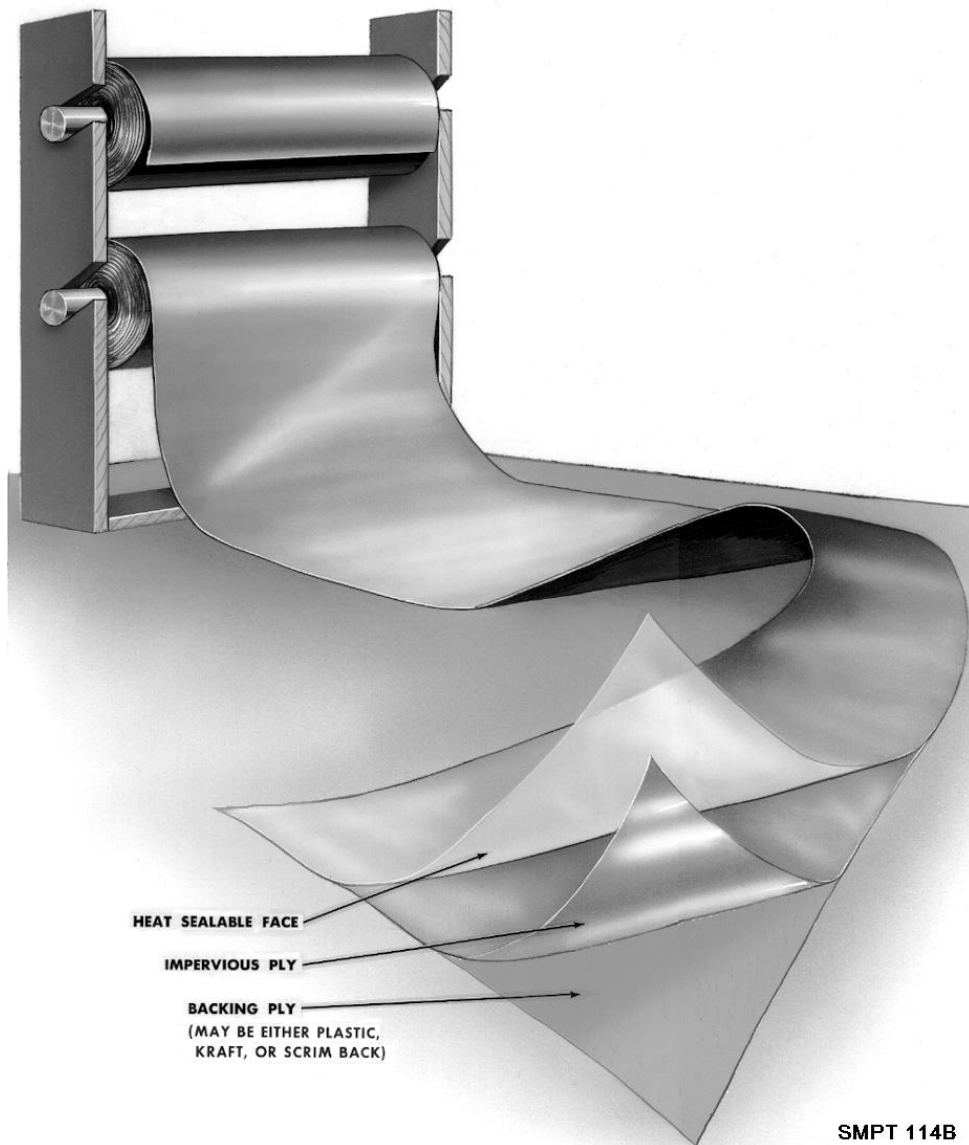


Figure 4-15. General structure of heat sealable barrier materials.

### Common Types of Heat Sealable Barrier Materials

Heat sealable barrier materials offer protection from liquid water (waterproof), watervapors (watervaporproof), grease (greaseproof) and electrostatic discharge (electrostatic free). The protection provided, along with specification numbers for the barrier materials are -

- X Waterproof: A-A-3174, Type I or II; and MIL-PRF-22191, Type III.
- X Waterproof-greaseproof: MIL-B-121, Type I or II, and MIL-PRF-22191, Type II.
- X Waterproof-electrostatic free: MIL-PRF-81705, Type II or III.
- X Watervaporproof-greaseproof: MIL-PRF-131 and MIL-PRF-22191, Type I.
- X Watervaporproof-electrostatic free: MIL-PRF-81705, Type I.

### **FACTORS ESSENTIAL TO PROPER HEAT SEALING**

To produce heat seals that can meet the military requirements there are three essential factors that must be considered and fully understood. These are the temperature, the pressure, and the dwell time. These factors are independent but fully interdependent of each other. If one factor varies, the other two must be adjusted for proper correlation.

#### **Temperature**

Enough heat must be applied to the thermoplastic material on the sheets to be bonded to allow it to soften and reach its flow temperature. Too low a temperature may result in either no seal being made or a weak seal (adhesive tack). Too high a temperature may cause delamination or separation of the backing ply from the other plies and/or decomposition of the thermoplastic. Barrier materials, generally, must be capable of being heat sealed at a temperature not to exceed 525°F. Manufacturers of heat sealable barrier materials are required to supply recommended temperatures for effective sealing of their materials on the different types of equipment authorized by the Military.

#### **Dwell Time**

Dwell Time is the length of time material remains in the heating zone. Enough time must be permitted to raise the temperature of the heat sealable face to its flow temperature and allow the molten thermoplastic surfaces to form one continuous mass. Dwell time and temperature are interdependent. The lower the temperature, the greater the dwell time and vice versa, provided the limits for each factor are not exceeded. As an example, a particular barrier material, when sealed at a temperature of 450°F., requires a dwell time of 2-1/2 seconds to produce heat seals with maximum strength. The same material, sealed at 400°F., requires a dwell time of 3 seconds to produce seals with the same strength characteristics. With the exception of special equipment, no dwell time below 1/2 second will produce a good heat seal regardless of the temperature used.

#### **Pressure**

Pressure is what brings the surfaces to be sealed into intimate and continuous contact, thereby aiding in the heat flow through the backing material (e.g., scrim or kraft) to the thermoplastic surfaces. Excessive pressure tends to force out the molten thermoplastic material and results in defective seals. Pressure should be maintained at 40 to 80 P.S.I.

### **HEAT SEALING EQUIPMENT**

Heat sealing equipment can be divided into two general classifications, unit or jaw type and continuous type. Each type may have many variations or attachments, depending upon the manufacturer; however, the basic operation is essentially the same within each classification. Specification A-A-2963 covers both unit and continuous type heat sealers intended for heat sealing thermoplastic film (unsupported) and barrier (supported) materials. All machines covered by this specification must have adjustable, directly calibrated controls to regulate the temperature, dwell time, and pressure.

***The Unit or Jaw Type Sealer (Figure 4-16)***

This type of sealer comprises two opposed, parallel jaws which can be brought together either manually or mechanically. One or both of the jaws are provided with heating elements. The temperature is controlled by means of a thermostat. The dwell time is controlled by the duration of pressure, either manually or by automatic timing devices. The pressure is usually controlled by a spring or by a pressure cylinder actuated by pneumatic or hydraulic power. The jaws of a unit type sealer are sometimes covered or coated with a antistick facing material to prevent adhesion of plastic films to the hot surfaces. Some sealers are made with one or more resilient jaws which help to smooth out irregular thicknesses of material such as wrinkles, splices, gussets, etc.

***The Continuous Type Sealer (figure 4-16)***

There are two basic variations of the continuous type sealer known as rotary and band type sealers, which are used for high volume heat sealing operations.

***Rotary Sealers***

In their simplest form, the sealers consist of a pair of driven and heated rollers between which the material to be sealed is passed. The rotating wheels are used to apply heat and pressure to the barrier material. Dwell time is controlled by varying the rate of speed at which the material passes through the rollers. Rotary sealers are usually equipped with a chain or belt type intake to feed the material into the sealer and a discharge unit to guide the material out of the sealer after it had been sealed. Some sealers employ "preheaters" to precondition the temperature of the thermoplastic prior to sealing.

***Band Type Sealers***

Band type sealers make use of two thin endless metal belts to carry the material through the heating zone (and sometimes a cooling zone) while applying pressure and heat continuously. The band type sealer may look like a rotary sealer but operates on a different principle. Heat is transferred from the heating jaws through the metal bands to the barrier material. The temperature is thermostatically controlled. The dwell time is controlled by varying the speed of the bands through the heating zone. The pressure is usually applied by pressure rollers, although a small amount of pressure is applied to the bands by the heating jaws. The roller pressure is controlled by mechanical or hydraulic power, or both.

***Hot Air Continuous Heat Sealer***

The hot air continuous sealer provides a much higher efficiency along with reduced setting up and maintenance time. The unsealed bag is fed into the sealer guides, where it is gripped by two belts and is carried through a heating section. Here, opposing streams of hot air strike the bag sides along a narrow band, causing a heated bond to be formed on the inside surfaces of the bag. After heating, the bag immediately passes through two pressure rollers to complete the weld. The hot air temperature is controlled by a proportional control circuit. The temperature is set on the control panel by the operator.

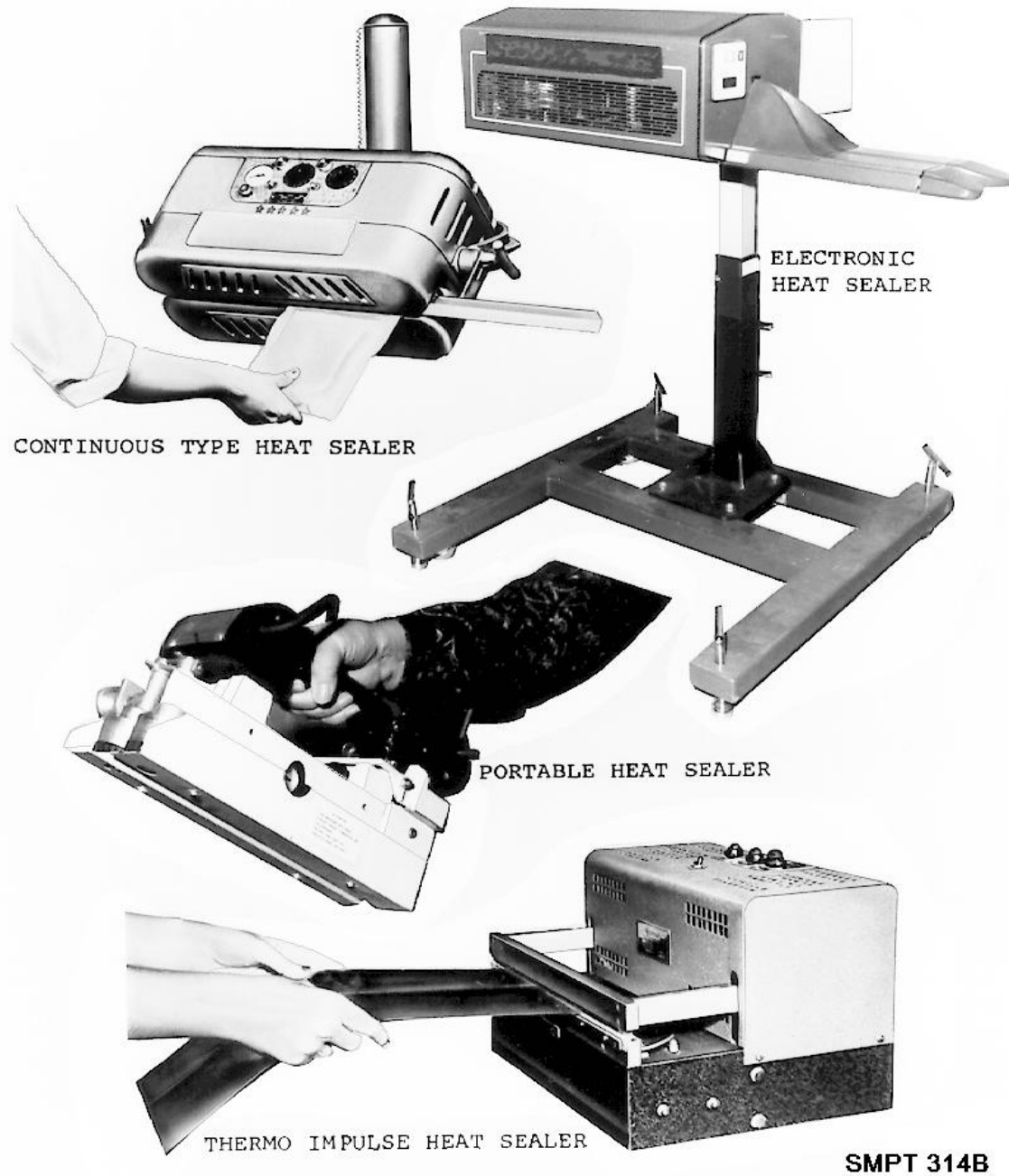


Figure 4-16. Heat sealing equipment.

#### OTHER TYPES OF HEAT SEALERS

There are other types of heat sealing machines which are used primarily for sealing of unsupported films. A brief description of two of these follows:

##### Electronic Type

This type uses a high frequency current to generate heat in the surface to be sealed as the material passes between two electrodes. The electrodes remain at room temperature.

### **Electrical Impulse Type (Figure 4-16)**

This machine, which is covered by A-A-2953, looks like a conventional jaw type sealer and operates mechanically the same way, except that an electrical resistance wire is mounted on one of the sealing jaws. The electrical resistance wire, when brought in contact with the material, is heated in a fraction of a second by a heavy current flow and melts and fuses the thermoplastic. The jaws remain closed after the flow of current, thus cooling the seal under pressure. Polyethylene, vinyl, polystyrene and polyester are some of the films commonly sealed with electrical impulse type sealers.

### **DETERMINATION OF TEMPERATURE, DWELL TIME, AND PRESSURE**

Several methods are used to determine starting points for achieving satisfactory heat seals. Two such methods are the manufacturer's recommendations and trial and adjustment.

### **THE MANUFACTURER'S RECOMMENDATIONS**

Manufacturers' recommendations are furnished with each roll of barrier material; these include the recommended temperature, dwell time, and pressure to be used on rotary, band, and jaw type equipment. These recommendations will usually give a good indication as to the settings to be used in the initial attempt to heat seal. The recommended values should be used cautiously because some thermoplastics and adhesives change characteristics upon aging; recommended values for one type of sealing machine do not apply to all machines of the same type; and machines of the same make may vary in temperature, dwell time, and pressure at identical settings.

### **TRIAL AND ADJUSTMENT**

If satisfactory heat seals are not obtained by following the manufacturers' recommendations, or if the recommendations are not available, the temperature, dwell time, and pressure should be determined by the following trial and adjustment method. Set the heat sealing machine controls for dwell time at 250 to 500 increments of temperature starting at about 250°F for kraft-backed sheets and 300EF for scrimbacked sheets. After cooling the sealed specimens to room temperature, pull each specimen slowly apart by hand and observe the following:

- X Degree of difficulty in separating the sheets of barrier material.
- X Delamination of the heat sealable face from the other plies of the barrier, and the extent of delamination.
- X Color changes on the heat sealed area of the backing material, such as scorching, burning or charring, which indicate too high a temperature.

The correct temperature to use is the lowest temperature at which the heat sealable face completely pulls away from the other plies of the material.

## **CONSTRUCTION OF METHODS OF PRESERVATION**

### **GENERAL CONSIDERATIONS**

#### **Item Protection**

The method selected must adequately protect the item from corrosion, deterioration and physical function damage during storage and multiple handlings and shipments associated with the military distribution system. Physical and mechanical function protection is required for all methods of preservation in addition to the specific environment protection provided.

### **Cushioning and Dunnage**

When specific methods require using a bag or container, the preliminary wrapping, cushioning or other dunnage material shall be applied as necessary to protect the item as well as the bag and the container from the item's projections and sharp edges as well as to restrict its movement within the unit pack. All cushioning and dunnage used shall be as clean and dry as practicable to minimize item susceptibility to corrosion and contaminants.

### **Surfaces Coated with Preservative**

Preliminary wrapping materials in contact with the preservation coated item shall be greaseproof and shall conform to the following:

- X MIL-B-121, Grade A
- X QQ-A-1876.

Preliminary greaseproof wraps applied solely to confine the contact preservative on item surfaces are not necessary when a method requires a bag as the preliminary container and the bag is made of material conforming to MIL-B-121, grade A; MIL-PRF-131; or MIL-PRF-22191, type I or II. However, wraps will not be excluded if necessary to protect the bags from rupture or perforation.

### **Metal Surfaces not Coated with Preservatives**

Only noncorrosive wrapping, cushioning and dunnage materials meeting the test requirements of Test Method 3005 of Federal Test Method Standard No. 101 shall be used in contact with metal surfaces of the item. The following neutral wraps meet this requirement:

- X MIL-P-130
- X MIL-P-17667.
- X A-A-3174.
- X A-A-1249

These papers are intended as an initial wrap where a noncorrosive, dust protective wrap is required prior to or as a part of unit packing wherein a greaseproof wrap is not required.

### **Weight and Cube**

Unit packs (methods) shall be designed to minimize weight and volume (cube) to the maximum extent practicable.

### **Use of Transparent Materials**

Where methods allow options in the selection of materials which include both transparent and opaque protection, transparent protection may be furnished at the option of the supplier but is not required unless specifically called for in the contract or order. When a transparent unit pack is specified, the preliminary wrapping, cushioning materials, etc., shall also be transparent.

### ***Critical Surfaces of Metal Items***

Do not touch critical surfaces of metallic items with your bare hands during packaging operations as these items are of such a nature that any degree of deterioration will result in premature failure or malfunction of the item or equipment in which installed or to which item is related. Either wear gloves (rubber or canvas) or handle these items with neutral wrapping material so as not to contaminate the item with perspiration, fingerprints, or similar residues.



### ***Electrostatic Discharge Sensitive (ESDS) Items***

People handling ESDS items should be trained in ESD precautionary procedures. Untrained personnel should not be allowed to handle ESDS items when the items are outside the ESD protective packaging.

ESDS items should be removed from ESD protective packaging using finger or metal grasping tool only after static charges are neutralized. Neutralize charges of ESD protective packaging containing an ESDS item by placing the packaged item on an ESD grounded workbench.

Alternately, charges can be neutralized by personnel wearing a grounded wrist strap touching the package.

### **Safety and Health**

The Occupational Safety and Health Administration (OSHA) established a Hazard Communication Standard entitled 29 CFR, Parts 1910.1200. This workers-right-to-know standard was written to reduce injuries or illnesses caused by personnel working with or exposed to chemicals. Workers need to know the chemical hazards they are exposed to and the safe practices linked with those chemicals used in the work place.

Many of the cleaning materials and preservatives used with the methods of preservation are chemicals that require Material Safety Data Sheets (MSDS) to let workers know the potential dangers they present if not properly used.

29 CFR tries to make certain that you understand chemical safety. The standard mandates that employers meet the following requirements:

- X Containers of hazardous materials must be properly labeled.
- X Training programs must be established to assist employees in using chemicals safely as well as to enable them to deal with an emergency in containing or neutralizing a spill.
- X A MSDS must be available at all times.

A MSDS identifies chemical substances or mixtures by trade name and chemical name. It also names the hazardous properties of the chemical. A MSDS contains safe conditions for handling hazards of a material plus procedures for dealing with an emergency including first aid procedures. Material Safety Data Sheets are a legal requirement as well as a source of efficient information in a safety program.

MSDS and/or Hazardous Material Information System (HMIS) files must be provided for each chemical/hazardous material that you will be working with during packaging operations.

Review the applicable MSDSs or HMIS files of the chemicals that you work with to insure that you are aware of the following information:

- X The chemicals being used.
- X Protective apparel to be worn while working with each chemical, i.e., aprons and goggles.
- X Health hazards, i.e., symptoms of exposure.
- X Safety procedures that should be followed, i.e., use of ventilation systems and reactions to leakage or materials spills.

- X You should report all spills of chemicals to your supervisor or as required by your local standard operating procedures.

## **METHOD 10 - PHYSICAL PROTECTION**

### **CONCEPT**

The unpreserved item(s) shall be tagged, bundled (i.e., tied, taped, strapped, etc.) skin packed, enclosed within wrappings, bags, cartons, boxes or other containers, as applicable to provide protection from physical damage and mechanical malfunction.

As the name of this method implies, it provides physical and mechanical protection only. No protection is afforded the item against the entry of water, watervapor, fumes, atmospheric gases, or the growth of microorganisms. No contact preservatives are authorized for this method of preservation.

Protection against climatic and atmospheric conditions is not provided because the items packed by Method 10 are, by the characteristics of their construction and composition, immune to such conditions.

If the item to be packed needs a contact preservative or a barrier such as a waterproof material to protect it, then Method 10 is not an appropriate method of preservation for the item.

### **Intended Use**

Method 10 is a method of preservation for items of a chemically noncritical nature made of corrosive-resistant metals or inert nonmetals such as crockery, ceramics or nonoptical glass or items rendered deterioration-resistant by the application of metal platings, paint, prime coatings, plastic coatings, or similar treatments or finishes. Items appropriate for Method 10 preservation include motor vehicle bumpers, tires, and windshields; tent pegs and poles; wire fencing; and many other items designed to be used in an unprotected environment.

### **CONSTRUCTION STEPS AND TECHNIQUES**

A variety of techniques used in the construction of Method 10 unit packs is provided below. These techniques include forming unit packs that are bundled (i.e., tied, taped, strapped, etc.), skin packed, or enclosed within wrappings, bags, cartons, boxes or other containers, as applicable, to provide protection from physical damage and mechanical malfunction. It is neither practicable nor possible to present detailed information on all of the Method 10 applications. Several of the most common applications are given below. Figure 4-17 illustrates some of these techniques.

### **Method 10 (bundling)**

Bundling is appropriate for items of military supply such as lumber, tent-poles and stakes, rods, metal and nonmetal pipe, tubes, automobile bumpers, and rolls of material such as wire or roofing. The following steps should be followed:

#### ***Step 1***

Clean and dry the item as required.

**Step 2**

Apply cushioning or dunnage or wrap (or blocking and bracing) to individual item(s) that are damageable. Materials will be clean and as dry as practicable.

Note: Also apply protective pads (i.e., cushioning or fiberboard) between the item and the bundling material as required to prevent the strapping, wire or twine from inflicting damage to the item(s).

**Step 3**

Tie or strap or tape the item(s), as applicable to form the unit pack. Bundling materials available include (but are not limited to) the following:

- X A-A-1451 (twine, cotton, up to 48 lbs breaking strength).
- X A-A-228 (twine, jute, up to 370 lbs breaking strength).
- X T-R-650 (rope, up to 18,600 lbs breaking strength).
- X T-R-605 (rope, up to 95,000 lbs breaking strength).
- X ASTM D 3953 (steel strapping, up to 47,150 lbs, depending on width and thickness).
- X ASTM D 5330 (filament reinforced tape, up to 400 lbs per inch of width breaking strength).

Note: Refer to specific specification (or ASTM) for use and limitations of bundling materials.

**Step 4**

Apply markings according to MIL-STD-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see the example of unit pack markings in figure 4-46.

**Method 10 (Cartonizing or Boxing)**

This technique involves enclosing the item cleaned, dried, cushioned, blocked and braced, as required, in a carton or box. Contact preservatives are prohibited as well as barriers that afford protection from the environment. Remember that any and all techniques used in Method 10 preservation protects the item from physical and mechanical damage only.

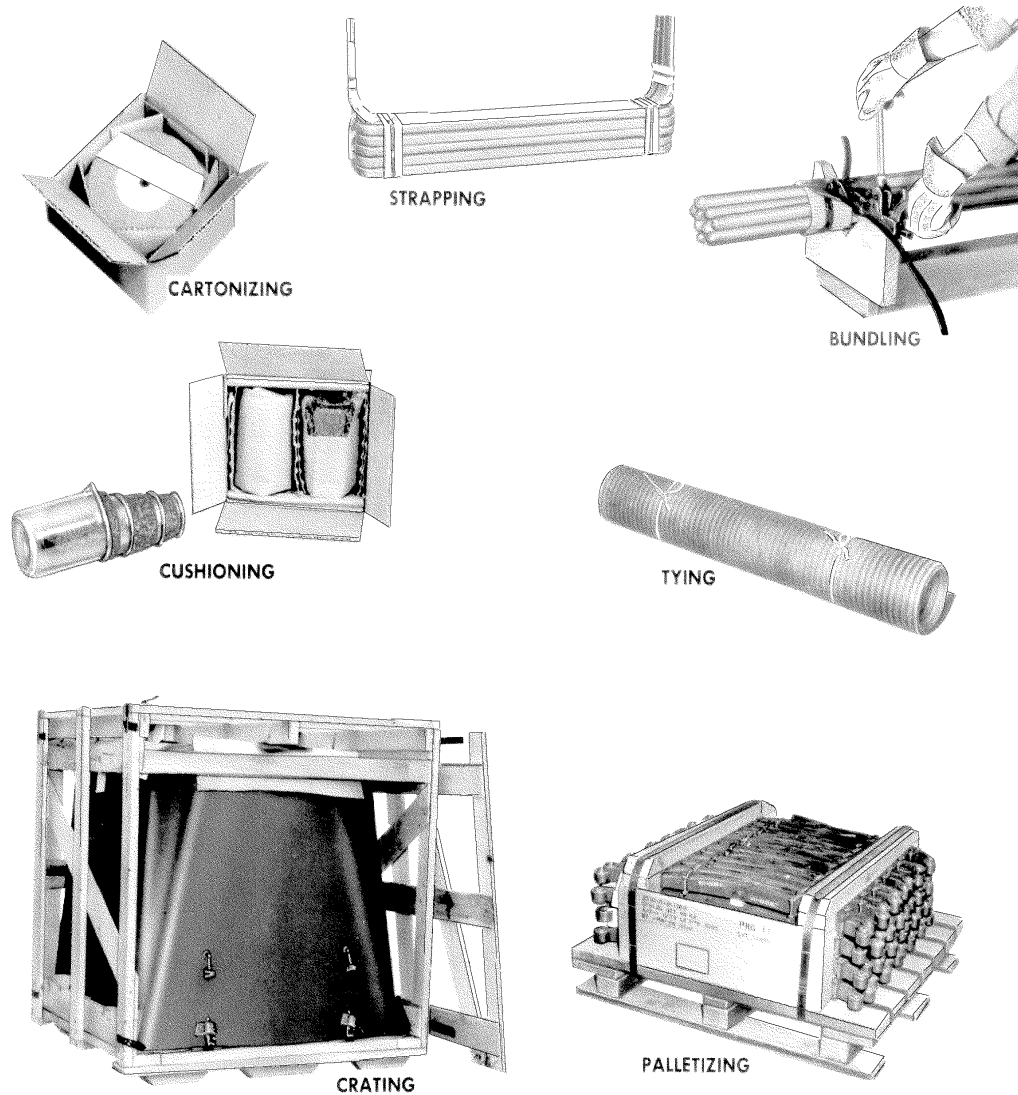
**Step 1**

Clean and dry the item as required.

**Step 2**

Apply cushioning materials, dunnage, blocking and bracing as required to protect the item(s) and the enclosing box or carton and to restrict the movement of the item within the container. (Note: See "METHODS OF CUSHIONING" presented earlier in this chapter).

Note: When the unit pack quantity is greater than one, individual items that are damageable should be wrapped, e.g., MIL-B-130, for protection.



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Figure 4-17. Application of Method 10.

**Step 3**

Enclose the item (cushioned as required) into a carton or box selected from MIL-STD-2073-1C, as appropriate (containers given in chapters 6 and 7 are examples). The following cartons and boxes (see chapter 6) are commonly used:

- X Fiberboard Boxes.
- X Folding Boxes.
- X Set-up Boxes.
- X Metal-edged Paperboard Boxes.

Note: Information of the use and closure of these boxes is given in chapter 6 of this manual.

The following types of reusable cushioned boxes (Fast Packs) are designed for items of various shapes and sizes and are also authorized for Method 10.

- X Type I - Vertical star packs.
- X Type II - Folding Convolved packs.
- X Type III - Telescoping Encapsulated packs.
- X Type IV - Horizontal Star Packs.

Note: See the different styles and available sizes as well as box closure information concerning Fast Packs in chapter 8.

***Step 4***

Apply markings according to MIL-STD-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see the example of unit pack markings in figure 4-46.

**Method 10 (Other Techniques)**

There are several other techniques that may be used to accomplish Method 10. These include skin packing, bagging, and wrapping. Skin packing will be covered in detail next in this chapter under the paragraph entitled "THERMOFORMED PACKING" as a separate entity, although you must remember that thermoformed packing is authorized as a technique used in Method 10. If skin packing (an example of thermoformed packing), bagging or wrapping is used, you must remember to mark the pack in accordance with MIL-STD-129 as you would any other method of preservation presented in detail earlier in this chapter.

## **THERMOFORMED PACKING**

Thermoformed packaging is packaging which employs thermoplastics which may be drawn tightly against the item, as in skin packaging, or molded to the approximate configuration of the item, as in bubble packing, by heating the plastic to its softening point and draping it about the item or mold. Examples of the films used are flexible vinyls, acetates, butyrates, styrene, polyester films, and polyethylene.

### **THERMOFORMING**

The most common method of thermoformed packing is known as vacuum forming. This method employs a machine capable of performing two functions basic to the method, i.e., the creating of a vacuum and the application of heat to transparent material used for the packing. In addition to the transparent film, there is usually employed a backing or mounting board. Figure 4-18 is an example of a typical machine used for developing vacuum formed packs.

### **VARIATIONS OF THERMOFORMING**

There are three variations of the thermoformed pack, the "skin" pack, the "blister" pack, and the "shrink" pack.

#### **Skin Pack**

The skin pack is so named because, as a result of the process, the transparent film is drawn tightly around the item being packed, forming a skintight protective covering. In forming this pack normally a backing board is used on which to mount the item and to which to heat seal the transparent film. This backing board extends from within a few inches of the heating unit in its forward position to an immediate proximity to the platen. In the uppermost position, heat is applied to the transparent film by drawing the heating unit over it. When the transparent film has been adequately heated, the clamping frame with the softened film is dropped to the lower position, bringing the film in direct contact with the item being packed. Simultaneously, a valve is opened allowing the air beneath the transparent film and surrounding the item to surge into the vacuum tank, thus permitting the atmospheric air pressure to force the film down tightly to the backing board and tightly around the item. When the film cools, it forms a sealed covering over the item.



Figure 4-18. Vacuum forming machine.

**Blister Pack**

The blister pack, sometimes known as the "bubble" pack, varies from the skin pack in that the transparent film is performed around a mold, resulting in a configuration being imparted to the transparent film which approximates the general contours of the item to be packed. This performed, rigid blister or bubble is usually formed with a flange either 1/4 or 1/2 inch in width. This flange permits the stapling, gluing, or sealing of the blister over the item to the backing. Figure 4-19 illustrates the basic components of the blister pack.

**Shrink Pack**

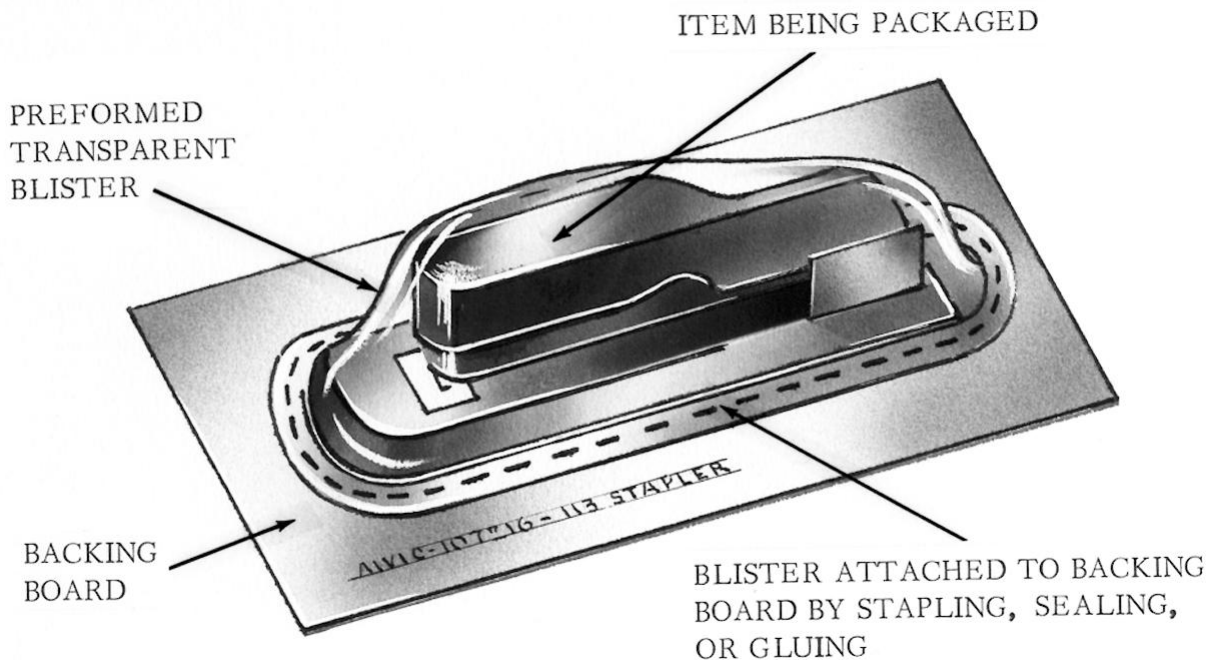
The shrink pack, unlike the two previous methods of packing, employs no vacuum but instead uses a heat tunnel and transparent films with a built-in memory. The item to be packed is wrapped in the film and then passed through the heat tunnel, where the heat shrinks the film (memory effect) to form a contour-fit pack.

**PROTECTION AFFORDED**

The packs resulting from the application of the above techniques can generally be considered to provide, as a minimum, Method 10 protection. Methods 30, 40, and 50 protection may be afforded by making such provisions as will insure the impermeability of the package to water or water vapor.

**DEVELOPMENT AND APPLICATION**

The above description of thermoformed packing serves mainly as an introduction to this type of packing. Further research of technical manuals, pamphlets, and texts, is necessary in developing a particular type of pack or in establishing thermoformed packing at a facility. See figure 4-20 for variations of plastic packages.



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Figure 4-19. Blister pack.



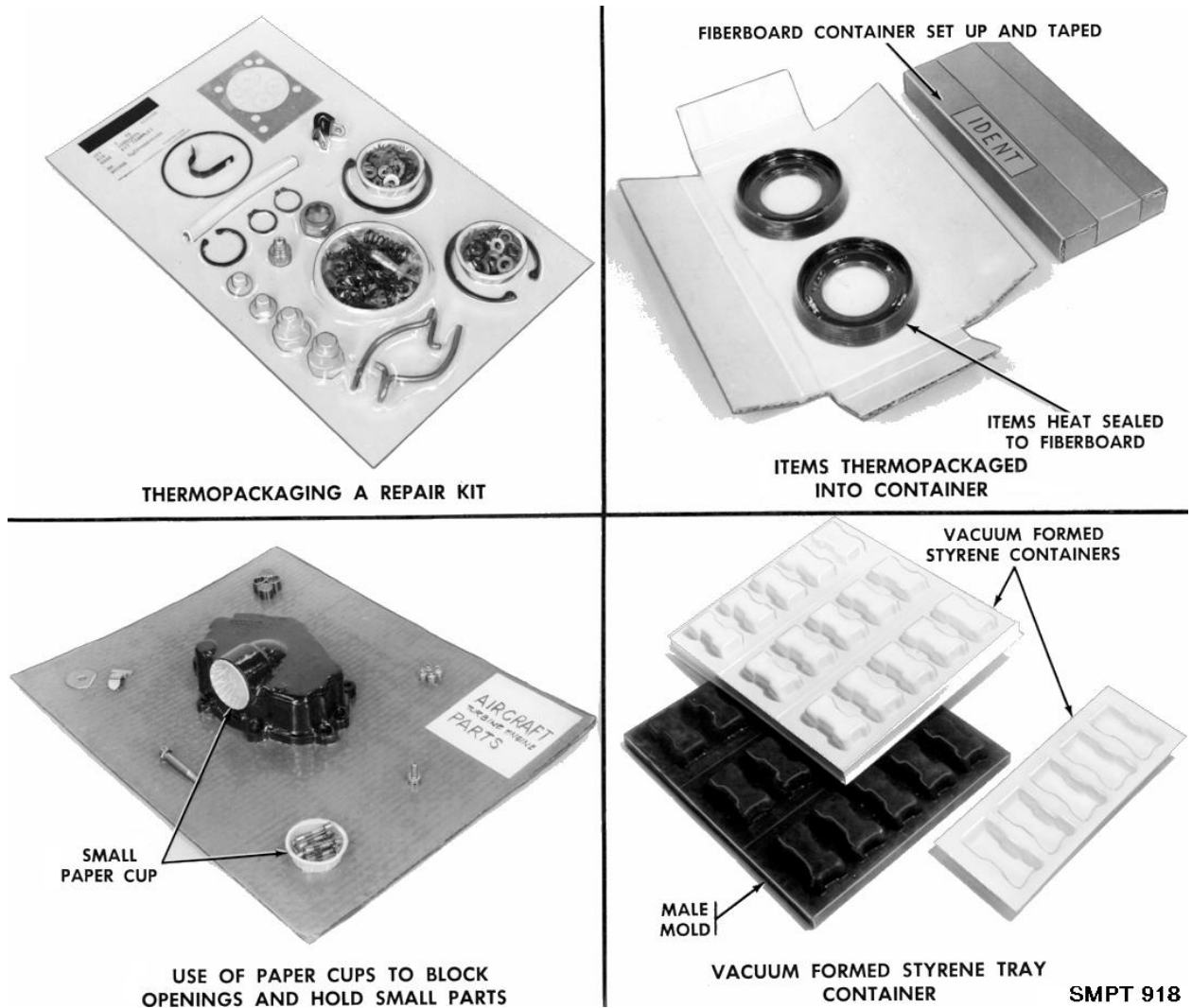


Figure 4-20. Variations of plastic packages.

#### THERMOFORMED PACKING EQUIPMENT

There are many machines on the market that are designed to accomplish thermoformed packing. These machines vary in size, configuration, productive capacity, and price range, but they are all of the same basic design. Figure 4-18 points out the basic design features of the vacuum forming machine. The simplest design includes the following components:

- X A rod-type heater, controlled to about 400°F output, mounted on the underside of a hood.
- X Two actuator switches, one for the heating unit and the other for the vacuum pump.
- X A master clamp frame and seal with spring-loaded lock grips.
- X A drape mechanism.
- X A machine platen, slightly smaller than the opening in the master clamp frame.
- X A vacuum unit and parts.

- X A timer for controlling the heating and vacuum cycles.
- X A mount for the roll of plastic film.

### THERMOFORMED PROCESS

To perform the thermoformed process, the manufacturer's instructions should be followed for operation of the equipment. Figure 4-21 shows how the plastic sheet is draped over the item and then sealed to the backing board.

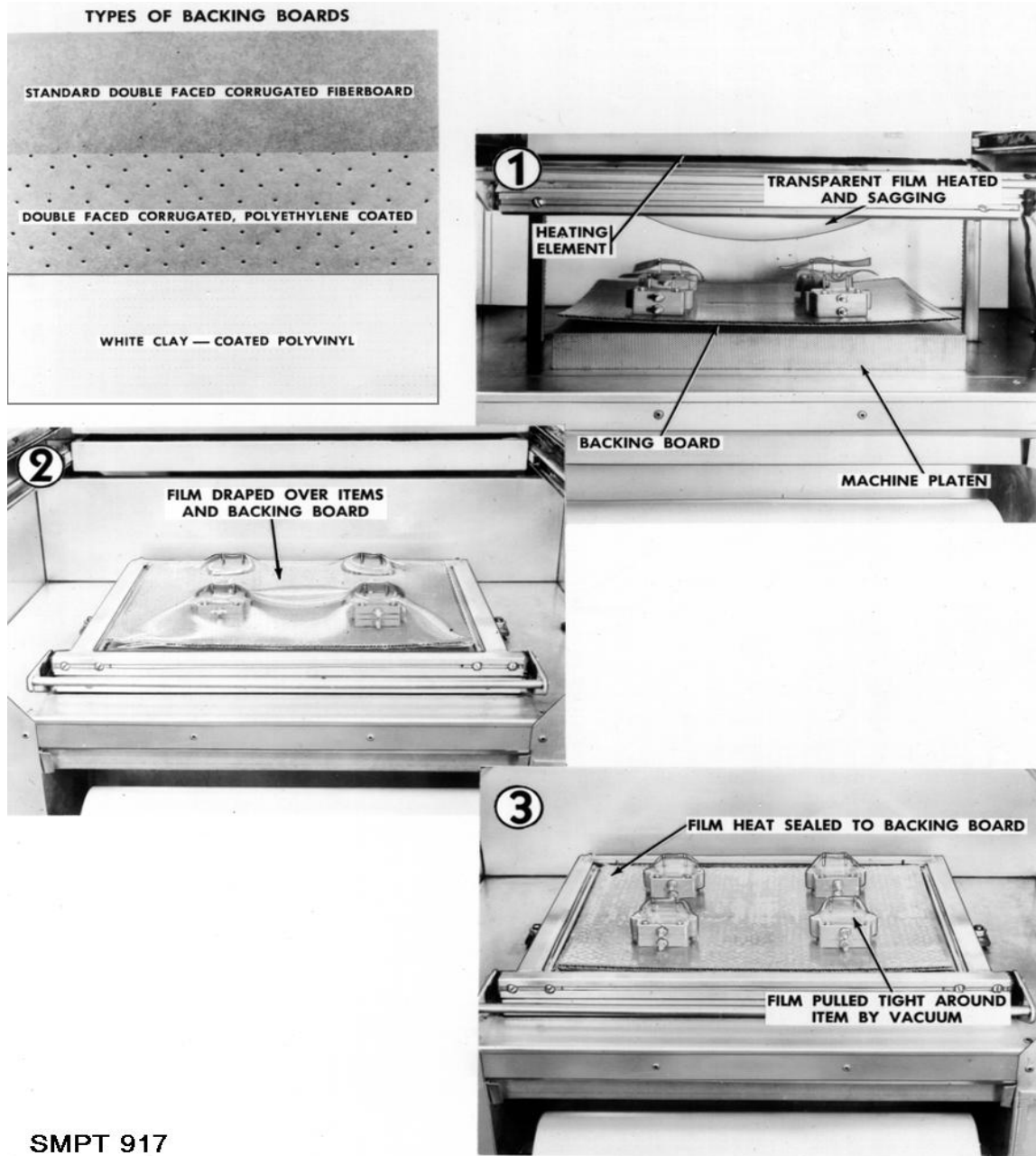


Figure 4-21. Basic steps in the thermoformed process.

**THERMOPLASTIC MATERIALS**

The materials vary depending on the thermoformed process utilized. The materials used in skin packing include the flexible vinyls, acetates, butyrates, and polyethylene. Each of these materials, excluding polyethylene, may be obtained with a polyethylene coating or as a polyethylene laminate.

**Polyethylene**

This material requires slightly less heat than other coating materials, and will adhere just as readily to the backing board. Polyethylene is widely used because of its lower cost. Some specially processed polyethylene films will adhere to a noncoated backing of ordinary paperboard or fiberboard, thus reducing the cost of the pack. Some packages prefer to use polyethylene coated butyrate or acetate because it is very clear. The most commonly used thicknesses is a 4-mil film. Polyethylene coated vinyl chloride may react with certain preservative oils, and metal items coated with oil and packed with this film will become discolored as a result of this chemical action.

**Backing Board**

The backing board is as important a factor as the thermoplastic material itself. Figure 4-21 shows three commonly used backing boards. The following identifies and provides information concerning the use and limitations of these boards:

***White, Clay-Coated Polyvinyl***

This board is coated with a layer of white clay and with a layer of polyvinyl chloride. It is to be used when the packaging film is uncoated polyvinyl chloride, or in the case of a polyvinyl-polyethylene laminate, the polyvinyl side of the film must face the board. The board is perforated through the polyvinyl coating only. This is because the polyvinyl coating is impervious to the flow of air, whereas the board stock is porous and will allow the air trapped between it and the film to be drawn out of the pack by the vacuum unit.

***Double-Faced, Corrugated Fiberboard, Polyethylene Coated***

This board is to be used when good adhesion to the polyethylene packing film is desired. This board is perforated through the polyethylene coating only, for the same reason as above.

***Double-Faced Corrugated Fiberboard, Noncoated***

For good adhesion, a specially processed polyethylene film must be used. This board is not perforated, nor is it finished with a glossy finish. This board cannot be used to pack metal parts intended for long-term storage. This is due to the sulfur content of the board, which, with the absorption of moisture from the air, will chemically attack and corrode the metal surfaces.

**Marking on Backing Boards**

Backing board are very often used for advertising purposes or as a surface on which to apply markings required by MIL-STD-129. Caution must be taken not to print with inks containing linseed oil, glycol, or varnish, as these substances will cause poor adhesion. Water-base and solvent-type inks are recommended.

**SAFETY PRECAUTIONS**

Before attempting to operate any thermoformed packing machine, read the safety precautions. On some machines, the top of the hood gets very hot after the heating coils are on. So make sure you keep your hands and elbows off of the hood. Also when the master clamp frame is raised to insert the plastic film, it may fall forward,

injuring your fingers, meaning that you should provide support to the frame when it is open.

**METHOD 20 - PRESERVATIVE COATING ONLY (WITH GREASEPROOF WRAP, AS REQUIRED)**

Method 20 is one of the five basic methods of preservation. Method 20 always requires the application of a preservative.

**CONCEPT**

Method 20 is accomplished by applying a preservative coating to the item. The coating protects the item against free water, salt spray, gases, and fumes which may be encountered during handling, shipping, and storage. The entire chemical protection afforded to the item is through the contact preservative. Figures 4-22 and 4-23 illustrate the basic steps used in forming the Method 20 unit pack.

**INTENDED USE**

Method 20 is used primarily on metal items whose characteristics allow ready application of a corrosion preventive compound by dipping, flow coating, slushing, spraying, flushing, brushing, or fogging.

Items preserved by Method 20 must be such that depreservation by means of solvents, vapor degreasers, or alkali metal-cleaning compounds will not damage the item nor impair its operation. The determining factor in the selection of this method is whether or not the nature and design of the items permit application and removal, when necessary, of the compound without damage to the items.



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Figure 4-22. Application of Method 20 using a soft film preservative.



Figure 4-23. Application of Method 20 using a hard-drying preservative.

Method 20, with a hard-drying, thin-film preservative Code 01 or Code 19 is particularly adapted to items whose function or operation is not impaired by the presence of a hard-surface coating. Such items include hammers, chisels, mounting brackets, and turnbuckles.

The protection of an item preserved by Method 20 depends upon a clean and moisture-free surface. After the cleaning operation, items must be protected, particularly, against moisture and deposits from fingerprints.

**CONSTRUCTION STEPS AND TECHNIQUES**

Method 20 is accomplished by applying a preservative coating to the item and using greaseproof wrap as required. The preservative coating protects the item against free water, salt spray, gases, and fumes which may be encountered during handling, shipping and storage. The entire chemical protection afforded to the item is through the contact preservative.

Use the following steps along with the illustrations depicted in figures 4-22 through 4-26 to accomplish Method 20.

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

**Step 2**

Select and apply a preservative coating to the item (or parts of the item), using selection criteria and application procedures given in chapter 3.

Note the following before proceeding to step 3:

- X Parts coated with Code 01 or Code 19 preservatives and allowed to dry do not require the wrap specified in step 3 unless called for in the contract or order.
- X Items treated with Code JL, VCI treated barrier material, MIL-PRF-22019, or bag, MIL-B-22020, and securely taped to make an airtight enclosure, shall be exempted from the wrap specified in step 3.

**Step 3**

Enclose the coated item, cushioned as required, in a wrap conforming to one of the following:

- X MIL-B-121, Grade A or C.
- X MIL-PRF-22191, Type II.
- X QQ-A-1876.

**Step 4**

Apply markings according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46 for an example of unit pack markings.



Figure 4-24. Method 20 - use large enough wrap to cover item completely.



Figure 4-25. Method 20 - conform wrap to shape of item.



Figure 4-26. Method 20 - include minimum of air volume.

## **METHOD 30 - WATERPROOF OR WATERPROOF-GREASEPROOF PROTECTION WITH PRESERVATIVE AS REQUIRED**

### **CONCEPT**

Items protected in accordance with this method must be sealed within a waterproof or waterproof-greaseproof enclosure required by the specific method. Method 30 itself is only a concept or description. Method 30 packs can only be accomplished in the form of one of the three methods discussed herein.

### **INTENDED USE**

Methods 30 packs are appropriate for almost any item that will fit into a bag; a rigid container other than all metal; or as long as only waterproof or waterproof-greaseproof protection is needed. If watervaporproofness is a requirement, then you must choose one of the Method 40 or Method 50 methods.

### **METHODS UNDER METHOD 30 CONCEPT**

Three applications of Method 30 are used, all of which involve the item being sealed within a waterproof or waterproof-greaseproof enclosure. The three methods of Method 30 are -

- X Method 31 - Waterproof bag, sealed.
- X Method 32 - Container, waterproof bag, sealed.
- X Method 33 - Greaseproof-waterproof bag, sealed.

### **METHOD 31 WATERPROOF BAG, SEALED**

This method is accomplished by inserting the item, wrapped and cushioned as necessary, into a waterproof bag, exhausting the excess air, and closing the bag. Normally, Method 31 is used for items that do not require a contact preservative. For items requiring a preservative, a Method 33 would be more appropriate. To construct this method, perform the following steps while also observing the construction techniques shown in figure 4-27.

#### **Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

#### **Step 2**

Apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as a part of unit packing. The following neutral wraps meet the compatibility requirements of MIL-STD-2073-1C:

- X MIL-B-130
- X MIL-B-17667
- X A-A-3174

Note: MIL-P-130 and A-A-3174, when used as an initial wrap, also provide a cushioning effect that helps protect the item as well as the bag from the item's projections and sharp edges as well as to restrict its movement within the bag.



**Step 3**

Select a barrier (bag) made from material conforming to MIL-B-117, Type I, Class B or MIL-B-22020 as limited by MIL-I-8574. You may use one of the following materials for the bag since they meet the MIL-B-117 requirements:

- X A-A-3174, Type I or II, Grade A, Class 1 (See note).
- X MIL-PRF-22191, Type III

Note: Unless otherwise specified, nominal thickness shall be 0.004 inch and finish shall be No. 2(treated).

**Step 4**

Enclose the item (wrapped, and/or cushioned as required) within the close-fitting bag that you selected in step 3.

**Step 5**

Heat seal the bag making sure excess air is kept to a minimum by compressing the bag or by a mechanical evacuation process before the final seal is effected.

**Step 6**

Apply markings to the bag according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

Note: When specified in the contract or order, a carton or box shall be required to be used with unit container, and the primary cushioning specified in the contract or order shall be placed between the outside of the bag and the inside of the carton or box. In this case, the carton or box will be marked the same as the bag.

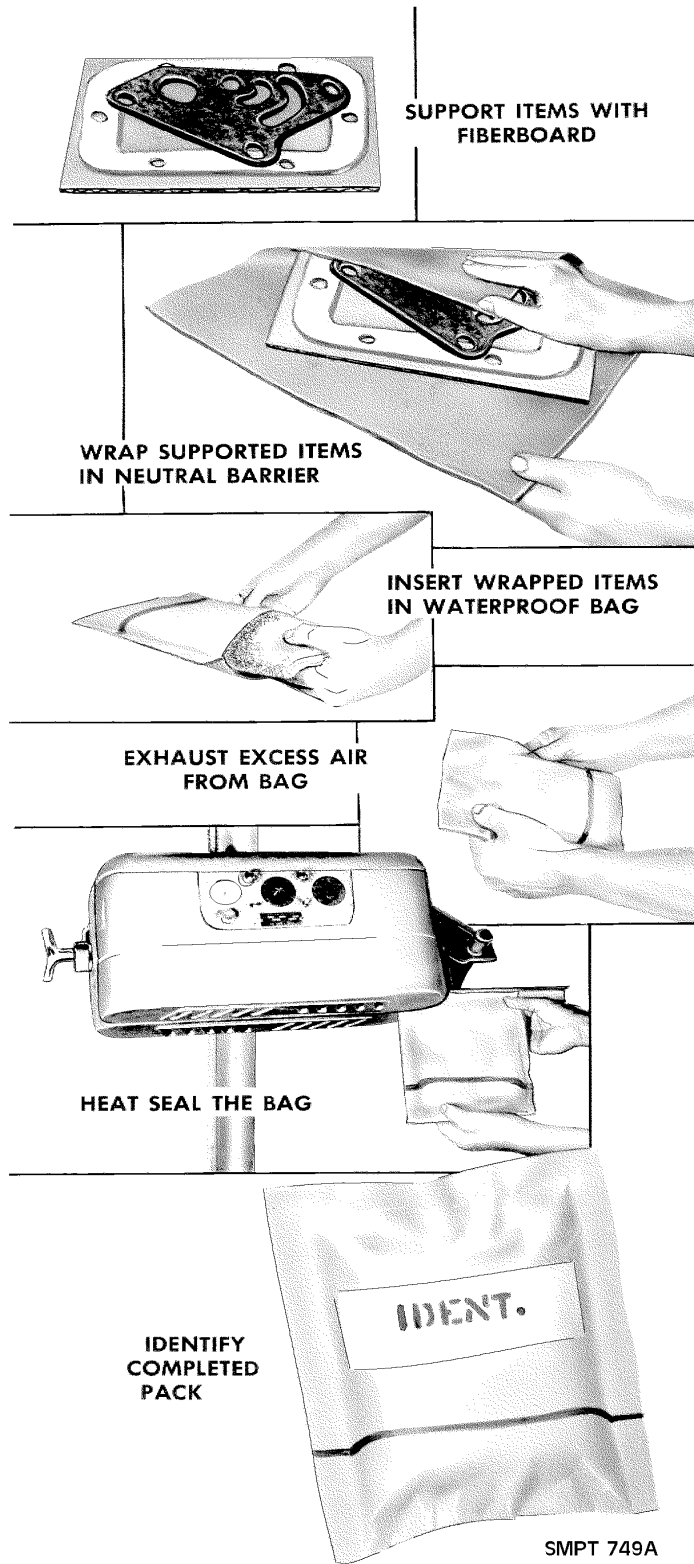


Figure 4-27. Application of Method 31.

**METHOD 32 CONTAINER, WATERPROOF BAG, SEALED**

This application involves placing the item (preserved, wrapped and cushioned as required) into a close-fitting box or carton which in turn shall be enclosed in a sealed waterproof bag. To construct this method, perform the following steps while also observing the construction techniques shown in figure 4-28.

**Construction Steps**

Note: The steps direct the item to be coated with a preservative. If this is not the case, then a noncorrosive wrap, as applicable, would be applied instead of the greaseproof wrap cited in step 3.

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

**Step 2**

Select and apply a preservative coating to the item (or parts of the item), unless otherwise specified, using selection criteria and application procedures given in chapter 3.

**Step 3**

Apply a greaseproof wrap conforming to one of the following:

- X MIL-B-121, Grade A.
- X QQ-A-1876.

**Container**

**Step 4**

Select a close-fitting inner container from MIL-STD-2073-1C (or a container specified by the contract or order). The following are examples of inner containers appropriate for this method.

- X Fiberboard Boxes.
- X Folding Boxes.
- X Set-up Boxes.
- X Metal-edged Paperboard Boxes.

Note: Information of the use and closure of these boxes is given in chapter 6 of this manual.

**Step 5**

Insert the item into the container along with the application of cushioning and dunnage, as necessary, to protect the item as well as the container from the item's projections and sharp edges and also to restrict its movement within the container.

**Step 6**

Blunt the sharp edges and corners of the box to protect the bag selected in step 7.

**Step 7**

Enclose the box in a bag conforming to MIL-B-117, Type I, Class B. The following are examples of barrier (bag) material meeting the MIL-B-117 requirement:

- X A-A-3174, Type I or II, Grade A, Class 1 (see note).
- X MIL-PRF-22191, Type III.

Note: Unless otherwise specified, nominal thickness shall be 0.004 inch and finish shall be number 2 (treated) for A-A-3174 material.

Note: When specified, a protective wrap of heavy duty kraft paper or equivalent (tape sealed) shall be used to protect the barrier material.

**Step 8**

Heat seal the bag.

Note: The trapped air between the box and the bag shall be kept to a minimum by compressing the bag or by a mechanical evacuation process (i.e., vacuum cleaner attachment). Caution shall be taken to prevent rupture of the bag.

**Step 9**

Apply markings to the bag according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.



Figure 4-28. Application of Method 32.

**METHOD 33 GREASEPROOF-WATERPROOF BAG, SEALED**

As the title suggests, this method is accomplished by enclosing the item (preserved, wrapped and cushioned, as required) in a close-fitting sealed bag. See the construction steps that follow along with the techniques shown in figure 4-29 to accomplish Method 33:

**Construction Steps**

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

**Step 2**

Select and apply a preservative coating to the item (or parts of the item), unless otherwise specified, using selection criteria and application procedures given in chapter 3.

**Step 3**

Apply a greaseproof wrap conforming to one of the following:

- X MIL-B-121, Grade A.
- X QQ-A-1876.

Note: Preliminary greaseproof wraps applied solely to confine the contact preservative on item surfaces are not necessary for this method if the bag is made of material conforming to MIL-B-121, Grade A or MIL-PRF-22191, Type II. However, wraps shall not be excluded if necessary to protect the bags from rupture or perforation.

**Step 4**

Apply cushioning as required to projections, sharp edges or other physical characteristics of the item which may damage the waterproof-greaseproof bag and also as required to mitigate shock, thereby preventing physical and functional damage to the item.

**Step 5**

Select a barrier (bag) made from material conforming to MIL-B-117, Type I, Class C, Style 1, 2 or 3, or Type II, Class C, Style 1 or bags conforming to MIL-B-22020 as limited by MIL-I-8574. Bags made from the following material meet the MIL-B-117 requirements:

- X MIL-B-121, Type I or II, Grade A, Class 1.
- X MIL-PRF-22191, Type II.

**Step 6**

Enclose the item (preserved, wrapped, and cushioned as required) within the close fitting bag, that you selected in step 5.

**Step 7**

Apply markings to the bag according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

Note: When specified in the contract or order (or when the weight of the item exceeds 20 pounds), a carton or box shall be required to be used on the unit container, and the primary cushioning specified in the contract or order shall be placed between the outside of the bag and the inside of the carton or box. The carton or box must be marked the same as the bag.

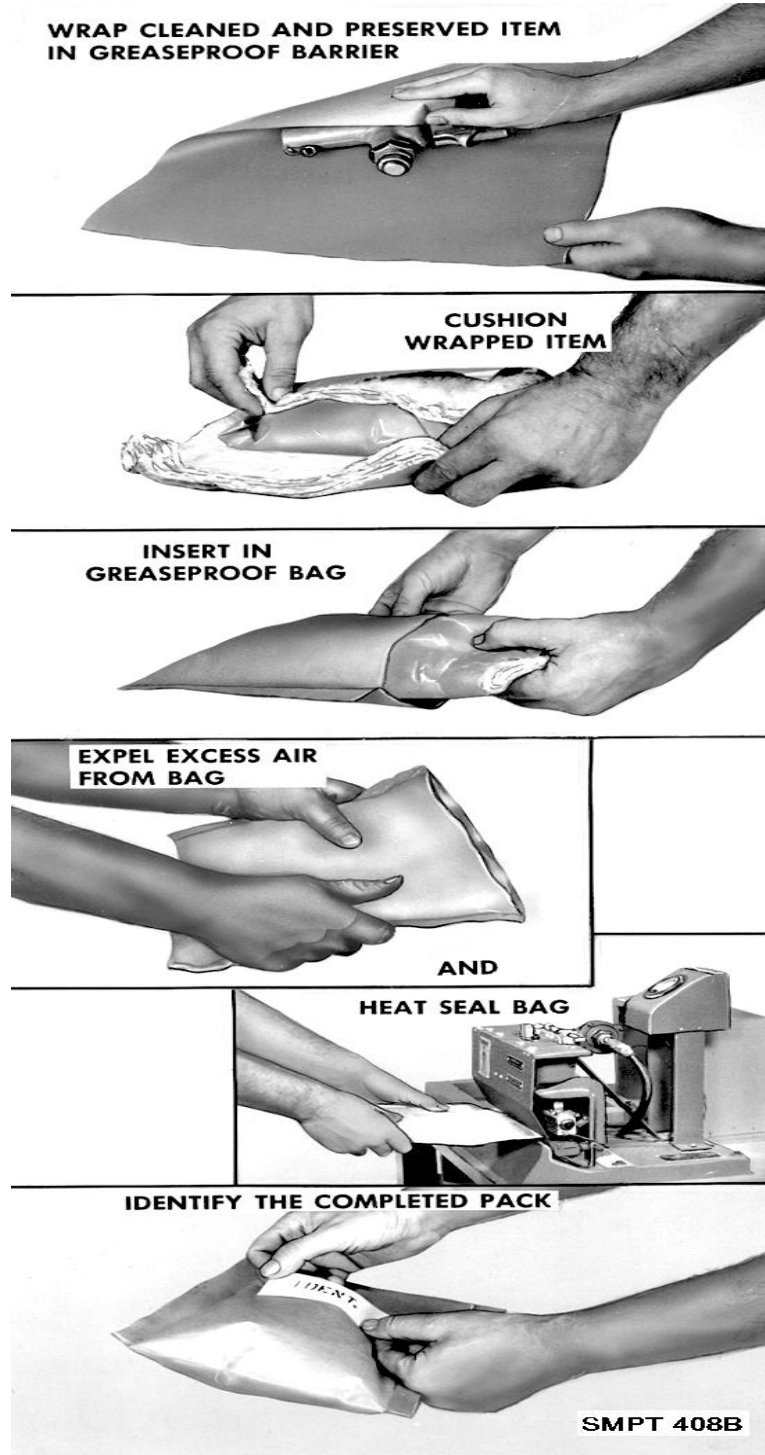


Figure 4-29. Application of Method 33.

## **METHOD 40 - WATERVAPORPROOF PROTECTION WITH PRESERVATIVE AS REQUIRED**

### **CONCEPT**

Method 40 is a watervaporproof enclosure in which the items, with or without a preservative coating, are placed. The enclosure may be a rigid container or a watervaporproof barrier, depending on the method being developed.

### **INTENDED USE**

This method of unit packing is intended to afford protection to metallic and nonmetallic items against deterioration caused by water or water vapor and by natural or industrial contaminants and pollutants.

Method 40, supplemented by contact preservatives, is applied to parts and equipment where critical functioning metal surfaces, held to close tolerances, are involved. When contact preservatives are used in Method 40, they should be selected from those preservatives which can be easily removed, if removal will be necessary before putting the item into use. While Method 40 was originally intended to prevent corrosion on metal parts, it can also be used without a contact preservative to keep fabric, paper, plastic, and other nonmetallic items clean and dry during shipment and storage.

### **METHODS UNDER METHOD 40 CONCEPT**

There are five military preservative applications under the Method 40 concept. They are made with or without contact preservatives, as required. Before fabricating any method or applying a preservative, all items must be properly cleaned and dried according to the instructions in chapter 2. When the application of a contact preservative is required, it shall be done as explained in chapter 3. The five methods of Method 40 are -

- X Method 41 - Watervaporproof bag, sealed.
- X Method 42 - Container, watervaporproof bag, sealed, container.
- X Method 43 - Floating watervaporproof bag, sealed.
- X Method 44 - Rigid container (other than metal), sealed.
- X Method 45 - Rigid metal container, sealed.

It is suggested that detailed steps involved in the application of all methods be followed carefully for consistent, satisfactory results.

### **METHOD 41 - WATERVAPORPROOF BAG, SEALED**

This method is accomplished by inserting the item, wrapped and cushioned as necessary, into a watervaporproof bag, exhausting the excess air, and closing the bag. Items packed by Method 41 are generally light in weight and flat in shape, so as to lend themselves to easy insertion into the flat or envelope-type bag. In the steps that follow, notice that this method is also used for items (such as circuit cards) which are sensitive to damage caused by electrostatic discharge (ESD). Make sure that only the correct electrostatic protective materials, as indicated in the steps that follow, are used for the wrap and the bag when packaging items sensitive to ESD. Refer to figure 4-30 and the following steps and techniques when constructing Method 41:

## **Construction Steps**

### ***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

### ***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3. Permanent preservative coatings to electrostatic discharge sensitive (ESDS) items are normally applied by the manufacturer.

### ***Step 3***

Apply a greaseproof wrap only if a soft dry preservative has been applied to the item.

### ***Step 4***

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing. Wrap ESDS items in barrier material conforming to MIL-PRF-81705, Type II or III, or an ESD protective cushioning material. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps for other than ESDS items.

### ***Step 5***

Place the item (wrapped and cushioned as required) into a close-fitting, heat-sealed bag, conforming to MIL-B-117, Type I, Class E, Style 1, 2 or 3, or Type I, Class F, Style 1, or Type II, Class E, Style 1 or 3, or Type III, Class E, Style I. Bags made from the following material meet the MIL-B-117 requirements:

- X MIL-PRF-131, Type I or II, Class 1 or 2.
- X MIL-PRF-22191, Type I.
- X MIL-PRF-81705, Type I, Class 1 (ESDS items only).

### ***Step 6***

Mark the bag in accordance with MIL-STD-129, MIL-HDBK-129, and the marking information given at the end of this chapter.

Note: When specified by the contract or order, a carton or box shall be required to be used with unit container cushioning specified in the contract or order will be placed between the bag and the carton or box. Mark the carton or box in the same manner as the bag.

## **METHOD 42 CONTAINER, WATERVAPORPROOF BAG, SEALED, CONTAINER**

This method is accomplished by placing the item preserved, wrapped and cushioned, as required, into a close fitting inner container. The container is enclosed in a sealed bag. Then, the item within the inner container and sealed bag shall be enclosed within an appropriate outer container. See the construction steps that follow along with the techniques shown in figure 4-31 to accomplish Method 42:

## **Construction Steps**

### ***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.



**Step 2**

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.

**Step 3**

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

**Step 4**

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps.

**Step 5**

Select a close fitting inner container from MIL-STD-2073-1C. The following containers are examples of inner containers appropriate for this method:

- X Fiberboard Boxes.
- X Folding Boxes.
- X Set-up Boxes.
- X Metal-edged Paperboard Boxes.

Note: Information of the use and closure of these boxes is given in chapter 6 of this manual.

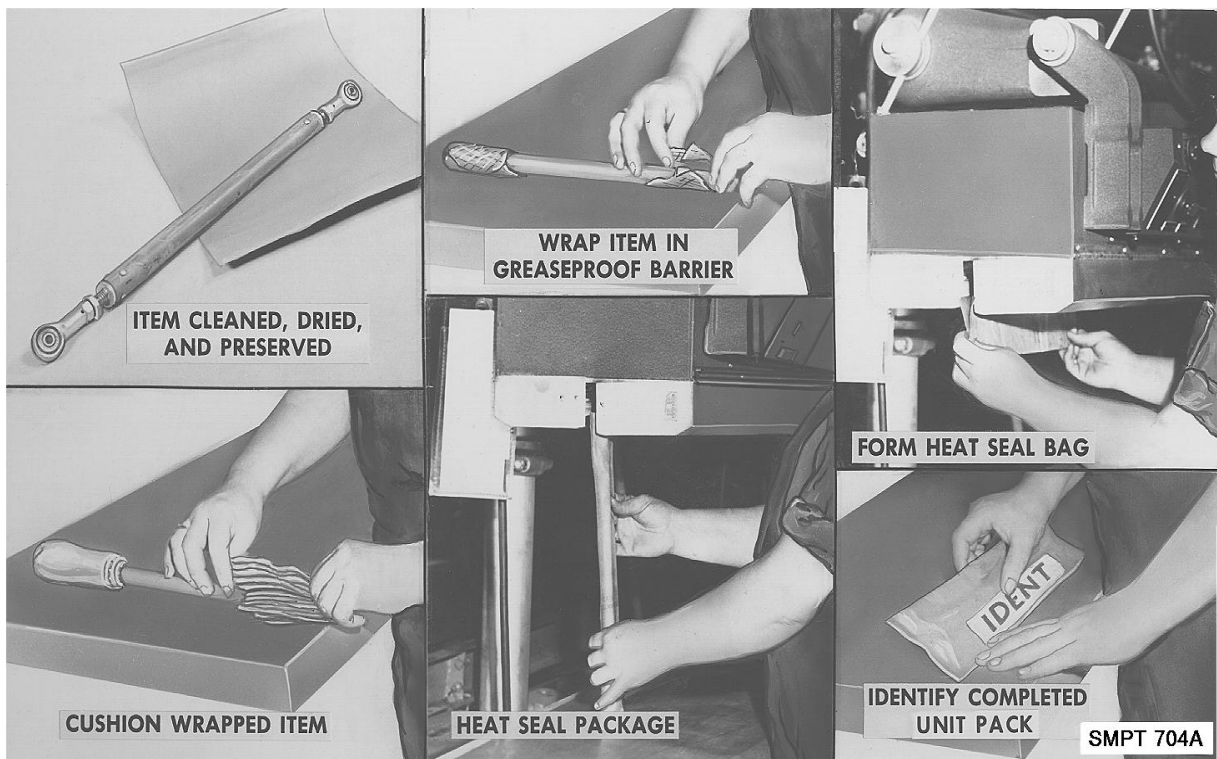


Figure 4-30. Application of Method 41.

**Step 6**

Insert the item into the container along with the application of cushioning and dunnage as necessary to protect the item as well as the container from the item's projections and sharp edges and also to restrict its movement within the container.

**Step 7**

Blunt the sharp edges and corners of the box to protect the bag.

**Step 8**

Enclose the box in a bag conforming to MIL-B-117, Type I, Class E. Use the following material:

- X MIL-PRF-131, Type I or II, Class 1 or 2.

**Step 9**

Heat seal the bag.

Note: Information on how to make bags (such as the maximum heat seal width) was provided earlier in this chapter under "BAGS, SLEEVES AND TUBING (MIL-B-117)".

**Step 10**

Enclose the item (within the inner container and sealed bag) in an outer container selected from MIL-STD-2073-1C. The following two outer containers are examples:

- X Fiberboard Box, Weather resistant class and grade (see chapter 6 for information on use and closure).
- X PPP-B-621 Boxes; wood, nailed and lock-corner.
- X PPP-B-601 Boxes; wood, cleated plywood.

Note: When wood or plywood (or wood or plywood in combination with other materials) boxes are used at the outer container, 6 mil polyethylene conforming to A-A-3174 or equivalent material shall be used as an overwrap (tape sealed) around the sealed bag to prevent chafing or rupture and waterproof the case contents. When the primary cushioning is located between the sealed bag and the outer container, the barrier protective wrap is not required.

**Step 11**

Close the outer container in accordance with the applicable container specification procedures, making certain that no damage is inflicted on the bag.

**Step 12**

Apply markings to the outer container according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

Note: When the outer container becomes the shipping container, it shall be marked as a shipping container in accordance with MIL-STD-129 and MIL-HDBK-129. In this case, the barrier (bag) will be marked as specified in MIL-STD-129 and MIL-HDBK-129 for unit packs.

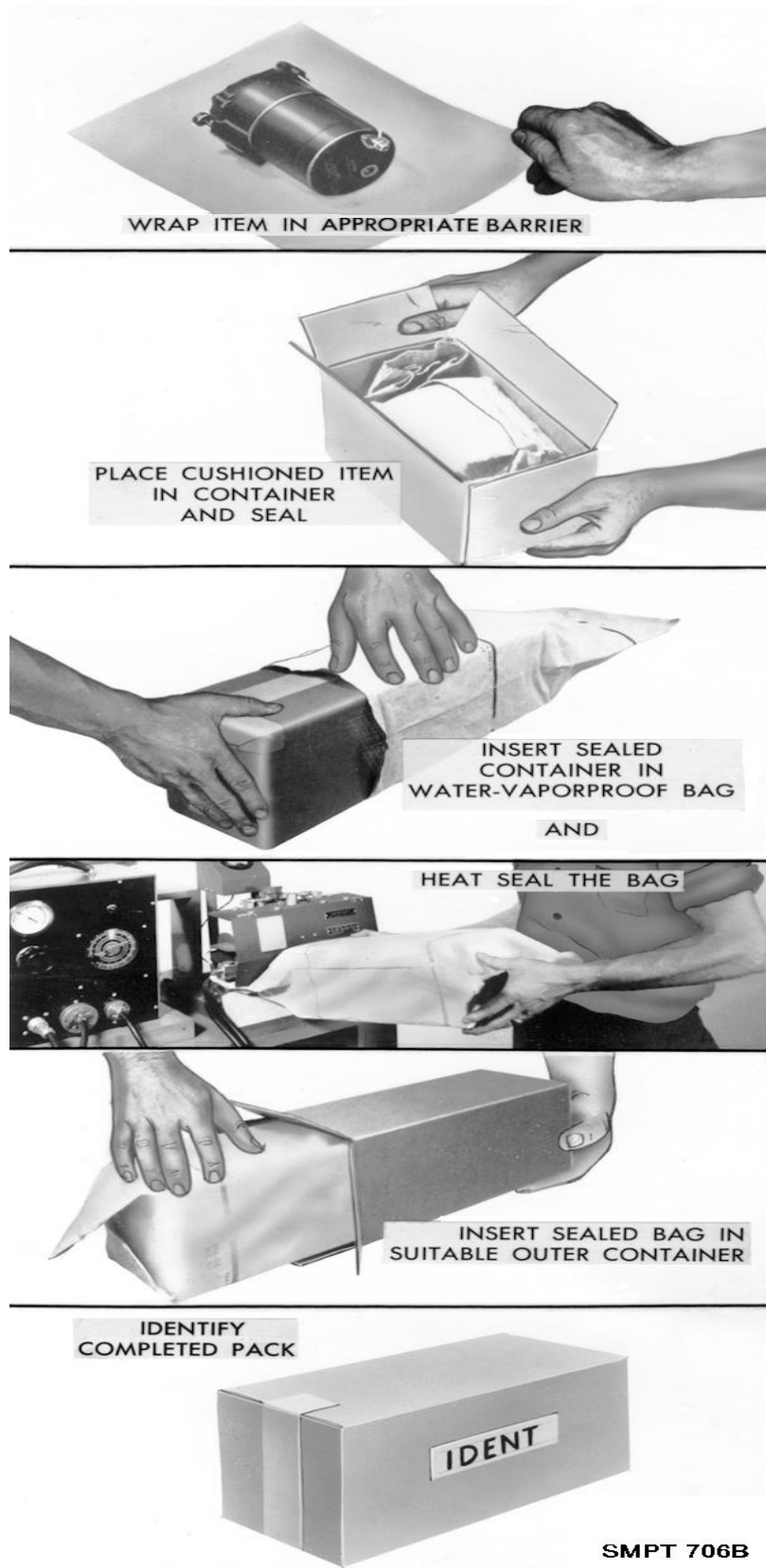


Figure 4-31. Application of Method 42.

**METHOD 43 - WATERVAPORPROOF FLOATING BAG, SEALED**

Method 43 is appropriate to unit pack equipment which has mounting facilities (such as a base plate with holes suitable for mounting the equipment to the base of a container). Generators, electric motors and transformers are examples.

The method is accomplished by attaching an item (preserved, wrapped, cushioned, anchored or shock mounted as required) to the internal supports (blocking) of the container or to one face or the skidded base of the container. This is done such that the watervaporproof bag will maintain its integrity.

**Construction Steps**

To construct this method, perform the following steps while also observing the construction techniques shown in figure 4-32.

***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.

***Step 3***

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

Note: If only a portion of the equipment is coated (such as the shaft of an electric motor) with a preservative, wrap only that portion with a greaseproof wrap, using tape to secure the wrap.

***Step 4***

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps.

***Step 5***

Apply cushioning or other dunnage as necessary to protect the item as well as the bag from the item's projections and sharp edges. Secure cushioning and wraps with string or tape if necessary.

***Step 6***

Select a barrier (bag) material conforming to MIL-B-117, Type I, Class E, F, or G, Style 1, or Type II, Class E, Style 1 or 3, or Type III, Class E, Style 1. You may use the following bag materials that meet the requirements of MIL-B-117 for this method:

- X MIL-PRF-131, Type I or II, Class 1, 2 or 3.

***Step 7***

Position the barrier (bag), with holes to accommodate the mounting bolts, on the mounting base, and seal bolt openings and gaskets with adhesive. See figure 4-32 on how to place and seal the gaskets.

Note: The gasket material quality, gasket application and performance evaluation shall be in accordance with applicable requirements of MIL-E-6060. Unless otherwise specified, gasket material shall conform to MIL-G-12803.

**Step 8**

Heat seal the bag.

Note: Information on how to make bags (such as the maximum heat seal width) was provided earlier in this chapter under "BAGS, SLEEVES AND TUBING (MIL-B-117)".

**Step 9**

Apply markings to the outer container according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

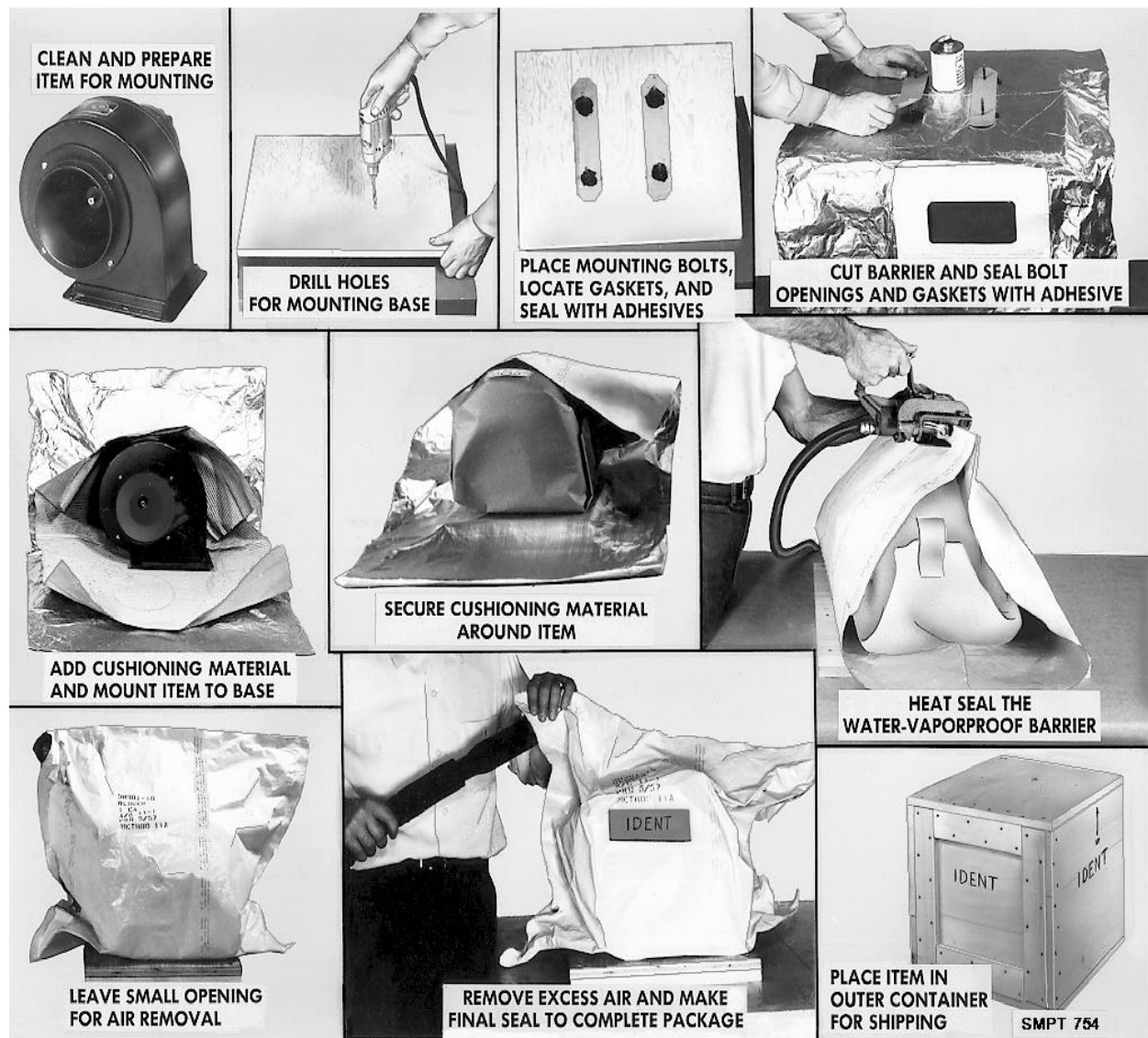


Figure 4-32. Application of Method 43.

**METHOD 44 - RIGID CONTAINER (OTHER THAN ALL METAL), SEALED**

Items wrapped and cushioned as required shall be enclosed in a sealed, snug fitting, rigid container, other than all metal. Use the techniques shown in figure 4-33 and the following steps to accomplish Method 44.

**Construction Steps**

***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2.

***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.

***Step 3***

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

Note: If a greaseproof liner is used instead of a greaseproof wrap, the liner shall conform to MIL-L-45973.

***Step 4***

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps.

***Step 5***

Place the item (wrapped and cushioned as required) into a snug fitting, rigid container other than all metal. The following fiber containers may be used:

X PPP-D-723, Type III, Grade A, Class 2, for contents exceeding 20 pounds.

Note: Other sealed rigid containers including reusable plastic or fiberglass containers (other than all metal) listed in MIL-STD-2073-1C may be used when the container body and closure mating surfaces afford a moisture vapor proof barrier with a water vapor transmission rate (WVTR) not exceeding 0.075 grams per 100 square inches per 24 hours, as established by government specifications or when tested in accordance with ASTM D 1008 as appropriate.

***Step 6***

Close the container in accordance with the container specification.

***Step 7***

Apply markings according to MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.



Figure 4-33. Application of Method 44.

**METHOD 45 - RIGID METAL CONTAINER, SEALED**

Method 45 is applied by snugly enclosing the item preserved, wrapped and cushioned, as required, in a sealed, rigid metal container. Use the following steps along with the illustrations shown in figure 4-34 to construct unit packs using Method 45.

**Construction Steps**

***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: If a preservative is not required, go to step 4.)

Note. When specified in the contract or order or when dictated by the requirements of the item, the metal container may be vacuum sealed. Figure 4-35 illustrates a method of vacuum sealing.

***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.

***Step 3***

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

***Step 4***

Apply a noncorrosive, neutral wrap conforming to one of the following specifications: (Note: If a neutral wrap is not a requirement, go to step 5).

- X MIL-B-130.
- X MIL-B-17667.
- X A-A-3174.
- X A-A-1249.

Note: These materials are intended as an initial wrap where a noncorrosive, dust protective wrap is required prior to or as a part of unit packing wherein a greaseproof wrap is not required. They meet the compatibility requirements of MIL-STD-2073-1C and are available at lower cost.

***Step 5***

Apply cushioning or dunnage or selective support (either rigid or resilient or in combination) to the item or to the container as required to insure against free movement of the item and shock transmissibility.

***Step 6***

Insert the item into any rigid metal container with machine seamed or reusable gasketed closure having a WVTR not exceeding 0.075 grams per 100 square inches per 24 hours, when tested in accordance with ASTM D 1008, unless a specific type of container is specified in the contract or order. The following container (see chapter 7) are among those that meet the WTVR requirement:

- X PPP-C-96 Metal Cans.
- X MIL-D-6055 Metal Drums.

***Step 7***

Close the container according to the container specification requirements. Chapter 7 includes closure information for the cans and drums listed in step 6.



**Step 8**

Apply markings to the container in accordance with MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

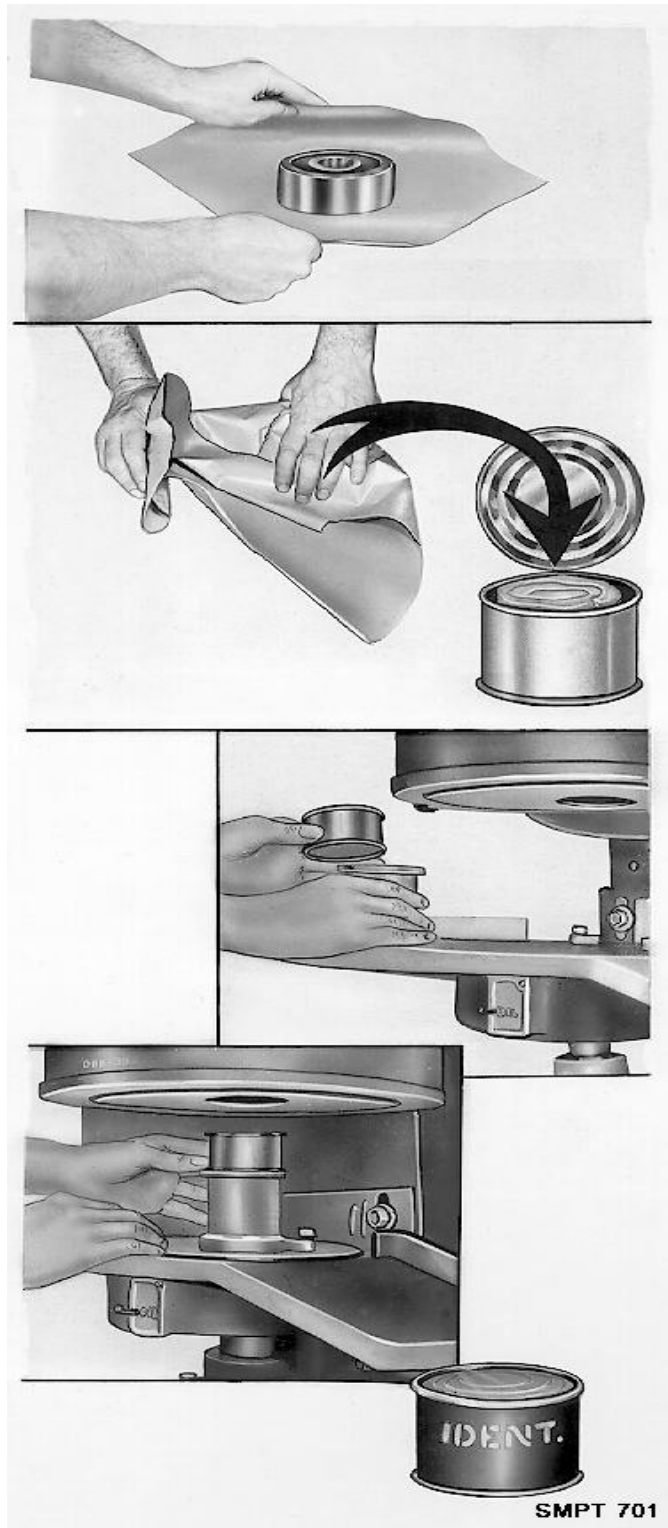


Figure 4-34. Application of Method 45.

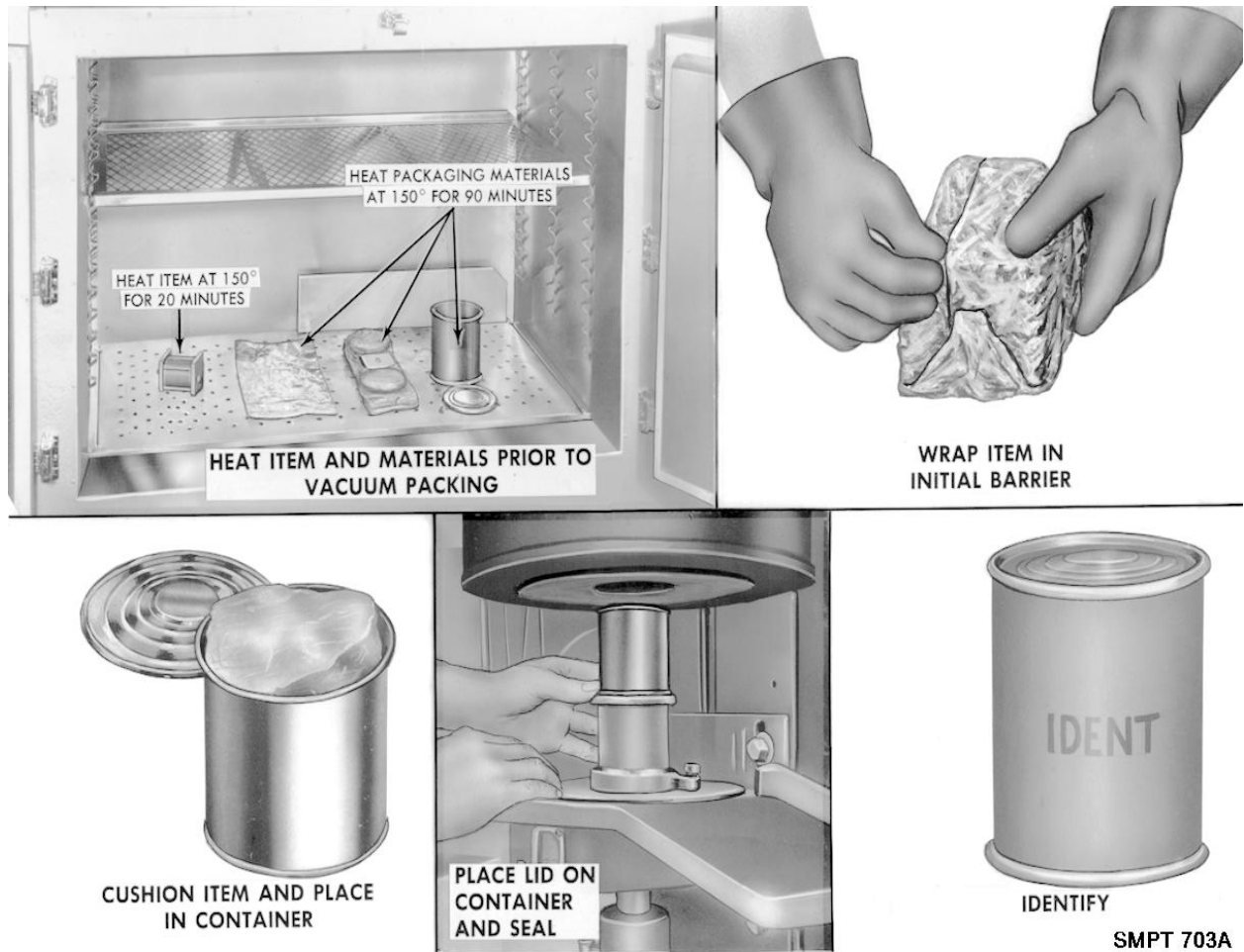


Figure 4-35. Application of method 45, vacuum sealed.

## METHOD 50 WATERVAPORPROOF PROTECTION WITH DESICCANT

### CONCEPT

Items protected in accordance with Method 50 shall be sealed in a watervaporproof enclosure with activated desiccant as required for the specific method of this group. Unless otherwise stated in the contract or order, unit packs of all methods shall include a humidity indicator.

Relative humidity is the ratio of the quantity of water vapor actually present in the air the greatest amount the air can hold at a given temperature. Once the quantity of water that must be removed to effect and maintain the required low relative humidity has been established, the amount of desiccant determined in accordance with table 4-11 must be provided. Accordingly the volume should be held to a minimum consistent with other packaging requirements.

## **METHOD**

Since experience and tests have proven that corrosion of a clean item will not normally occur when a relative humidity of 30 percent is maintained within a barrier, complete protection for items packed by Method 50 is afforded by keeping the relative humidity below that level.

Usually, 20 percent relative humidity is established in order that small leaks which inadvertently occur will not raise the internal relative humidity higher than 30 percent during a normal storage period. The effectiveness of Method 50 preservation rests upon the following factors:

- X The volume of enclosed space.
- X The surface area of the enclosing barrier.
- X The water vapor transmission rate of the enclosing barrier.
- X The moisture content of item and dunnage at the time of preservation.
- X The quantity of desiccant used.

## **INTENDED USE**

Method 50 preservation is used for items of a highly critical nature which require the highest degree of protection from damage by the effects of water vapor. It is applicable to mechanical or electrical items including assemblies with functional components which, because of their nature, cannot be treated with a preservative. A preservative, when used for additional protection, must be such as to permit the operation of the equipment without removal of the preservative. This method is not used on any item where the withdrawal of moisture would cause damage to the item. The size and weight limits allowed in any barrier bag is established in MIL-B-117 and MIL-E-6060, as applicable.

## **DESICCANT**

Desiccant shall be in standard unit sized bags conforming to MIL-D-3464, type I, unless type II or III is specified or required because of special characteristics of the item. The desiccant shall be located in the pack in a place most accessible to voids in the item or pack interior. Desiccant bags shall be secured within the unit pack by tying, taping, etc., or in specially designed desiccant baskets affixed to the container interior. Desiccant shall be adequately secured so as to prevent its shifting or movement and under no circumstances be permitted to come in direct contact with critical surfaces of the enclosed item. When direct contact is absolutely unavoidable, the desiccant shall be isolated from the item with MIL-B-121, Grade A barrier material.

The desiccant shall not be unnecessarily exposed to the ambient environment when removed from the vaporproof desiccant storage container. Removal of the desiccant and its insertion into the unit pack shall be the last action prior to effecting the final seal of the bag or container.

## **METHODS UNDER METHOD 50 CONCEPT**

Five applications of Method 50 are used. The following general requirements apply to all methods of Method 50:

- X Items shall be sealed in a watervaporproof enclosure with activated desiccant.
- X Unit packs of all methods shall include a humidity indicator.

- X Method 50 labels will be applied to unit packs. A method 50 label is shown in figure 4-36.
- X Items shall be cushioned as required to mitigate shock, thereby preventing physical and functional damage to the item.
- X When bags are used, the sealed edge of the bag that would normally be opened for item inspection shall be of sufficient surface area to permit two subsequent resealings after item inspection, unless otherwise specified.

The five methods of Method 50 are -

- X Method 51 - Watervaporproof bag, sealed.
- X Method 52 - Container, watervaporproof bag, sealed, container.
- X Method 53 - Floating watervaporproof bag, sealed.
- X Method 54 - Rigid container (other than metal), sealed.
- X Method 55 - Rigid metal container, sealed.

### **METHOD 51 WATERVAPORPROOF BAG, SEALED**

#### **Bag, Heat Sealed**

Item preserved, wrapped, cushioned and desiccated as required shall be enclosed within a sealed bag. A humidity indicator and Method 50 label is also required. Follow the steps below and observe the techniques shown in figure 4-37.

#### **Construction Steps**

##### ***Step 1***

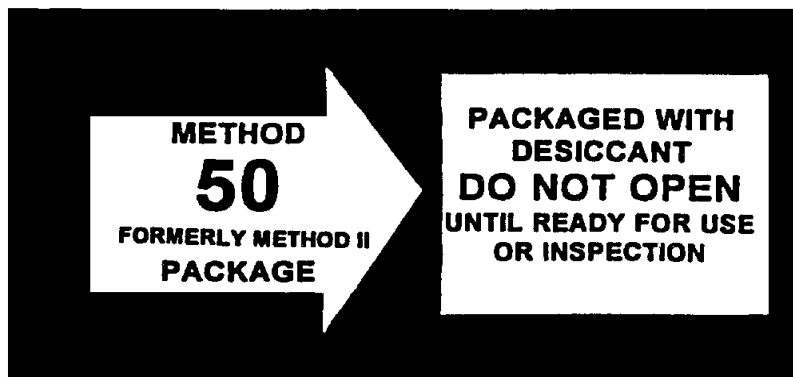
Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: Go to step 4 if a preservative coating is not applied.)

##### ***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3. Permanent preservative coatings to electrostatic discharge sensitive (ESDS) items are normally applied by the manufacturer.

##### ***Step 3***

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item. See the information provided earlier in this chapter under "SURFACES COATED WITH PRESERVATIVE."



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Figure 4-36. Method 50 label.

**Step 4**

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing, if applicable.

**Step 5**

Place the item, including the required number of units of desiccant (wrapped and cushioned as required) into a close-fitting, heat-sealed bag, conforming to MIL-B-117, Type I, Class E, F or G, Style 1, 2 or 3, or Type II, Class E, Style 1 or 3, or Type III, Class E, Style I. Bags made from the following material meet the MIL-B-117 requirements:

- X MIL-PRF-131, Type I or II, Class 1 or 2.
- X MIL-PRF-22191, Type I.
- X MIL-PRF-81705, Type I, Class 1 (ESDS items only).

**Step 6**

Firmly secure the humidity indicator immediately within the closing edge of the bag which is applied in the next step.

**Step 7**

Mark the bag, including the application of a Method 50 label, in accordance with MIL-STD-129 and MIL-HDBK-129 and the marking information given in the paragraph on "MARKING OF UNIT AND INTERMEDIATE PACKS" and figure 4-46 located at the end of this chapter.

Note: When specified by the contract or order, a carton or box shall be required to be used with the unit container. Cushioning specified in the contract or order will be placed between the bag and the carton or box. Mark the carton or box in the same manner as the bag.

**METHOD 52 CONTAINER, WATERVAPORPROOF BAG, SEALED, CONTAINER**

This method is made by enclosing the item (preserved, wrapped, cushioned and desiccated as required) in a close fitting inner container selected from MIL-STD-2073-1C, as appropriate, unless otherwise specified. The item within the inner container shall then be enclosed in a sealed bag. Finally, the item within the inner container and sealed bag is enclosed within an appropriate outer container selected from MIL-STD-2073-1C unless otherwise specified in the contract or order. Notice that this method is the same as Method 42 except for the desiccant, humidity indicator, and Method 50 label requirements.

**Construction Steps**

Construct the method using the steps that follow while observing figure 4-38 for guidance:

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: If a preservative is not required, go to step 4.)

**Step 2**

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.



Figure 4-37. Application of Method 51.

**Step 3**

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

**Step 4**

Apply a noncorrosive, neutral wrap conforming to one of the following specifications: (Note: If a neutral wrap is not a requirement, go to step 5).

- X MIL-B-130.
- X MIL-B-17667.
- X A-A-3174.
- X A-A-1249

Note: These materials are intended as an initial wrap where a noncorrosive, dust protective wrap is required prior to or as a part of unit packing wherein a greaseproof wrap is not required. They meet the compatibility requirements of MIL-STD-2073-1C.

**Step 5**

Select a close fitting inner container from MIL-STD-2073-1C. The following containers are examples of inner containers appropriate for this method.

- X Fiberboard Boxes.
- X Folding Boxes.
- X Set-up Boxes.
- X Metal-edged Paperboard Boxes.

Note: Information of the use and closure of these boxes is given in chapter 6 of this manual.

**Step 6**

Insert the item into the container along with the application of desiccant and cushioning and dunnage as necessary to protect the item as well as the container from the item's projections and sharp edges and also to restrict its movement within the container.

**Step 7**

Blunt the sharp edges and corners of the box to protect the bag before proceeding to the next step.

**Step 8**

Firmly secure the humidity indicator to the outside face of the inner container facing the closing edge of the barrier bag which is applied in the next step.

**Step 9**

Enclose the box in a bag conforming to MIL-B-117, Type I, Class E, F or G, Style 1, 2 or 3, or Type II, Class E, Style 1 or 3, or Type III, Class E, Style 1. Also, bags in accordance with MIL-B-6060 shall be used for bag sizes exceeding the limitations of MIL-B-117. The following is a partial list of bag material conforming the MIL-B-117 types, classes and styles:

- X MIL-PRF-131, Type I or II, Class 1 or 2.
- X MIL-PRF-22191, Type I.

Note: When specified in the contract or order, a designated bag will be used.

**Step 10**

Heat seal the bag leaving sufficient surface area to permit two subsequent resealings after item inspection, unless otherwise specified.

Note: Information on how to make bags (such as the maximum heat seal width) was provided earlier in this chapter under "BAGS, SLEEVES AND TUBING (MIL-B-117)".

**Step 11**

Enclose the item (within the inner container and sealed bag) in an outer container selected from MIL-STD-2073-1C. The following outer containers are examples:

- X Fiberboard Box, Weather resistant class and grade (see chapter 6 for information on use and closure).
- X PPP-B-621 Boxes; wood, nailed and lock-corner.
- X PPP-B-601 Boxes; wood, cleated plywood.

Note: When wood or plywood (or wood or plywood in combination with other materials) boxes are used at the outer container, 6 mil polyethylene conforming to A-A-3174 or equivalent material shall be used as an overwrap (tape sealed) around the sealed bag to prevent chafing or rupture and waterproof the case contents. When the primary cushioning is located between the sealed bag and the outer container, the barrier protective wrap is not required.

**Step 12**

Close the outer container in accordance with the applicable container specification procedures, making certain that no damage is inflicted on the bag.

**Step 13**

Apply markings to the outer container, including the Method 50 label, in accordance with MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

Note: When the outer container becomes the shipping container, it shall be marked as a shipping container in accordance with MIL-STD-129 and MIL-HDBK-129. In this case, the barrier (bag) will be marked as specified in MIL-STD-129 and MIL-STD-129 for unit packs.

**METHOD 53 FLOATING WATERVAPORPROOF BAG, SEALED**

This method is accomplished by attaching an item (preserved, wrapped, cushioned, desiccated, anchored or shock mounted as required) to the internal supports (blocking) of the container or to one face or the skidded base of the container. This is done such that the watervaporproof bag will maintain its integrity.

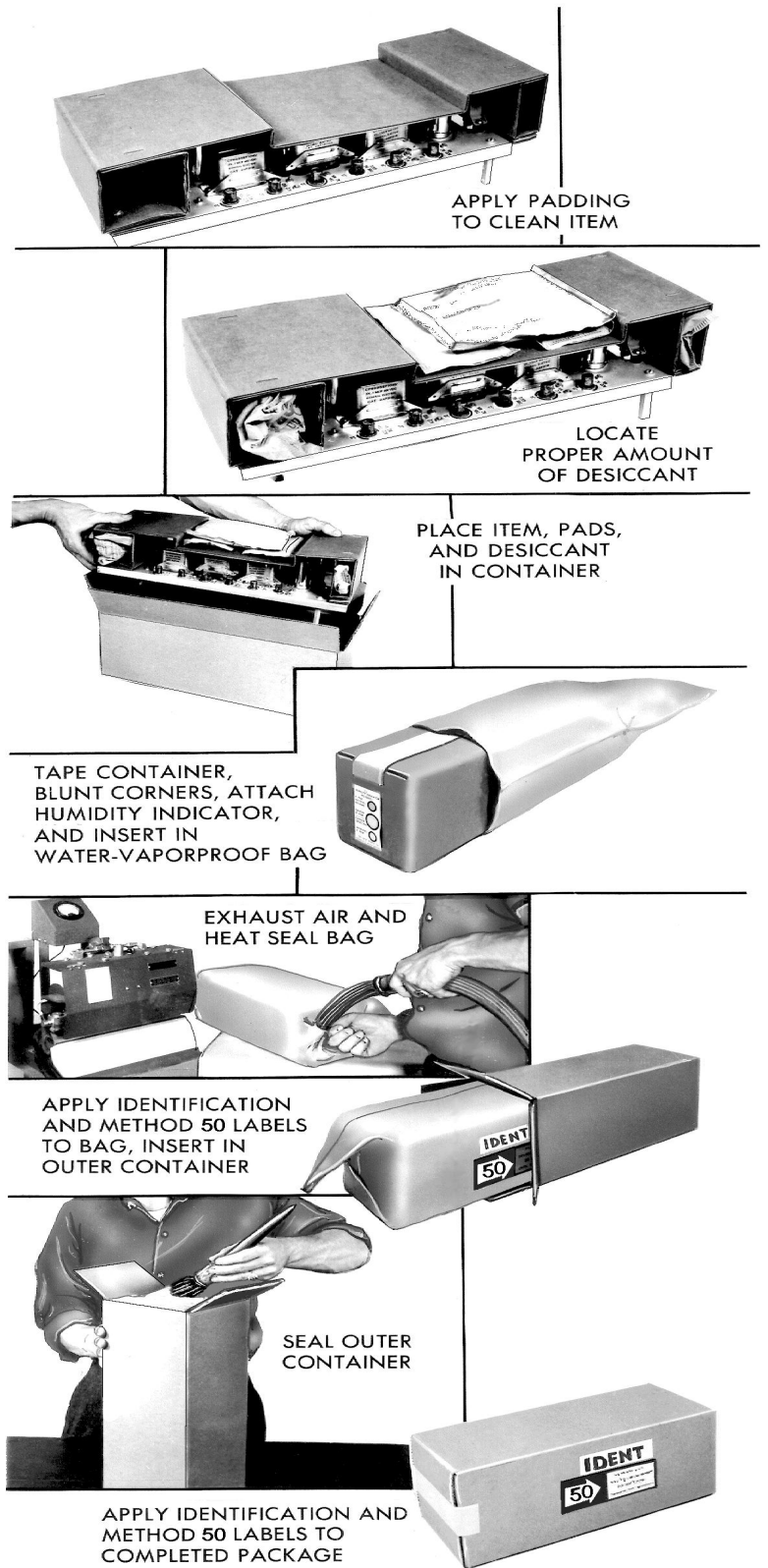
**Construction Steps**

To construct this method, perform the following steps while also observing the construction techniques shown in figure 4-39.

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: If a preservative is not required, go to step 4.)





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Figure 4-38. Application of Method 52.

**Step 2**

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3.

**Step 3**

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

Note: If only a portion of the equipment is coated (such as the shaft of an electric motor) with a preservative, wrap only that portion with a greaseproof wrap, using tape to secure the wrap.

**Step 4**

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or part of unit packing. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps.

**Step 5**

Apply desiccant to control the relative humidity and cushioning or other dunnage as necessary to protect the item as well as the bag from the item's projections and sharp edges. Secure cushioning and wraps with string or tape if necessary.

**Step 6**

Select a barrier (bag) material conforming to MIL-B-117, Type I, Class E, F, or G, Style 1, 2 or 3, or Type II, Class E, Style 1 or 3, or Type III, Class E, Style 1. You may use the following bag materials (that meet the requirements of MIL-B-117) for this method:

- X MIL-PRF-131, Type I or II, Class 1 or 2.
- X MIL-PRF-22191, Type I
- X MIL-PRF-81705, Type I, Class I (ESDS items only).

**Step 7**

Position the barrier (bag), with holes to accommodate the mounting bolts, on the mounting base, and seal bolt openings and gaskets with adhesive. See figure 4-39 on how to place and seal the gaskets.

Note: The gasket material quality, gasket application and performance evaluation shall be in accordance with applicable requirements of MIL-E-6060. Unless otherwise specified, gasket material shall conform to MIL-G-12803.

**Step 8**

Firmly secure the humidity indicator immediately within the closing edge of the barrier bag.

**Step 9**

Heat seal the bag leaving sufficient surface area to permit two subsequent resealings after item inspection, unless otherwise specified.

Note: Information on how to make bags (such as the maximum heat seal width and size and weight limits) was provided earlier in this chapter under "BAGS, SLEEVES AND TUBING (MIL-B-117)".

**Step 10**

Apply markings to the bag, including the Method 50 label, in accordance with MIL-STD-129 and MIL-HDBK-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see figure 4-46.

Note: When the outer container becomes the shipping container, it shall be marked as a shipping container in accordance with MIL-STD-129 and MIL-HDBK-129. In this case, the barrier (bag) will be marked as specified in MIL-STD-129 and MIL-HDBK-129 for unit packs.

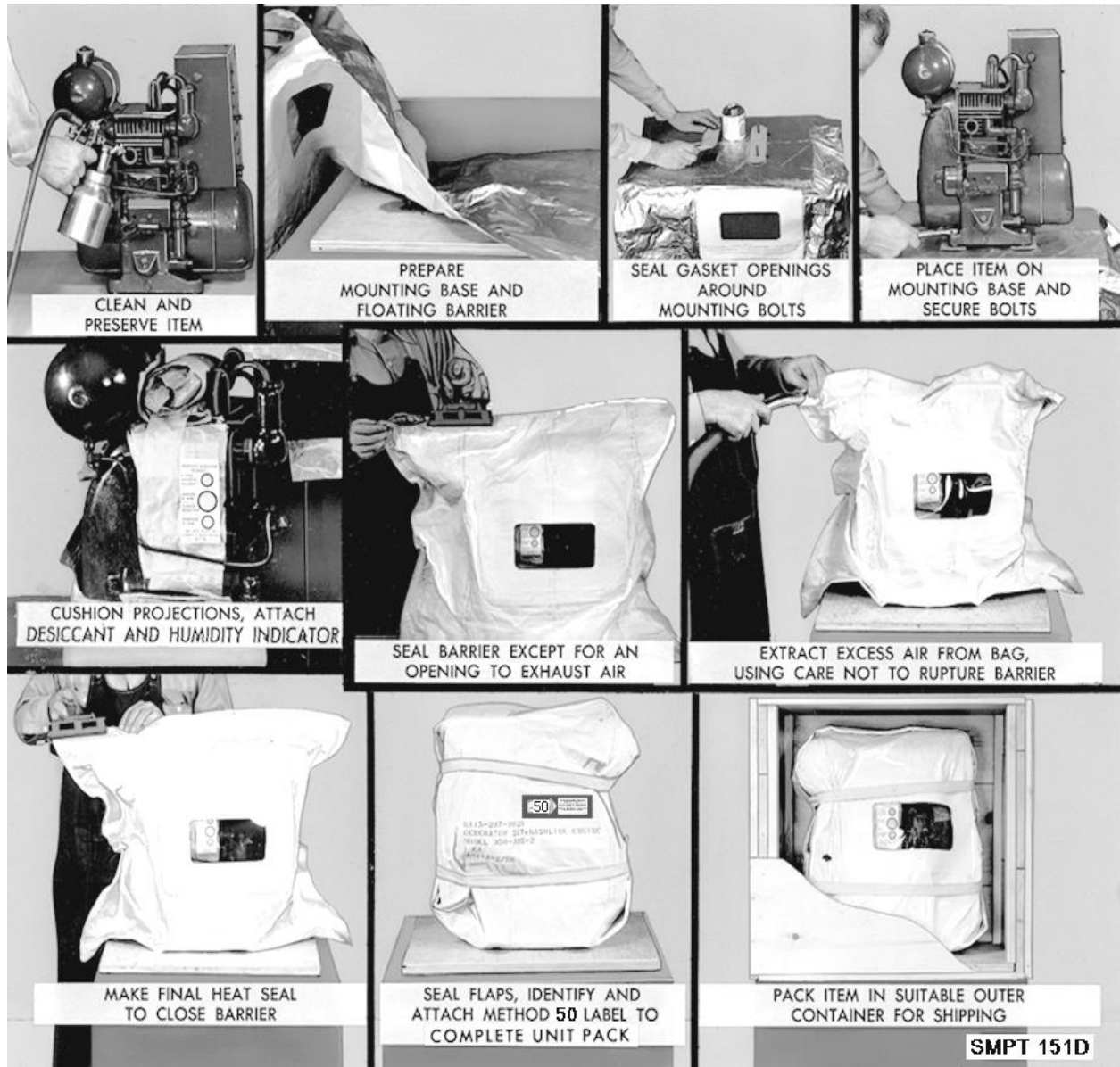


Figure 4-39. Application of Method 53.

**METHOD 54 RIGID CONTAINER (OTHER THAN ALL METAL), SEALED**

This method is accomplished by enclosing the item, preserved, wrapped, cushioned and desiccated as required, in a sealed, close fitting, rigid container other than all metal.

**CONSTRUCTION STEPS**

To accomplish this method, use the steps below as well as the illustrations provided in figure 4-40.

***Step 1***

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: Go to step 4 if a preservative coating is not required.)

***Step 2***

Select and apply a preservative coating to the item (or parts of the item), if required, using selection criteria and application procedures given in chapter 3. Permanent preservative coatings to electrostatic discharge sensitive (ESDS) items are normally applied by the manufacturer.

***Step 3***

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

Note: If a greaseproof liner is used instead of a greaseproof wrap, the liner shall conform to MIL-L-45973.

***Step 4***

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as part of unit packing. See "METAL SURFACES NOT COATED WITH PRESERVATIVES" to identify noncorrosive wraps.

***Step 5***

Place the item along with the required number of bags of desiccant (wrapped and cushioned as required) into a snug fitting, rigid container other than all metal. The following fiber containers may be used:

- X PPP-D-723, Type III, Grade A, Class 2, for contents exceeding 20 pounds.

Note: Unless otherwise specified, other sealed rigid containers other than all metal listed in MIL-STD-2073-1C may be considered for use as long as the watervaporproofness of the container provides a WVTR not exceeding 0.075 grams per 100 square inches per 24 hours when tested in accordance with ASTM D 1008.

***Step 6***

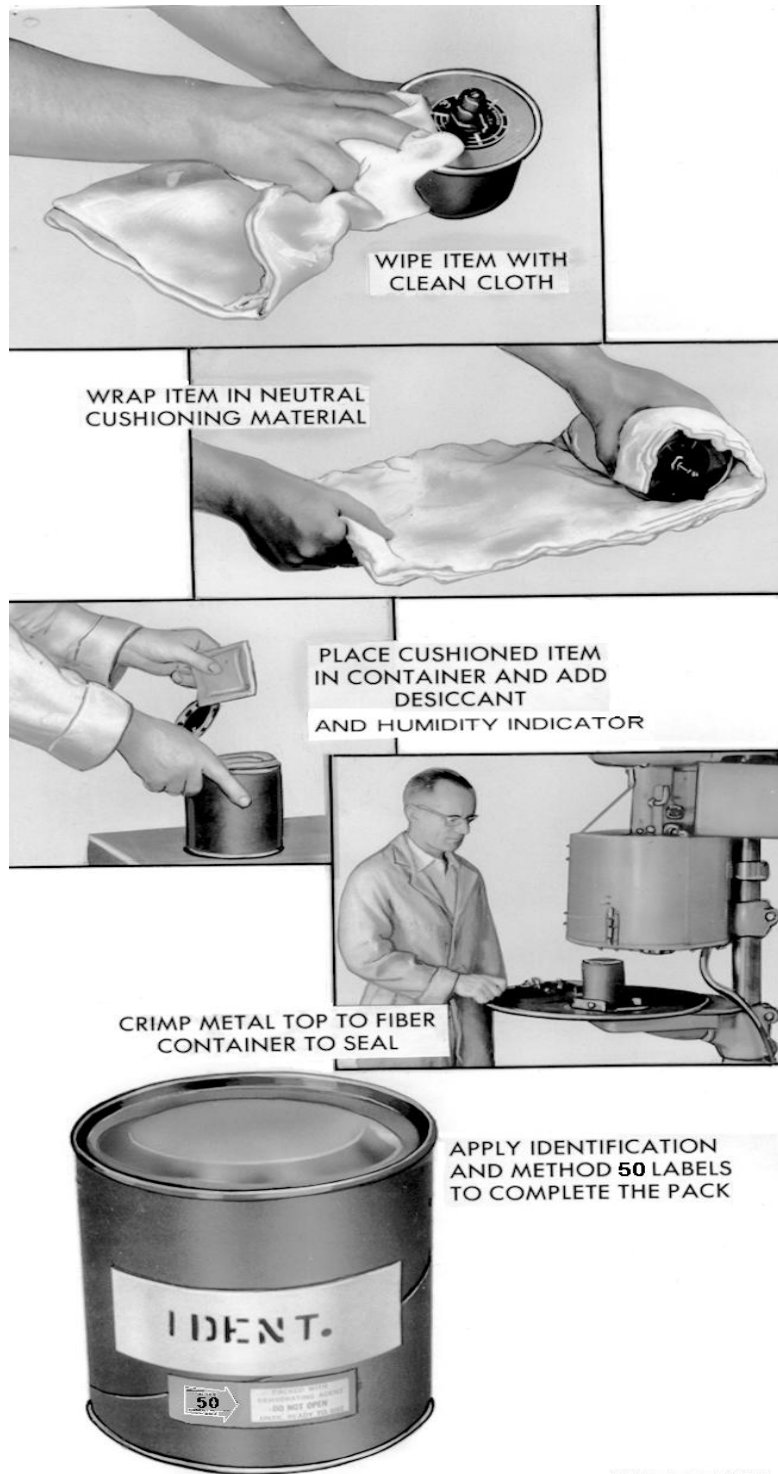
Firmly secure the humidity indicator immediately within the cover of the container.

***Step 7***

Close the container in accordance with the container specification.

**Step 8**

Apply markings, including the Method 50 label, according to MIL-STD-129. See the paragraphs under "MARKING OF UNIT AND INTERMEDIATE PACKS" near the end of this chapter. Also see the example of unit pack markings in figure 4-46.



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Figure 4-40. Application of Method 54.

**METHOD 55 - RIGID METAL CONTAINER, SEALED**

Item preserved, wrapped, cushioned and desiccated as required shall be enclosed within a snugly fitted, sealed, metal container.

**Construction Steps**

To accomplish this method, use the steps below as well as the illustrations provided in figure 4-41.

**Step 1**

Clean and dry the item, as required, using one or more of the processes and procedures given in chapter 2. (Note: Go to step 4 if a preservative coating is not required.)

**Step 2**

Select and apply a preservative coating, if required, using selection criteria and application procedures given in chapter 3. Normally, contact preservatives are not required for this method unless required by a contract or order.

**Step 3**

Apply a greaseproof wrap only if a soft drying preservative has been applied to the item.

**Step 4**

When greaseproofness is not a requirement, apply a neutral wrap where a noncorrosive, dust protective wrap is required prior to or as a part of unit packing, if applicable.

**Step 5**

Apply the required number of units of desiccant along with cushioning or dunnage or selective support (either rigid or resilient or in combination) to the item or container as required to insure against free movement and protect the item from shock damage.

**Step 6**

Insert the item into any rigid metal container with machine seamed or welded closure or reusable gasketed closure having a WVTR not exceeding 0.075 grams per 100 square inches per 24 hours, when tested in accordance with ASTM D 1008 unless a specific type of container is specified in the contract or order. The following is a partial list of containers authorized for this method:

- X PPP-C-96 Metal Cans.
- X MIL-D-6055 Metal Drums.

**Step 7**

Firmly secure the humidity indicator immediately within the cover of the container.

**Step 8**

Close the container according to the container specification requirements. (Note: Chapter 7 includes closure information for the can and drum shown in step 6.)

**Step 9**

Mark the bag, including the application of a Method 50 label, in accordance with MIL-STD-129 and the marking information given in "MARKING OF UNIT AND INTERMEDIATE PACKS" and figure 4-46 at the end of this chapter.



Figure 4-41. Application of Method 55.

## **QUANTITY PER UNIT PACK (QUP)**

Unless otherwise specified by the acquiring activity, the quantity per unit pack (QUP) shall be determined in accordance with MIL-STD-2073-1C. Except for the several categories given below, you must consult MIL-STD-2073-1C for QUP requirements.

### **HI-VALUE OR HI-PRIORITY REPAIRABLE ITEMS**

A QUP of one (1) will be established for all items identified as repairable (depot or field level) or items designated Hi-value or Hi-priority.

### **CONSUMABLE ITEMS**

QUP shall be one (1) for all consumable items with a unit cost of \$50.00 or more. Items of less than \$50.00 requires the use of MIL-STD-1073-1C to determine the QUP.

### **IRREGULAR, DELICATE OR FRAGILE ITEMS IN METHOD 50 UNITS**

The QUP for items which are unit packed in accordance with Method 50 of MIL-STD-2073-1C and items of irregular configuration, delicate or fragile nature, not lending themselves to multiple packs, is one each.

## **QUALITY ASSURANCE PROVISIONS**

### **MILITARY PACKING EXAMINATIONS AND INSPECTIONS**

MIL-STD-2073-1C suggests that, due to the unique environment to which military packages are often exposed, examinations of preservation and packing inspections be considered when developing the quality system in accordance with ANSI/ASQC-Q9002, Quality Systems Model for Quality Assurance and Production Installation and Servicing (DOD adopted). Preservation examinations and packing inspections will be discussed in subsequent paragraphs.

### **WORKMANSHIP**

Workmanship shall be such that, when the proper procedure is followed, materials and equipment being processed will receive the required protection against corrosion, deterioration, and damage during shipment and storage and will require the minimum of processing for service.

### **TESTING OF PRESERVATION METHODS**

The tests described herein are used to determine the effectiveness of the various methods of preservation as set forth in MIL-STD-2073-1C. When a combination of methods is used for a specific item, tests applicable to the various methods employed will be listed in table 4-13. To be acceptable, the packaging materials and the item within the unit pack must show no signs of damage or operational malfunction due to deterioration as a result of a test.

Military packages shall be subjected to the preservation inspection criteria as directed in Table G.I. of MIL-STD-2073-1C. More specifically, packages must not have the defects specified in Table G.I. The criteria of Table G.I. is, partially, based upon the testing requirements of Table G.II, in appendix G, MIL-STD-2073-1C.

### **DETERMINATION OF PRESERVATIVE COMPOUND APPLICATION**

The continuity and appearance of preservatives after application shall be determined visually. The retention of preservatives shall also be determined by visual examination. The surfaces of the items protected by the application of preservatives shall be rejected if the surface coatings are not uniform and show



evidence of preservative decrements or corrosion at points of contact of the item with the barrier. Hard preservative films shall be examined closely for breaks in the coating. Criteria for visual inspections of items are listed in MIL-STD-2073-1C, Table G.I., "Preservation Inspection Provisions."

Table 4-13. Schedule of Quality Conformance Tests.

METHOD (note 1)	LEAK TEST	HEAT-SEALED SEAM TEST	CONTACT PRESERVATIVE	MARKING & LABELING (note 2)	WORKMANSHIP (hints) (notes 3 & 4)
10	----- ---	-----	----- -----	Markings on wrap and container when used. (see note 11). Identification not required on wraps placed in snug containers where identification is on the containers.	Dunnage and wrapping of container, as applicable, to prevent contamination and physical damage in storage.
20	----- ---	-----	Required	See Method 10	See Method 31
31	Required	Required (Note 10)	-----	Markings applied on bag & container when used (note 11)	Appropriate size bag. Minimum air void. Cushioning as required.
32	Required	Required	-----	Markings applied on barrier and outer container when used.	Minimum void. Cushioning or blocking as required. Corners of inner carton blunted.
33	Required	Required (Note 10)	-----	Markings applied on bag and container when used. (Note 11)	Appropriate size bag. Minimum air void. Cushioning as required.
41	Required (Note 5)	Required	when specified	Marking applied on bag & container when used (Note 11)	See Method 31
42	Required (Notes 7 & 9)	Required	when specified	See Method 32	See Method 32
43	Required (Notes 6 & 9)	Required	when specified	See Method 32	Minimum air void. Cushioning or blocking as required.
44	Required (Note 8)	-----	when specified	Marking applied on container	Min. air void. If additional protection other than basic wrap is needed, cushioning or blocking should be used.
45	Required (Note 8)	-----	when specified	Marking applied directly on metal containers	See Method 44

METHOD (note 1)	LEAK TEST	HEAT-SEALED SEAM TEST	CONTACT PRESERVATIVE	MARKING & LABELING (note 2)	WORKMANSHIP (hints) (notes 3 & 4)
51	Required (Note 5)	Required	-----	See Method 33	Desiccant, proper amt. used. Humidity indicator properly placed. Window when required. With flexible barrier, sufficient material at closure edge. Corners of inner carton blunted for Method 52.
52	Required (notes 5, 7, & 9).	Required	when specified	Markings applied on barrier & outer container.	See Method 51
53	Required (notes 5, 6, & 9).	Required	when specified	See Method 52 and note 11.	See Method 51
54	Required (Note 8)	-----	-----	Marking applied on container.	See Method 51
55	Required (Note 8)	-----	-----	Marking applied directly on metal container.	See Method 51

*Notes.*

1. Determination of cleanliness required for all methods.
2. When a container for a unit or multiple unit package is used also as an exterior shipping container, the marking applicable to shipping containers as specified in MIL-STD-129 shall be used in lieu of pack markings. Identification is not required on wraps placed in snug containers, where identification is on the container.
3. These provisions are meant to be in addition to those listed in Table G.I. of MIL-STD-2073-1C.
4. Materials for preservation-packaging shall be as required for the specific method and as specified in the contract or order.
5. When size or shape of the pack precludes the use of the vacuum chamber test the hot water technique or vacuum retention test may be used in lieu of the vacuum chamber test.
6. Vacuum Retention Test may be used in lieu of the Vacuum Chamber Test.
7. When specified by the procuring agency, the Vacuum Retention Test shall be used on specified items in lieu of the Vacuum Chamber Test.
8. Pneumatic Pressure Test may be used in lieu of the Vacuum Chamber Test. MIL-C-3955 cans may be tested by the Submersion Test in lieu of the Vacuum Chamber Test.
9. Remove outer container prior to testing.
10. A cold-sealed seam test as defined in MIL-B-22020 shall be substituted in cases where a VCI treated cold-sealed bag is employed as the unit container.
11. Transparent or opaque labels may be inserted in transparent unit containers when the label can be placed in a stationary position and will not affect or be affected by the method of preservation. Opaque labels shall not obscure more than 50 percent of one surface of transparent unit containers.

**LEAKAGE TESTS**

Unit packs shall be tested for leaks in accordance with one of the following techniques (tests) of Method 5009 of Federal Test Method Standard No. 101 and are required by table G.II. of MIL-STD-2073-1 for the applicable method of preservation. Materials such as containers, wraps, dunnage, etc., shall be removed from the watervaporproof barrier before testing the pack.

**WETTING AGENT**

As an alternative to the use of the aerosol solution recommended by Method 5009 of FED-STD-101, a solution of 4 grams of water-soluble detergent conforming to type I of MIL-D-16791 per gallon of test water may be used to release entrapped air so that actual leakage of air through the barrier may be detected.

**SELECTION OF TECHNIQUE**

The most appropriate technique will depend principally upon the construction, size and weight of the unit pack and the information needed. There may be more than one technique applicable to certain unit packs.

**Hot water technique**

Use this technique for large unit packs. Observe evolution of air bubbles at each position of the sample. Bubbles which appear on the surface of the unit pack but are not released or are released at a slowly decreasing rate are not to be construed as indication of failure. There shall not be a steady stream or recurring succession of bubbles from any surface or seam.

**Squeeze Technique**

Small unit packs constructed of flexible materials such as plastic film may be tested using this technique. During sealing as much air as possible is entrapped within the flexible bag at normal conditions as if for shipment and then is squeezed to increase the internal air pressure as the container is observed to detect the leaks. There shall not be a leak with bubble-supporting film.

**Vacuum Retention Technique**

This technique does not specifically locate leaks and may not indicate the existence of tiny leaks in a large unit pack. The technique may be performed using either a sealed rigid container (see the first bullet below) or a sealed flexible bag (see the second bullet below) as follows:

- X Sealed rigid container. When air in the sealed rigid container has been evacuated to a constant specified pressure, allow the sealed container to remain undisturbed for 10 minutes. The loss of vacuum from the sealed rigid container system shall not exceed twenty-five percent of the original vacuum.
- X Sealed flexible bag. Sufficient air shall be drawn from the sealed flexible bag to cause the bag material to cling snugly to the enclosed item. Allow the bag to remain undisturbed for two hours at room temperature. Grasp the bag and draw it away from the item; then release it quickly. The bag shall remain taut and cling to the item. The stretched bag shall not cause the flexible bag to lose its tautness after remaining undisturbed for two hours. Figure 4-42 shows the vacuum retention technique used on a sealed flexible container system.

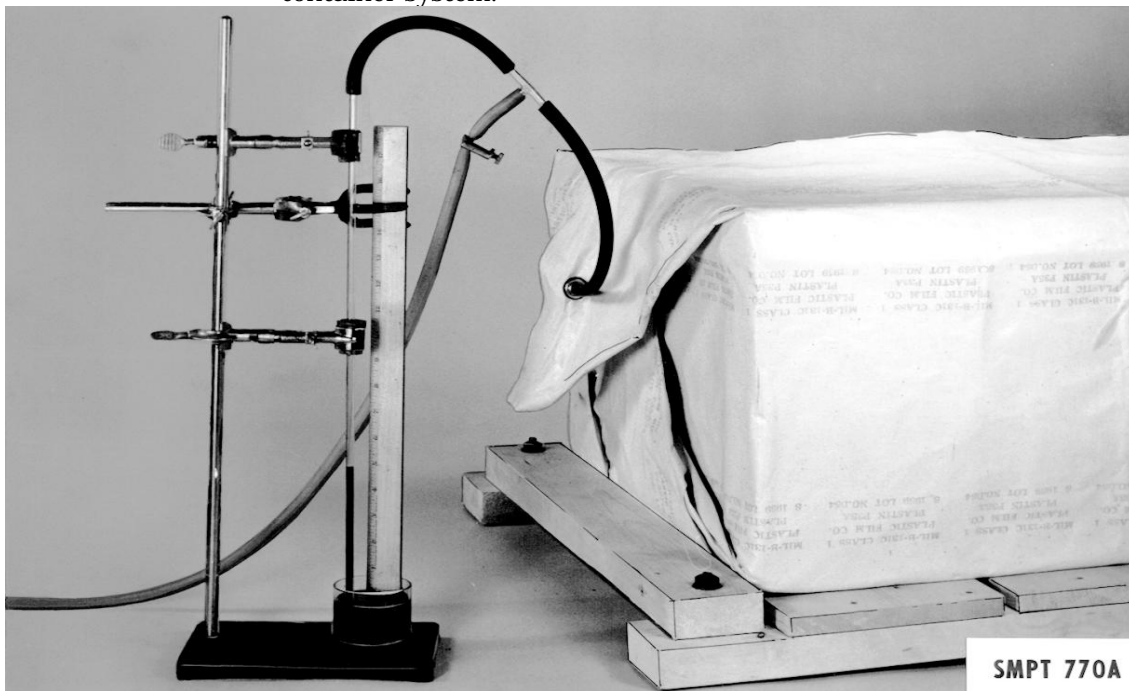


Figure 4-42. Vacuum retention technique.

### **Submersion (or Immersion) Technique**

This technique for detecting water leakage is not as sensitive as the air leakage tests, but it is appropriate to reveal whether or not water might leak into the unit packs, and depending upon the duration of the test, gives some indication of the extent to which the materials used in the pack are waterproof. After submersion and before opening the sealed system, carefully dry the outside. Open the sealed system and note whether leakage has occurred. There shall be no evidence of moisture within the bag. Figure 4-43 shows details of the submersion technique.

### **Pneumatic Pressure Technique**

The pneumatic pressure technique is primarily appropriate for rigid containers. Neither the hot water nor the pneumatic pressure techniques are appropriate for rigid containers that are sealed with tapes. The submersion technique must be used. When the sealed system is pressurized to a constant specified pressure and the line to the compressed air supply is closed, read and record the initial pressure. When required to pinpoint leaks, coat surfaces with a soap solution or submerge the system under water and record the results. Read and record the final gage pressure. Repeat the test if there is any loss in pressure and no leaks are detected. During the pneumatic pressure technique test, there shall be no loss of gage pressure for a period of 30 minutes. When a water solution or immersion procedure is used, there shall be no evidence of air leakage as evidenced by soap bubbles increasing in size or being blown away by the escaping air or by evidence of a steady stream or recurring succession of bubbles from any surface. See "Submersion Technique" in figure 4-43.

## **HEAT-SEALED SEAM TEST**

### **SELECTION OF SAMPLES FOR TEST**

Selection of the heat seals shall be obtained from sealed unit packs. The number of sealed specimens required will be in accordance with sampling procedures described in ANSI/ASQC-Q9002. Requirements for conducting the test are based on the method of preservation and as described in paragraph G.4.3. of MIL-STD-2073-1C.

### **Alternate Sampling Procedure for Heat-Sealed Seam Test**

When heat seals are made with equipment designed to control the temperature, dwell time and pressure, test samples may be prepared from specimen heat seals in lieu of taking samples directly from heat sealed packs. Specimen heat seals shall all be prepared daily prior to production from sample(s) of each material sealed on each sealing device. Machine settings used in production shall be identical with the settings used in fabrication of test specimens. In cases where any of the alternately prepared heat seal specimens fail the seam strength test, tests of heat seals from actual unit packs shall be performed as necessary to assure that unit pack seals meet the requirements given in the next paragraph.

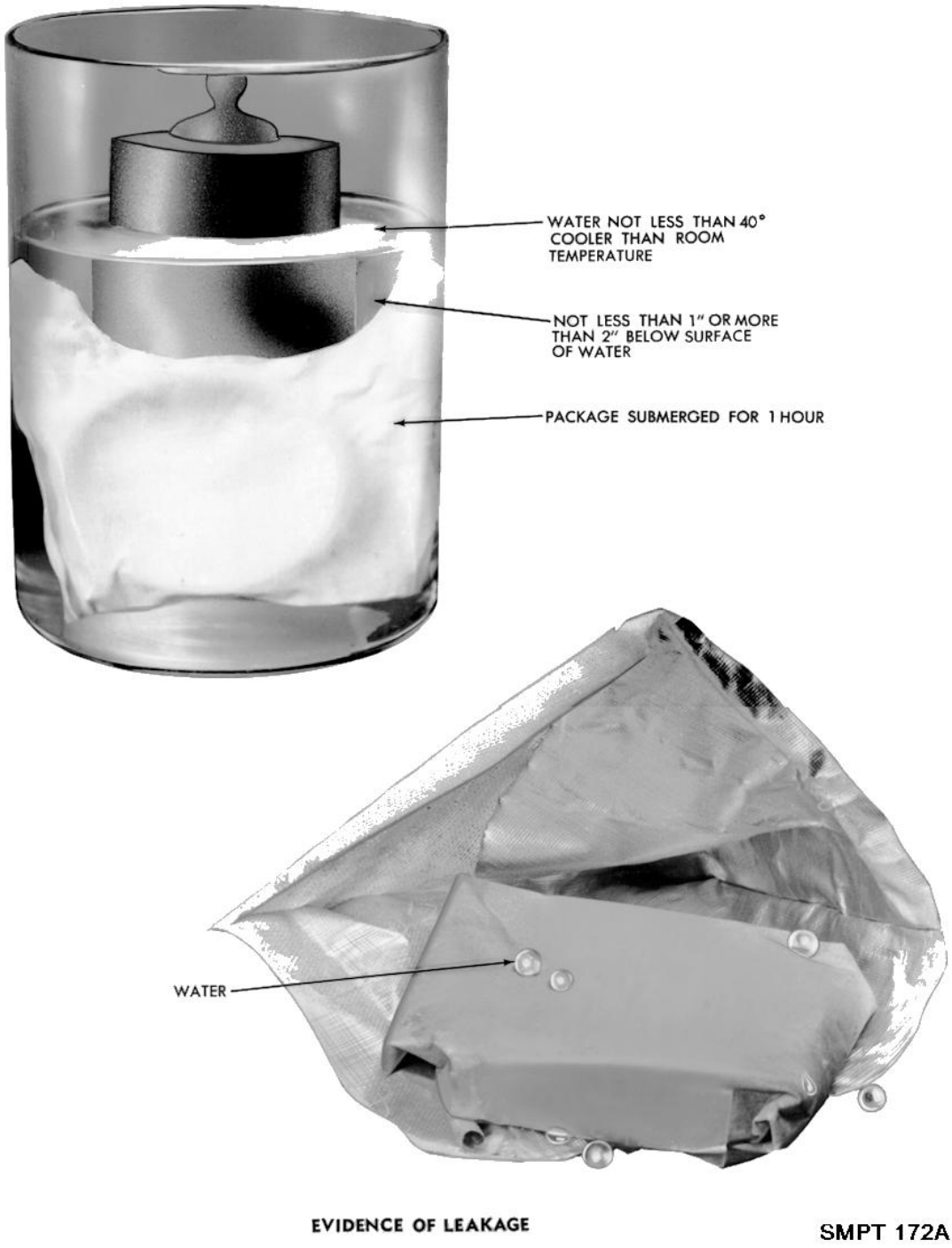


Figure 4-43. Submersion (immersion) technique.

**Performance of Heat-Sealed Seam Test (see figure 4-44)**

The heat-sealed seam test shall be performed in accordance with Method 2024 of Federal Test Method Standard No. 101 as follows:

- X After the heat sealed seams are cooled (one hour), sections of the heat seals 1 inch in width cut perpendicular to the line of the seal will be obtained from the test specimens or pack barriers as applicable. The length of the legs of the test section is not critical.
- X The sections will be unfolded and clamped with the line of the seal perpendicular to the direction of the load application. The seams will be positioned midway between the jaws of the testing clamps.
- X A static load will be applied slowly and uniformly without impact and allowed to act for 5 minutes at normal room temperature.
- X Any separation at the heat sealed area will be noted, without disturbing the seal, after 2 minutes and at the end of the 5-minute interval.
- X The static load shall be 36 oz plus or minus 2 ounces when barriers conform to MIL-B-121. However, when the barrier materials conform to A-A-3174, MIL-PRF-131, or MIL-PRF-22191, the static load weight shall be 50 ounces plus or minus 2 ounces.
- X A five percent reduction in static load weight is permitted when the room temperature in the test area exceeds 90°F.

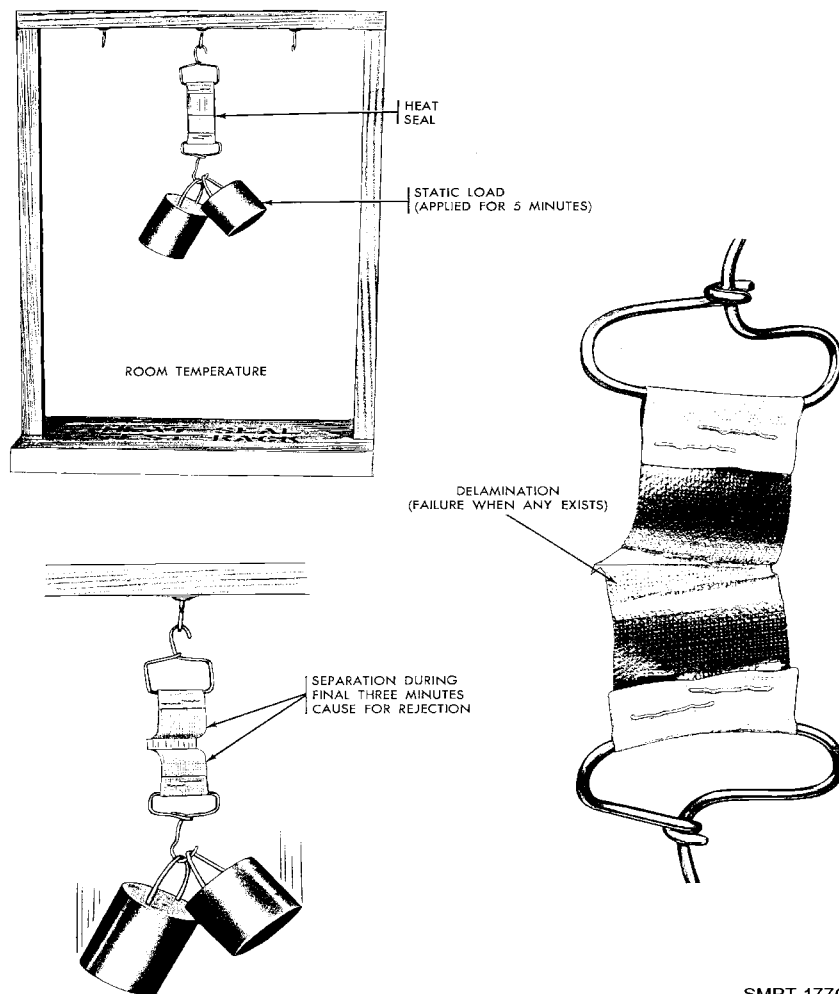


Figure 4-44. Heat-sealed seam test.

### **Interpretation of Results**

Partial separation of the heat seal is acceptable within the first two minutes of the test to allow areas of partial fusion adjacent to the actual seal to pull apart. Any selection of the heat-sealed area during the final 3 minutes of the test will be cause for rejection. The heat-sealed seam test depicted in figure 4-44 is a specimen from a barrier material that will be used to make unit packs.

## **CONTAINER PERFORMANCE TESTING**

### **UNIT CONTAINER**

The unit container shall be subject to various handling, vibration, stacking, and other performance tests which are delineated in –

- X ASTM D4169, “Standard Practice for Performance Testing of Shipping Containers and Systems.

MIL-STD-2073-1C recommends the use of ASTM D4169 among other non-Government documents. For example, MIL-STD-2073-1C also supports the use of “Quality Assurance” provisions with the following DOD adopted document:

- X ANSI/ASQC-Q9002, Quality Systems – Model for Quality Assurance and Production Installation and Servicing.

MIL-STD-2073-1C explains that the “contractor shall implement and maintain a quality system that satisfies program objectives and meets the requirements of ANSI/ASQC-Q9002.”

Except for hazardous materials packaging, package testing for design validation shall conform to –

- X Applicable performance tests (in sequence) of ASTM D 4169.
- X Preservation inspections outlined in Appendix G, MIL-STD-2073-1C.

The steps detailed in ASTM D 4169, leading to performance testing of containers are as follows:

- X Define the Shipping Unit (See “Terminology” in ASTM D 996).
- X Establish “Assurance Levels” by specifying the level of test intensity required for the package. For example, “Assurance Levels” denotes the level of intensity based on its probability of occurring within a distribution cycle (DC).
  - o Level I – a high level of intensity but low probability.
  - o Level II – the middle level or less than level I but greater than level III below.
  - o Level III – a low level of intensity but high probability of occurring.
- X Determine Acceptance Levels. For example, \*when level II is used, based upon the value and volume of the shipment, then, the criterion for passing is that
  - o no product damage occurs, and,
  - o all packages are in good condition.

\*Note: An updated ASTM D 4169 should be consulted before key decisions are made.

DOD levels of protection for Military packing may be equated in the following manner:

<u>Commercial</u>	↔	<u>Military</u>
Assurance Level 1	↔	Level A protection
Assurance Level 2	↔	Level B protection
Assurance Level 3	↔	(N/A) per DOD policy

Determine the Distribution Cycle (DC). This means the sequential listing of the elements expected to occur for a specific routing of a shipping unit, e.g., from production to ultimate consumption. ASTM D 4169 lists ten (10) different DCs, but only seven (7) examples will be shown in the following table for the purpose of elucidating points concerning Government shipments.

DC Element*	DC Description	Test Required
A	Manual Handling	Drop
B	Mechanical Handling	Drop, Stability
C	Warehouse Stacking	Compression
D	Truck and Rail Transport (stacked or unitized)	Vibration
F	Loose-load vibration	Repetitive Shock
H	Rail Switching	Longitudinal Shock
J	Environmental Hazard	Cyclic Exposure

\* Three other Hazard Elements are listed in ASTM D 4169.

Formulate a Test Plan. ASTM D 4169 suggests the sequencing of tests such as in the following manner:

Sequence	ASTM Test Required	Approved Methods	Degree or Test Level**
1 (A/B)	Handling	ASTM D 1083-91	**
2 (C/D)	Stacking	ASTM D 642	**
3 (F)	Vibration	ASTM D 999-91, Method C	**
4 (A/B)	Handling	ASTM D 1083-91	**
5 (C/D)	Stacking	ASTM D 642	**

\*\*The test level or degree is determined by the engineer as to what shall be appropriate according to the container being tested. For example, sequence 5 may require compression to 756 lbs per container. Consult ASTM D 4169 for details.

The remainder of the other steps in the testing procedure are as follows:

- (6) Selecting representative samples for the test
- (7) Conditioning samples.
- (8) Performing tests in accordance with the test plan.
- (9) Evaluating the test results.
- (10) Determining the test results.



## **APPLICABILITY OF TESTS**

### **Small Containers**

The free-fall drop test, super-imposed loading and vibration test shall apply to small containers; either one or both vibration tests in table 4-14, or as modified by table 4-15, may be performed at the contractor's option. Small containers are those having no one edge or diameter of the container exceeding 60 inches and/or a gross weight of 150 pounds or less. Any container not exceeding the above dimension and weight criteria but equipped with skids shall be considered a large container for testing purposes.

### **Large Container**

All rough handling tests shall apply to large containers. Either one or both vibration tests shall be conducted at the option of the contractor. However, tipover tests will apply only when specified. Either impact test shall be conducted at the option of the contractor. Large shipping containers are those measuring more than 60 inches on any one edge or diameter, or those which, when loaded, have gross weights in excess of 150 pounds or those which have skids.

## **INTERPRETATION OF RESULTS**

Any damage resulting from the rough handling tests that would prevent the container from performing its intended function will be cause for rejection.

## **DETERMINATION OF PRESERVATION RETENTION**

### **DETERMINATION**

Samples will be examined, where applicable, for retention of the preservative compounds. Figure 4-45 shows examples of this visual test.

### **INTERPRETATION OF RESULTS**

Evidence of failure of retention of the preservative or evidence of corrosion, particularly at points of contact of the item with the barrier, will be cause for rejection.

Table 4-14. Rough handling tests.

Test	Methods of FED-STD-101	Special requirements or exceptions
Free-fall drop tests: Corner drop Flat drop	5007 Procedure E 5007 Procedure B	See note 1 See note 2 See note 2
Tipover	5018	See note 4
Rotational drop tests: Edgewise Cornerwise	5008 5005	See note 1
Impact tests: Pendulum Incline	5012 5023	See note 1
Superimposed load (Stackability with dunnage) (Uniformly distributed without dunnage)	5016 5017	See note 3
Vibration: Repetitive shock Sinusoidal motion	5019 5020	See note 1

Notes:

1. Unless otherwise specified, the contractor shall have the option as to what method is to be applied in accomplishing the free-fall rotational, impact and vibration tests.
2. Containers employing internal shock mitigation systems, cushioning, blocking or bracing shall be subjected to both corner and flat drop tests.
3. Unless otherwise specified, both methods shall be applied.
4. Not required unless specified.

Table 4-15. Graduated drop and impact test heights.\*

Gross weight of container and contents	Edgewise drop (2 drops each end)	Cornerwise-drop test (2 drops on each of 2 diagonally opposite corners of bottom)	Impact test (1 impact on each of 2 opposite ends)	
			Pounds	
	Height of drop (inches)	Height of drop (inches)	Pendulum impact (inches)	Incline impact (feet)
150-250	30	30	14	7.0
Over 250 thru 500	24	24	11	5.5
Over 500 thru 1000	18	18	8	4.0
Over 1000	12	12	5	2.5

Note:

\* Excludes Method 5007.



Figure 4-45. Determination of preservative retention.

## DISPOSITION OF SAMPLES

All samples used for inspection and tests will be reprocessed as necessary. They may, after reprocessing in accordance with the original method of preservation, be considered a part of the original lot. When the packed item may have been damaged as a result of testing, it will be inspected and tested as necessary to determine its acceptability.

## MARKING UNIT AND INTERMEDIATE PACKS

### GENERAL

Markings applied to labels or applied directly to barriers or interior containers identify the packaged item and give other important information in regard to the unit or intermediate pack. Lack of proper markings on these packs will cause serious difficulties and problems in the supply system. A unit or intermediate pack is not complete until it has been properly identified.

### MIL-STD-129 MARKING REQUIREMENTS

The marking of unit and intermediate packs will be done in accordance with the requirements of MIL-STD-129/MIL-HDBK-129.

### Identification Markings

Unless specifically exempted in the procurement contract or order, the following minimum identification information shall be marked on all unit packs, intermediate containers, and unpacked items in the order listed (see figure 4-46).

### NSN/NATO Stock Number

The stock number shall include spaces or dashes and any prefix or suffix shown in the contract or requisition. The stock number shall be in-the-clear and bar coded. If no NSN is assigned, then this line may be omitted. For ammunition, when a DOD Identification Code (DODIC) is specified, it shall be placed on the same line as the NSN/NATO stock number.

### Part Number (PN)

The part number cited in the contract shall be shown (except for ammunition items with NSN/DODIC designations). If the item has no PN assigned to it or if no PN is required, then nothing is shown.

**Quantity and Unit Of Issue (UI)**

A nondefinitive UI shall be accompanied by a quantitative expression such as "1 RO (100 FT)."

**Contract Number or Purchase Order Number**

This information shall include the four-digit delivery order or call number, when used.

**Military Method and Date of Unit Preservation**

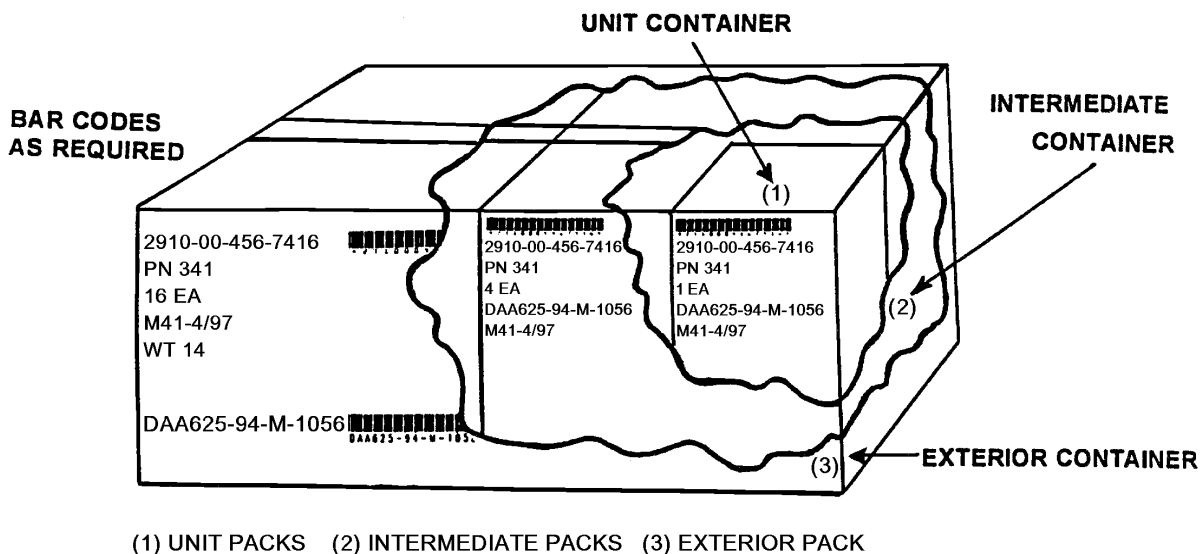
For example, "M41-4/97" - method 41 preservation from MIL-STD-2073-1C, was provided April 1997. Use of the letter "M" in the first position indicates that the pack is a military preservation method; "41" is the method number; and "4-97" indicates the date of preservation (month and year).

**Special Markings**

Special markings consist of markings and labels such as Method 50, shelf-life, and the ESD sensitive devices attention label for unit and intermediate packs. Special markings will be in accordance with MIL-STD-129.

**Bar Code Markings**

The bar code and human readable interpretation (HRI) of the NSN/NATO stock number shall be applied to all unit packs and intermediate containers when required by MIL-STD-129, see figure 4-46. The bar coded NSN/NATO stock number shall consist of the basic 13 data characters. Prefixes and suffixes to the stock number, as well as spaces and dashes, shall not be barcoded. Detailed descriptions and applications of bar coded markings are found in MIL-HDBK-129.



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Figure 4-46. Unit pack and intermediate container identification markings and exterior container identification and contract data markings (including bar code markings).

## Chapter 5

# Sprayable, Strippable Films And Controlled Humidity Sprayable, Strippable Films

### GENERAL

The use of spray-applied synthetic vinyl resins carried in solvents is one of the methods of protecting large pieces of equipment for long-term storage or sealing door and window joints in various vehicles. There are various types of sprayable, strippable films, each described by specification.

Although the application of sprayable, strippable films has been an effective way of providing protective covers, or cocoons, over very large items such as locomotives, diesel engines, aircraft, etc., remaining in outdoors storage for long periods of time, its use has declined due to newer, safer, and more environmentally acceptable methods. The application of sprayable, strippable films is declining because of the following:

- X Economics (Manpower intensive and expensive).
- X Hazardous (Chemicals used require utmost safety precautions and environmental use/disposal procedures).
- X Newer methods (such as nitrogen blankets, flexible containers for long-term storage, and the building of more controlled-humidity storage facilities).

Nevertheless, the use of the following chemicals and techniques are still approved for DOD use.

### MIL-C-16555

This specification covers two types and two classes of coatings intended to protect metal surfaces from deterioration and physical damage on items in outdoor storage and during shipment. They are capable of being sprayed and stripped from painted surfaces in addition to metal surfaces. The films can quickly be peeled off in large pieces. MIL-C-16555 establishes the percentages of the virgin unprocessed vinyl resins, plasticizers, solution and film stabilizers, pigments, and solvents to be used in the formation of the compounds. The solvent used is methyl-ethyl-ketone (MEK) with 20 percent of toluene allowed. The specification has separate requirements for testing samples after weathering. The compounds provide waterproof protection.

### MIL-PRF-6799

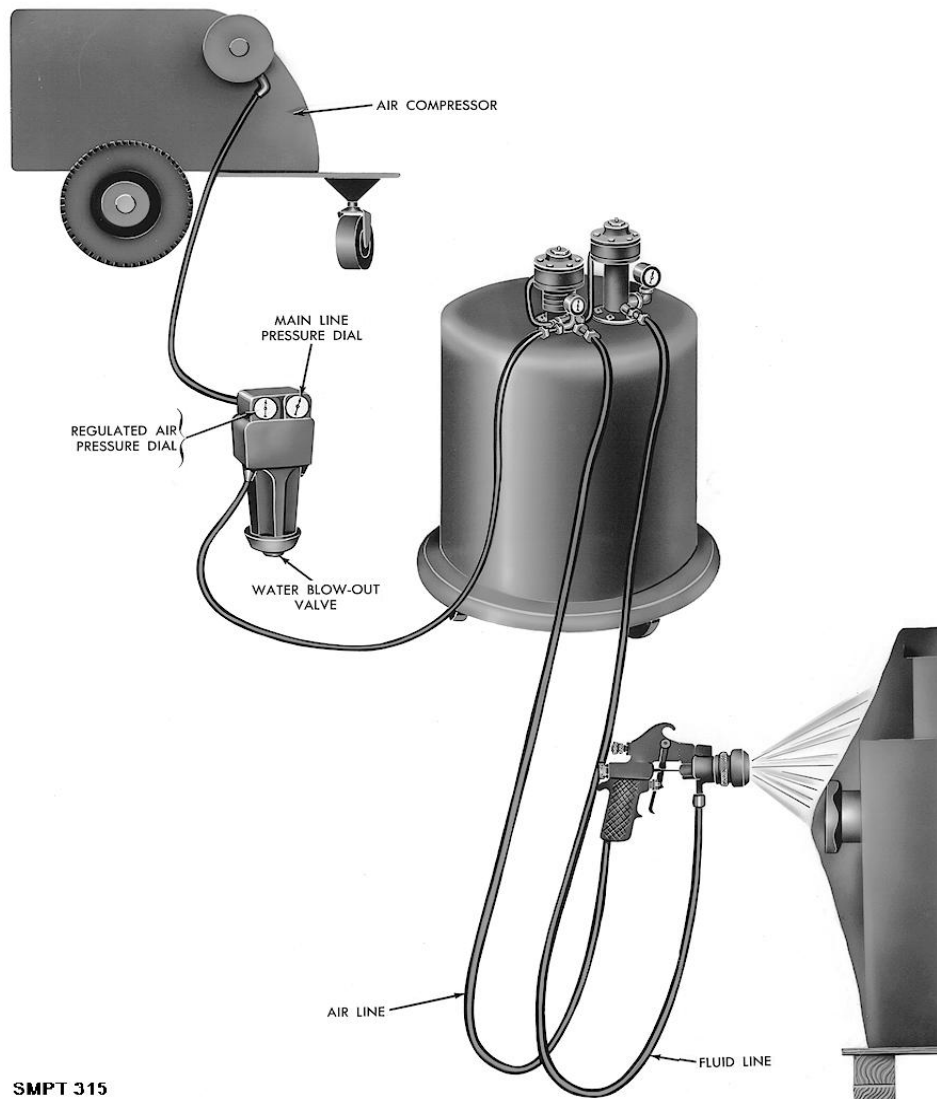
This specification covers the requirements for water emulsion protective, strippable, sprayable, or multicoat coatings for application over metallic, painted, and plastic surfaces. They are classified in one type (type II) and three classes. Type II - Multicoat system (exterior has four classes); Class 1 - Basecoat (black) is intended for use when protected item is shipped fully covered or stored under cover, as a basecoat. Class 5 - Topcoat (white or olive drab) is intended to be used only as top coating for Type II, Class 1 materials. In combination, this coating system serves to protect such items as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and oversea deck loaded shipments. The Type II - Class 6 topcoat (white) is a single coat

strippable protective coating used on items such as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and oversea deck loaded shipments. Type II - class 7 topcoat, brushable is used for repair or patching to either of class 5 or 6 above.

**ADHERING, STRIPPABLE COMPOUNDS**

**Application and Other Uses of MIL-C-16555 Compounds**

MIL-C-16555 compounds are applied by heavy duty spray equipment (figure 5-1). The film, 4 hours after application, must have a dry thickness of 0.35 to .045 inch. The first coat is applied horizontally, overlapping each pass 50 percent. The second coat is applied at right angle to the first coat. Each successive coat will be at right angle to the previous coat until the required thickness is built up. This takes about seven coats. The coating will be overlapped on the adjacent metal for a distance of 2 inches. Besides their intended use as protective coatings of metal and fabric surfaces, these materials are used on vehicle preservation over Osnaburg (cotton drill) stretched on a framework to form a watershed, on engine grills, gun tubes, etc.



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Figure 5-1. Sprayable, strippable films equipment.

### **Safety Precautions**

Since MEK (methyl-ethyl-ketone) is the principal solvent used in the adhering, strippable compounds, a word of caution is in order as this solvent is classified as dangerous from health and fire standpoints. Methyl-ethyl-ketone is also known as "butanone" and is considered more toxic than acetone.

### **Health Precautions**

When spraying compounds containing MEK, the operation should be performed in well-ventilated areas to keep the vapor concentration to a minimum. The operator should wear an especially designed mask as specified in safety regulations. Smoking must not be permitted within 50 feet of the work being sprayed.

### **Fire Precautions**

The vapors of MEK form flammable mixtures with the air at temperatures as low as 24°F. MEK has the property of spontaneous ignition in the presence of oxidizers such as potassium and dichromate, sodium dichromate, chromic acid, and potassium permanganate.

### **MIL-PRF-6799**

This specification establishes the requirements for water emulsions, protective, strippable, sprayable, single or multicoat coatings for application over metallic, painted, and plastic surfaces. The coatings furnished under this specification are of the following type and classes:

- X Type II, Class 1, Black. This material is intended for use as a strippable protective coating for acrylic plastic bulk materials and assemblies containing acrylic plastics when the protected item is shipped fully covered or stored under cover; and (2) as a basecoat for Type II, Class 5 and 6 materials.
- X Type II, Class 5, White or olive drab. This material is intended to be used only as a topcoating for Type II, Class 1 materials. In combination this protective system serves as a sprayable, strippable, protective coating for application of metallic, painted and plastic surfaces, such as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and overseas deckloaded shipments. For Army, the color shall conform to FED-STD-595, Color N 024081.
- X Type II, Class 6, white. This material is intended to be used only as a topcoating for Type II, Class 1 material. In combination, this protective system serves as a sprayable, strippable, protective coating for applications on metallic, painted and plastic surfaces, such as entire aircraft, missiles, rockets, and transportation vehicles during outdoor storage and overseas deckloaded shipments. It is recommended for use with Binks Model No. 18 or VeVilbiss MBC spray gun or equal.

## **CONTROLLED HUMIDITY**

### **GENERAL**

Prevention of deterioration of clean metals and organic materials, especially in the complex assemblies of modern military equipment, is often most economically attained by the elimination of the excessive amounts of moisture from the storage atmosphere. The general principles set forth in this paragraph are basic to understanding dehumidification of storage air whether it is inside a Method 50 pack or an oversea warehouse storing prepositioned military supplies, or a large warehouse.

### **ATMOSPHERIC AIR**

Atmospheric air is a remarkably constant mixture of many true gases, principally nitrogen (78 percent) and oxygen (21 percent). In addition, watervapor is always mixed with atmospheric air. The actual amount of watervapor present in atmospheric air varies widely. For instance, there can be as much as 500 times as much watervapor actually in the air on a humid summer day in Louisiana as on a winter day in Alaska. Although temperature does not determine the amount of watervapor actually present in atmospheric air, temperature is the only factor that determines the ability to hold watervapor.

### **RELATIVE HUMIDITY**

In storage atmosphere, it is not the actual amount of watervapor present that determines the effect on corrosion. It is the actual amount which can be held at ambient temperature. This ratio is relative humidity. Figure 5-2 illustrates what happens to relative humidity in an inclosure with a fixed amount of actual watervapor as temperature changes. With every 20°F, increase in temperature, the ability of air to hold watervapor doubles and the relative humidity is cut by half. As temperature goes down, relative humidity rises approximately 50 percent for every 20°F until it reaches 100 percent. After this, any further drop in temperature results in condensation of liquid water.

### **RELATIVE HUMIDITY IN STORAGE ATMOSPHERE**

The preservation quality in dehumidified storage atmosphere is controlled in terms of relative humidity. A sustained 50 percent relative humidity is the maximum considered safe for the storage of ferrous materials. Relative humidity is maintained under 50 percent in controlled humidity storage to provide a margin for the control of increases in relative humidity which result from nightly temperature drops.

### **BASIS FOR RECOMMENDED RELATIVE HUMIDITY LEVEL**

It has been demonstrated in laboratories that relative humidities up to 100 percent alone are not destructive to pure ferrous metals. It has been concluded that the corrosive action is started when dirt, salt dusts, polluting gases, or impurities in the metal absorb moisture from the air to wet metal surfaces. Since it has been observed that this wetting action does not take place when the relative humidity is below 50 percent, maintenance of a sustained relative humidity at this level provides a "preservation" atmosphere.

### **DUST**

All dusts are basically objectionable because of their water-absorption characteristics, but acid dusts and salt dusts are the most destructive. Clay dusts, which are the most common, are alkaline, whereas dusts from sulfate-containing soils or from decayed organic matter are acidic. Salt dusts include sodium chloride from sea water mist, ammonium sulfate from the combustion of bituminous coal, and calcium chloride from roads which have been treated for deicing or dust laying.



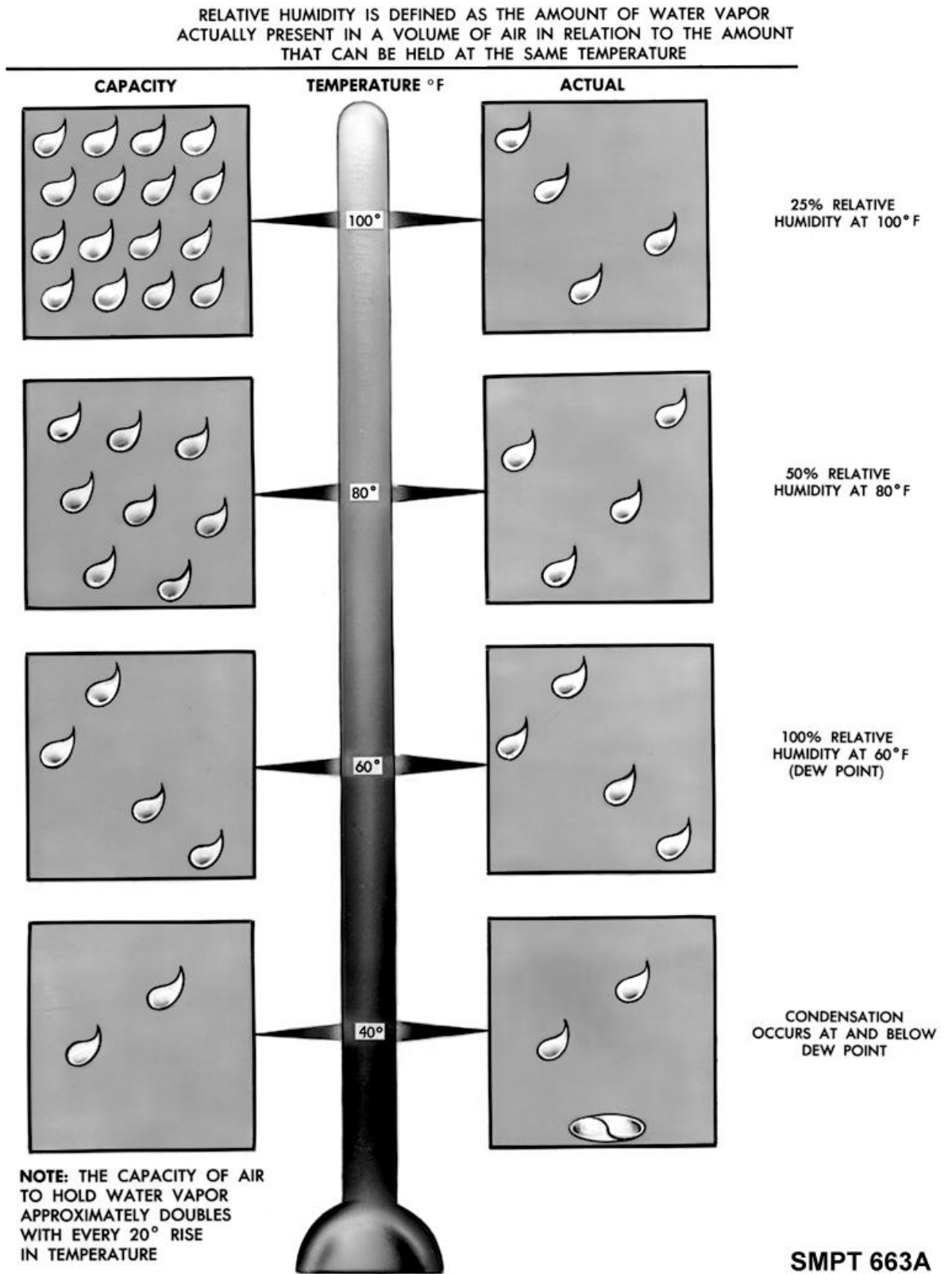


Figure 5-2. Temperature and relative humidity relationship.

## **HUMIDITY CONTROL**

Military publications classify methods of controlling relative humidity by removing watervapor from storage air as "static dehumidification" and "dynamic dehumidification". Relative humidity can also be controlled by heating the storage area. Descriptions and criteria for selection of these methods are as follows:

### **Static Dehumidification**

Method 50 provides a fixed static environment in a sealed watervaporproof pack in which a dehumidified atmosphere is maintained by bagged desiccant. Activated desiccant in quantities specified by MIL-STD-2073-1C can maintain an average 20 percent relative humidity even during normal temperature drops.

In time, packs must be opened to replace saturated desiccant, since there is a slow but continuous transmission of watervapor through the flexible barriers used in Method 50.

### **Dynamic Dehumidification**

This application deals primarily with dehumidification by forcible dynamic circulation for storage air through mechanical equipment which removes watervapor. The one type of mechanical dehumidifier most commonly used in military applications is discussed below. The devices for controlling dehumidifiers and recording dehumidification results are also described below.

Generalizations which determine the suitability of various structures for dehumidification and the storage of military equipment in controlled humidity storage are also discussed below.

### **Static vs. Dynamic Dehumidification**

Static dehumidification is utilized in Method 50 packs and other airtight watervaporproof metal containers. Dehumidification of such airtight containers over 5000 cubic feet, especially of nonmetal construction, is generally more economically accomplished by dynamic dehumidification.

### **Humidity Control by Heating Storage Area**

In the paragraph above, it was stated that relative humidity decreased by half with every 20°F rise in temperature. Heating the storage area may be the most economical manner of dehumidification where yearly average temperature is under 50°F and where comfort heating is also desired. To illustrate the practical limitations of this method, after outside temperature reaches 75°F and relative humidity reaches 75 percent, an inside temperature of over 90° would be required to keep relative humidity at a 50 percent level. It should be noted that in static and dynamic dehumidification, relative humidity is controlled by removing watervapor from the atmosphere; in heating, no watervapor is removed.

### **Dynamic Dehumidification Equipment**

There are two kinds of equipment through which storage air is power-circulated to remove moisture. The next paragraph explains the flow and function of refrigeration-type equipment and explains the flow and function of the solid absorption, i.e., desiccant bed equipment. Desiccant bed equipment is best suited to the average military dynamic dehumidification operation. Refrigeration-type equipment is suitable in warmer climates where air does not have to be cooled below 40°F to cause condensation.

**Function of Refrigeration Dehumidification Equipment**

Figure 5-3 illustrates the flow of air on through typical refrigeration dehumidification equipment used to remove watervapor from storage air. Storage air first passes over the cold evaporating coils (the refrigerant in the coils takes the heat it needs to vaporize out the air passing over the outside of the coils). In this process, storage air is cooled below dewpoint, causing watervapor to condense. As it drips off the evaporating coils, it is drained out of the storage area. The limitation of this method of dehumidification can be seen at this point. If the air has to be cooled below 40°F to reach its dewpoint, frosting of the coils tends to make this process uneconomical.

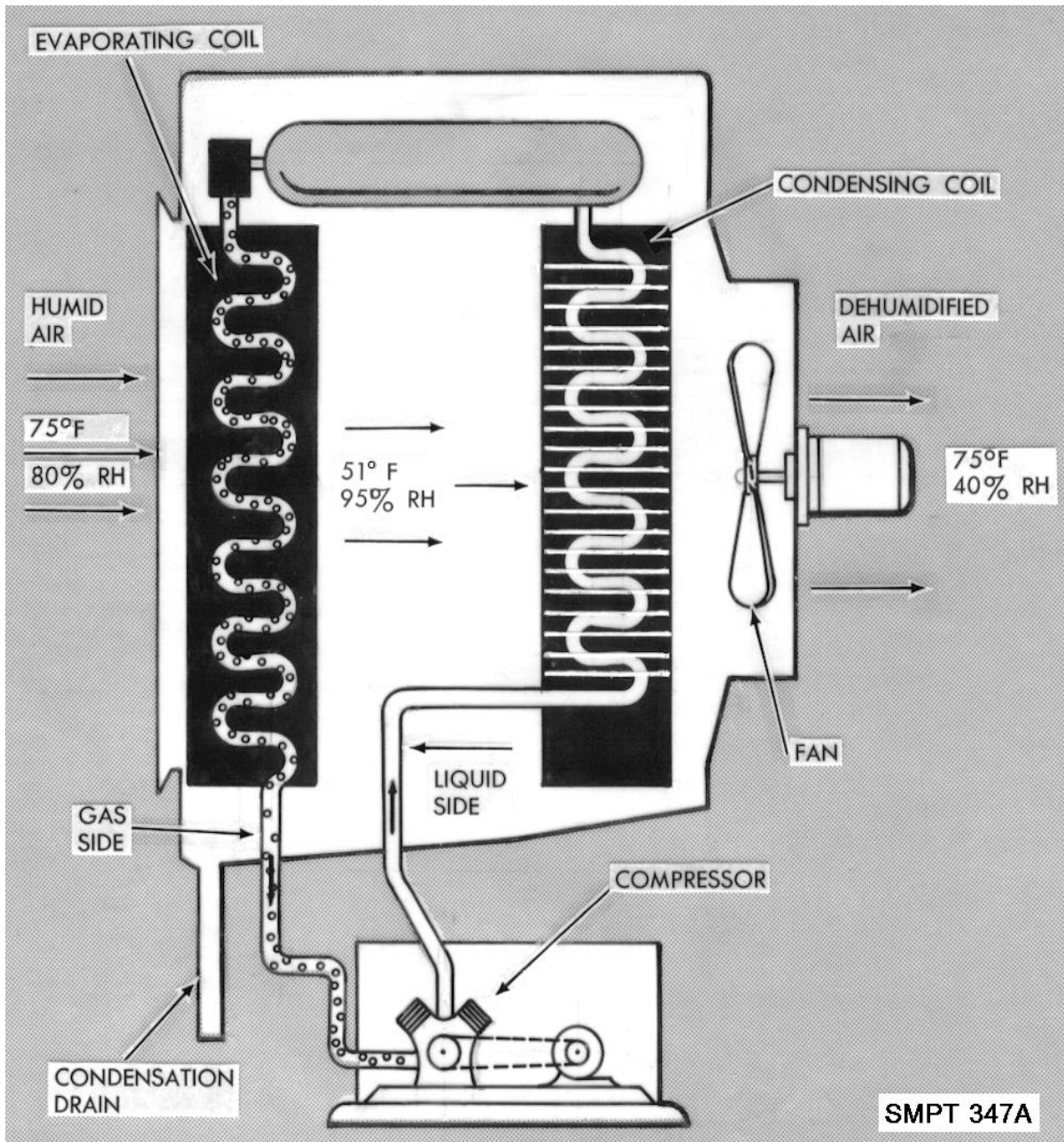


Figure 5-3. Flow diagram-mechanically refrigerated dehumidifier.

### **Necessity to Reheat Storage Air**

An apparent contradiction appears in figure 5-3 in that the storage air, after passing over the cold evaporating coils where watervapor was condensed, now has a higher relative humidity than when it entered the dehumidifier. This is because the ability of air to hold watervapor decreases approximately on half with every 20°F drop of temperature. At this point, the storage air in the equipment has less actual humidity but more relative humidity than when it entered. By passing this air over the condensing coils of the dehumidifier, which are warm like the coils on the back of a refrigerator, the air is warmed and relative humidity drops well below the original level. Since this form of dehumidification is best suited for warm climates, there is a tendency to place the condensing coils outside the storage area. This results in comfort cooling but may actually increase the relative humidity in the storage area.

### **FUNCTION OF SOLID ADSORPTION (DESICCANT) DEHUMIDIFIERS**

The basis for this method of dehumidification is the surface attraction of watervapor by granular materials known as desiccants which have tremendous microscopic surface area. Materials such as silica gel or alumina can absorb 40 percent of their weight in moisture without undergoing physical or chemical change. The key to the use of these materials is that the adsorbed moisture can be vaporized by heating saturated desiccant to about 300°F. This "reactivation" process is accomplished automatically in mechanical dehumidifiers.

### **Single and Dual Bed Machines**

Figure 5-4 pictures a typical solid adsorption machine. It has two beds or two chambers which hold desiccant, plus a relatively simple arrangement of air ducts, blowers, filters, air valves, heaters, and controls. Smaller capacity single bed machines are available. These cannot provide a constant supply of dehumidified air since the same desiccant bed must be cycled to dehumidify and to be reactivated. These two phases are carried on simultaneously in dual bed machines.

### **Dehumidification Cycle**

Refer to the adsorbing desiccant bed on the right-hand side of figure 5-5. Notice the position of the cycling valves. Storage air is simply brought through intake and filter, power circulated by blower through the activated desiccant bed and returned to storage area.

### ***Reactivation Cycle***

Refer to the reactivating desiccant bed on the lefthand side of figure 5-5. Notice the position of the cycling valves. Outside weather air is ducted to the machine, filtered, power circulated by blower over heaters which raise the temperature to approximately 300°F, through the desiccant, and returned to the outside. A thermometer in the duct returning the reactivation air to the outside provides a check for cycling time setting. When the temperature rises noticeably, the heat is no longer being used to volatize moisture adsorbed on the desiccant, and the automatic timer setting should cause the cycling valves to turn, thereby reversing desiccant bed cycles.

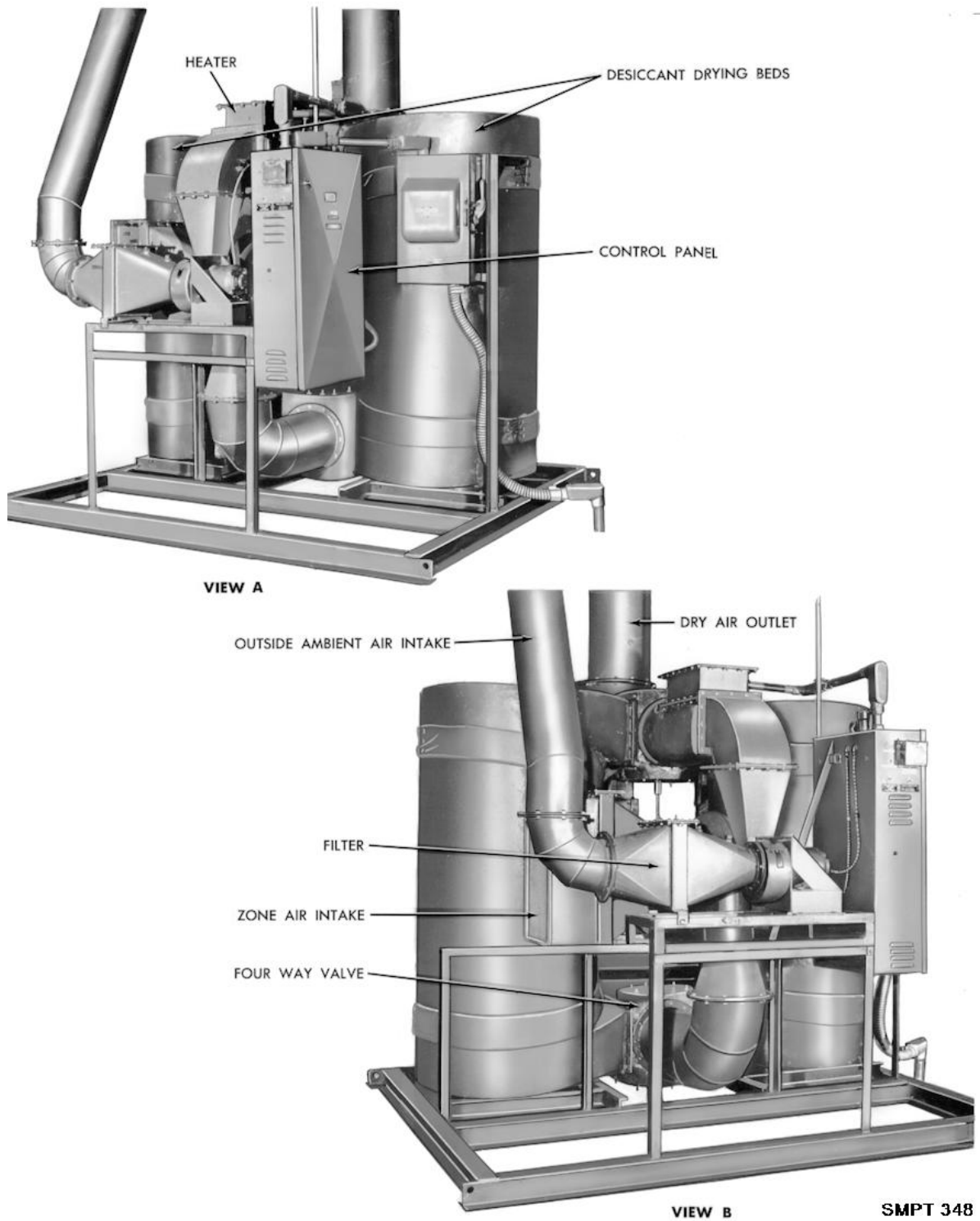


Figure 5-4. Typical dual bed desiccant dehumidifier.

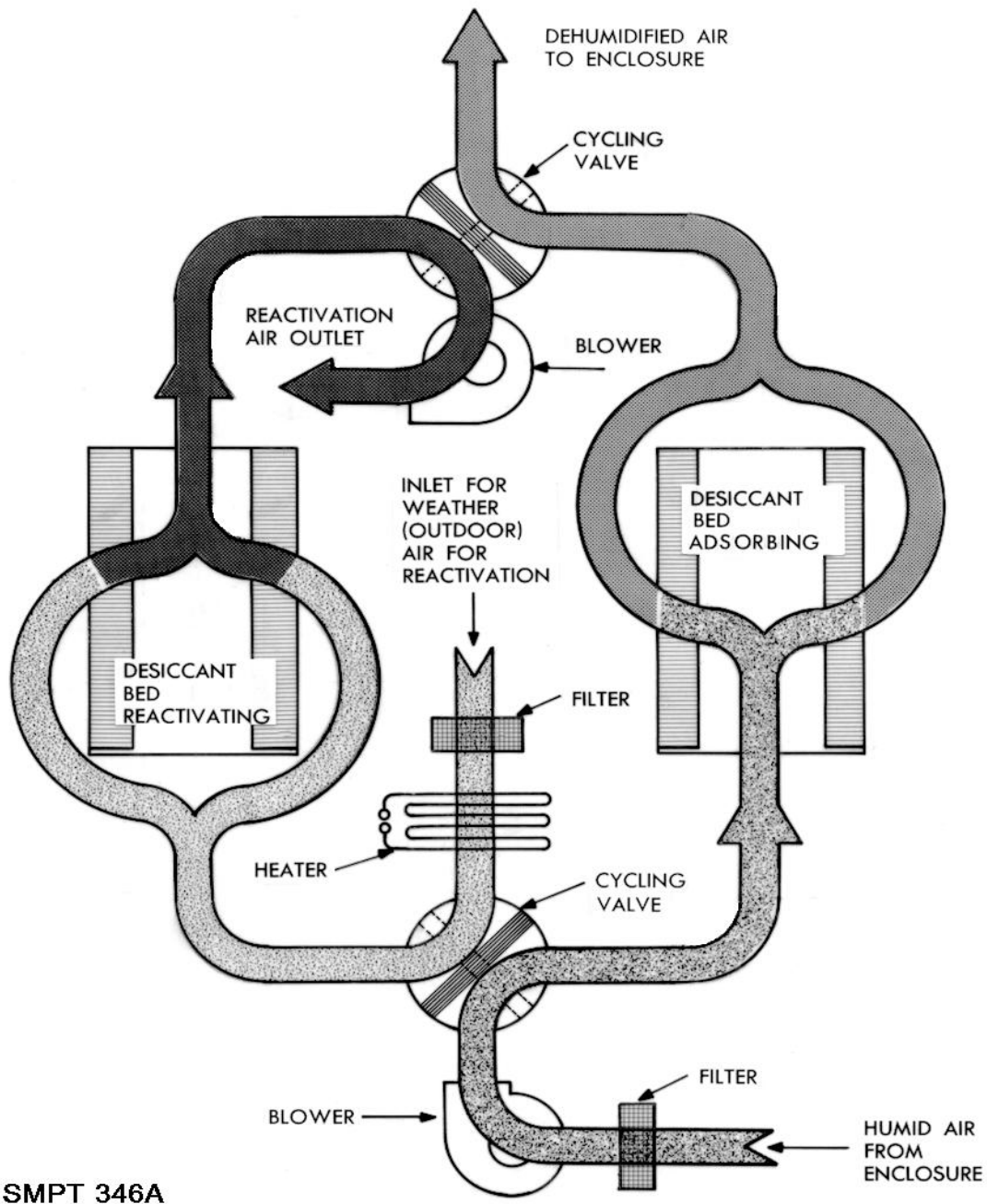


Figure 5-5. Flow diagram - dual bed desiccant dehumidifier.

### Installation of Machines

Solid desiccant machines can be installed either inside or outside the dehumidified space. In either case, it is necessary to run two separate air ducts through the walls of the inclosure. When installed inside, the duct lines bring in and discharge outside weather air used in reactivation. When installed outside, the ducts bring and return storage air from the inclosure. Location of machine, inside or outside, should be so that dry air is returned to the coldest part of the dehumidified space (where relative humidity is the highest). Floor space is generally saved by outside installation. In some instances, installation of machines from suspended platforms has saved floor space in warehouses.

## Equipment

Continuous duty, automatic desiccant dehumidifiers having capacities up to 15,000 cubic feet per minute may be procured under specification MIL-D-16886. These machines may be ordered for reactivation by electric, steam, or gas heat. Bulk desiccant to replace dirty or accidentally scorched material is obtainable under MIL-D-3716.

## CONTROL AND RECORDING EQUIPMENT

Economical human hair element humidistats are generally used in military applications to control the on-off operation of dehumidification equipment. A continuous relative humidity and temperature record is usually provided by a recorder (figure 5-6). Because of the unpredictability of the calibrations of these instruments, their accuracy is periodically checked with a psychrometer and a psychrometric table. These devices operate as follows:

- X Humidity and temperature recording device. A continuous 7-day temperature and relative humidity recording device known as a hygrothermograph provides a weekly record of the quality of the dehumidified atmosphere being furnished and is also useful in adjusting the timing of the desiccant bed cycles. In this machine, two pens mark a spring-driven chart that makes one revolution each week. A human hair element moves one of the pens to record relative humidity; a bimetallic temperature element moves the other pen to record temperature. When either humidistats or hygrothermographs are removed from dehumidified inclosures to be checked, they should be carried in a box containing desiccant because the humidity in the outside weather air should cause the human hair element to elongate and might put the devices out of calibration.
- X Instrument checking. Humidistats and hygrothermographs are usually exchanged for fresh ones and taken to a test bench at least every 2 months. A standard method of obtaining a true relative humidity reading to check these devices is to use a psychrometric chart. There are vertical and horizontal lines on this chart for dry bulb temperatures and the difference between dry bulb temperatures and the difference between dry bulb and wet bulb temperatures. Curved lines which cross the intersection of appropriate vertical and horizontal lines indicate relative humidity. Accurate dry bulb and wet bulb temperatures are provided by an instrument called a psychrometer. The type psychrometer used for this purpose has a centrifugal blower which fans two thermometers, with one having a wick wetted bulb. The sling psychrometer used by the military to determine the feasibility to troop training on hot humid days does not give accurate wet bulb readings in dehumidified air.
- X Human hair humidistat. The humidistat element consists of one or more bundles of human hair, from 3 to 8 inches long. These hairs are clamped at both ends into yokes. Attached to the yokes are multiplying linkages and levers which move a contact in a switch. As the relative humidity of the storage atmosphere increases, the hairs elongate, thereby closing a circuit to turn the machine on when the relative humidity reaches a preset level. The hairs shrink as the relative humidity decreases, thus reversing the process. The position of the pivot points can be changed to adjust the instrument if contact is not being made at the correct relative humidity.

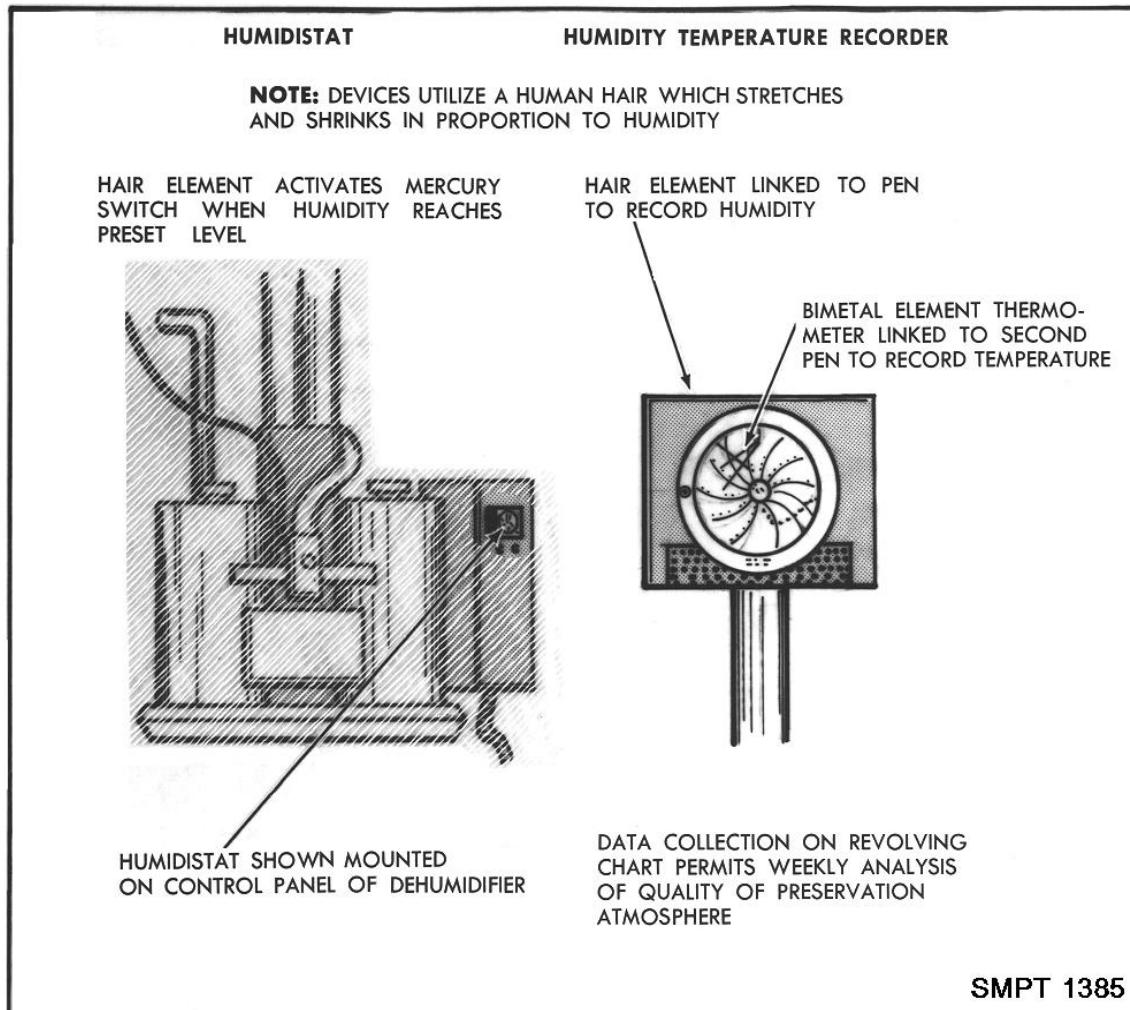


Figure 5-6. Relative humidity control and recording devices.

**CONTROLLED HUMIDITY STRUCTURES**

The general factors that determine the amount of watervapor that must be removed from an inclosure are

- X the daily entry of watervapor in the accompanying air from the outside and the process called "infiltration"
- X the daily entry of watervapor passing directly through construction materials and the process called "transmission"
- X the moisture contained in packing materials and skids are also a source of humidity that contributes to the need for dehumidification on a daily basis.

**Infiltration**

Controlled humidity storage structures should be caulked and closed tighter than normal structures to prevent infiltration of weather air and, if in active use, door openings must be rigidly controlled to prevent mass entry of weather air. However, structures must not be too tight or they might explode as inside air warms with heat from the sun through the roof. This necessary inward and outward flow of air through cracks and crevices with temperature changes is called breathing. To accommodate breathing, specifications for suitability of



outside structures for controlled humidity storage permit up to one complete turnover of air each 24 hours in a test where internal air pressure is raised to a point which is equal to a wind coming at the structure from the outside at 14 m.p.h. For comparison, maintenance of similar pressure conditions in an unprepared warehouse or ordinary factory building would produce 60 complete turnovers of air in 24 hours.

**Transmission**

The walls, roof, and floor of structures may be sealed with polyethylene, aluminum foil, paint, bituminous coating, or mastic topping to reduce watervapor transmission. Although air pressure remains the same on the outside as on the inside of a controlled humidity structure, there will be a great difference in watervapor pressures. Watervapor will leave outside air and pass directly through building materials to get to the area of lower watervapor pressure inside. In determining the suitability of structures for controlled humidity storage, daily load from watervapor transmission is estimated on the basis of the permeability of construction materials, their thicknesses, and sealing.

**Dehumidification Load From Storage**

In controlled humidity structures in active use, it has been estimated that 5 percent of the daily load of moisture which must be removed by dehumidifying machines results from drying out new storage. For instance, wood boxes and skids probably lose 7 percent of their weight in drying out. Once wood has been "brought down" in moisture content, it is a stabilizing factor in maintaining an even level of controlled humidity. See figure 5-7 which illustrates a theoretical, daily watervapor load in a dehumidified warehouse.

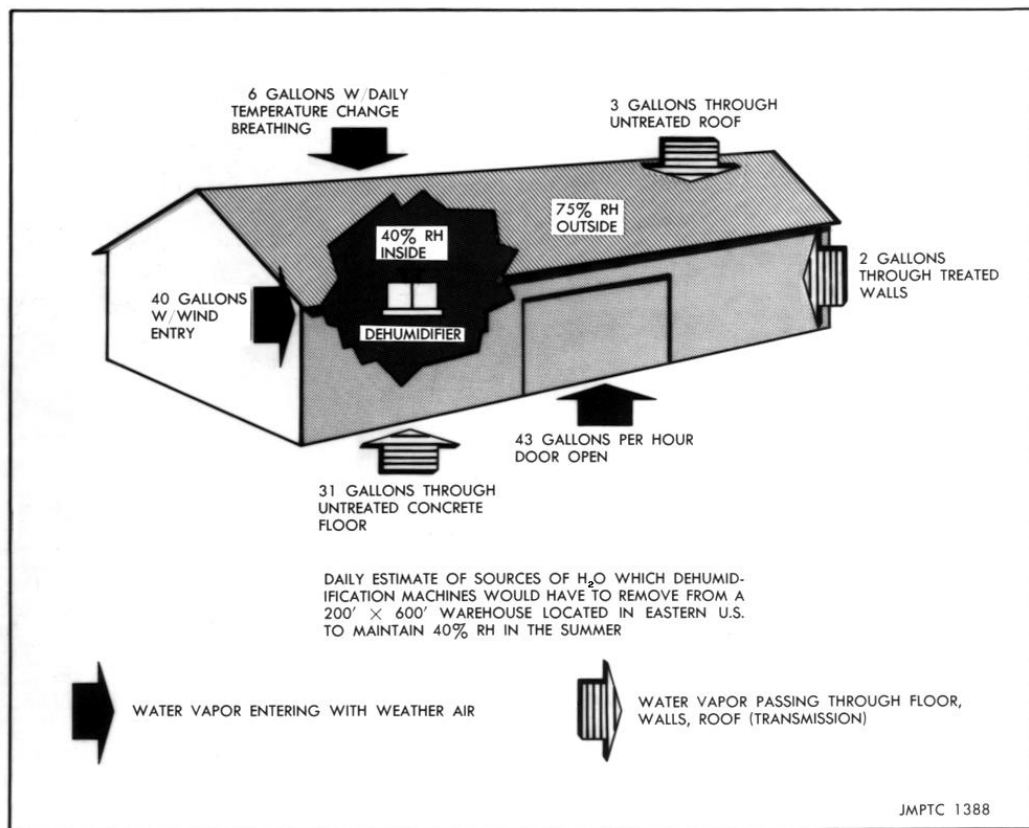


Figure 5-7. Example of daily watervapor load in a dehumidified warehouse.

#### **APPLICATION OF CONTROLLED HUMIDITY STORAGE**

The cost of providing preservation air through dynamic dehumidification has to be justified in the utilization of this type of storage. Some of the advantages in implications are as follows:

- X Commercially packed material. Military supplies which have been packaged commercially are protected by corrosion control methods which are consistent only with limited tenure of storage; however, the supplies so protected may be stored for longer periods of time in controlled humidity storage.
- X Level A and B - packed material. The more extensive corrosion control provided by levels A and B is extended in controlled humidity storage. For example, where desiccant in a Method 50 package might have to be replaced after extended conventional storage, it would probably still be near the beginning of its effective condition after extended controlled humidity storage. Periods between cyclic inspections may be lengthened for all levels of packing.
- X Packing containers. If wood shipping containers are included in controlled humidity storage, it should be borne in mind they may be weakened by splitting around nails as shrinkage occurs. Strapping applied to wood shipping containers before controlled humidity storage will loosen as shrinkage occurs, usually to the point where it must be replaced before shipment.
- X Machinery and equipment. Complicated machinery and heavy equipment, protected only by light oils and dust covers which permit the item to be readied for use without disassembly and removal of heavy preservatives, can be stored for indefinite periods of time in controlled humidity storage.
- X Prepositioned material. There is a growing requirement for the indefinite storage of military supplies in prepositioned oversea locations and floating depots. This material can be maintained in nearly ready-for-issue condition in controlled humidity inclosures.
- X Work in controlled humidity atmosphere. Working conditions, so far as the extent of dehumidification required for storage, may be considered desirable. Drier climates in the southwest are sought for their healthfulness. Reluctance of some operators to work in dehumidified areas may be due to experiences with dangerous concentrations of fumes from internal combustion forklifts which would have occurred in any warehouse where doors cannot be left open.

## CHAPTER 6

# Fiberboard and Paperboard Containers

## INTRODUCTION

Containers are required in several of the MIL-STD-2073-1C preservation methods. Two of these methods specify a container-bag-container combination. MIL-STD-2073-1C allows the procuring agency to specify supplementary cartons, boxes, or other suitable containers with any method of unit protection to facilitate storage, handling and packing.

MIL-STD-2073-1C does not require containers which conform to any particular specification for the purposes stated in the preceding paragraph. The most common containers are fiberboard shipping boxes, folding paperboard boxes, set-up paperboard boxes, and paperboard metal edged boxes.

## FIBERBOARD BOXES

### GENERAL

The classification of fiberboard boxes is described in ASTM D4727, Standard Practice for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes. Other standards and specifications, Government and non-Government references, regulating the use and shipment of fiberboard boxes are as follows:

### ASTM Standards

- X D685, Practice for Conditioning Paper and Paper Products for Testing.
- X D996, Terminology of Packaging and Distribution Environments.
- X D3950, Specification for Strapping, Nonmetallic.
- X D3951, Practice for Commercial Packaging.
- X D3953, Practice for Strapping, Flat Steel and Seals.

### Federal Specifications and Standards

- X MM-A-250, Adhesives, Water-Resistant (for Closure of Fiberboard Boxes).
- X PPP-B-638, Packing of Boxes, Caps, Liners, and Sleeves.
- X FED-STD-123, Marking for Shipment (Civil Agencies).

### Military Standard

- X MIL-STD-129, Marking for Shipment and Storage.

### Code of Federal Regulations

- X Title 49 - Transportation.

### Other Publications

- X National Motor Freight Classification.
- X Uniform Freight Code.
- X Federal Food, Drug and Cosmetic Act.

### ADVANTAGES

Fiberboard shipping boxes constructed in accordance with ASTM D 5118 using fiberboard conforming to the type, class, variety, and grade of ASTM D 4727, Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes, offer the following advantages:

- X Two types of fiberboard (corrugated or solid) provide for a more rigid or a more resilient container. Both singlewall (SW) and doublewall (DW) varieties are available in the corrugated type.
- X A wide range of fiberboard grades (bursting strength in lb/in<sup>2</sup>) allows economical application in a wide range of items of several weights and sizes.
- X Various box styles (designs) are available for the combination of type, variety, class, and grade of fiberboard selected. The regular slotted box (style RSC) is standard. It can be procured in as small a size as 4 X 4 inches for unit packing.
- X Prefabricated boxes are procured with only the *manufacturer's joint* stitched for flat shipment and storage. Assembly and closure are easy.
- X Hand-operated and automatic box making machines are available when local custom production from sheet stock is justified. Such equipment facilitates making economical nesting fits for container-barrier-container unit packs.
- X Interior pack marking can be neatly applied by practically all approved methods. Marking methods such as printing, lithographing, silk-screening, and photo marking should be considered at time of ordering boxes for large runs.
- X Unit or intermediate containers in bin storage are usually suitable for parcel post shipment without overpacking.

**CLASSIFICATION**

“Type, class, variety, and grade” of corrugated fiberboard (CF) and solid fiberboard (SF), figure 6-1, shows the two types and three varieties of fiberboard and figure 6-2 illustrates various flute (corrugation) arrangements.

Type-Corrugated Fiberboard (CF) is available in the following classes, varieties, and grades:

- X Class-Domestic
  - S Variety singlewall (SW) is available in the following grades (pounds per square inch bursting strength): 125, 150, 175, 200, 275, and 350.
  - S Variety doublewall (DW) is available in the following the grades: 200, 275, 350, 500, and 600.
  - S Variety triplewall is available in grade 1100.
- X Class-Weather-resistant.
  - S Variety singlewall (SW) is available in the following grades: V3c, W5c, and W6c.
  - S Variety doublewall (DW) is available in the following grades:
- X Class-Water and Watervapor Resistant (WWVR) is available in the following grades: V3c, WWVR, and W5c, WWVR.

Type-Solid Fiberboard (SF) is available in the following classes and grades:

- X Class-domestic is available in the following grades: 125, 175, 200, 275, 350, 500, and 600.
- X Class-weather-resistant is available in the following grades: V2s, V3s, V4s, W5s, and W6s.

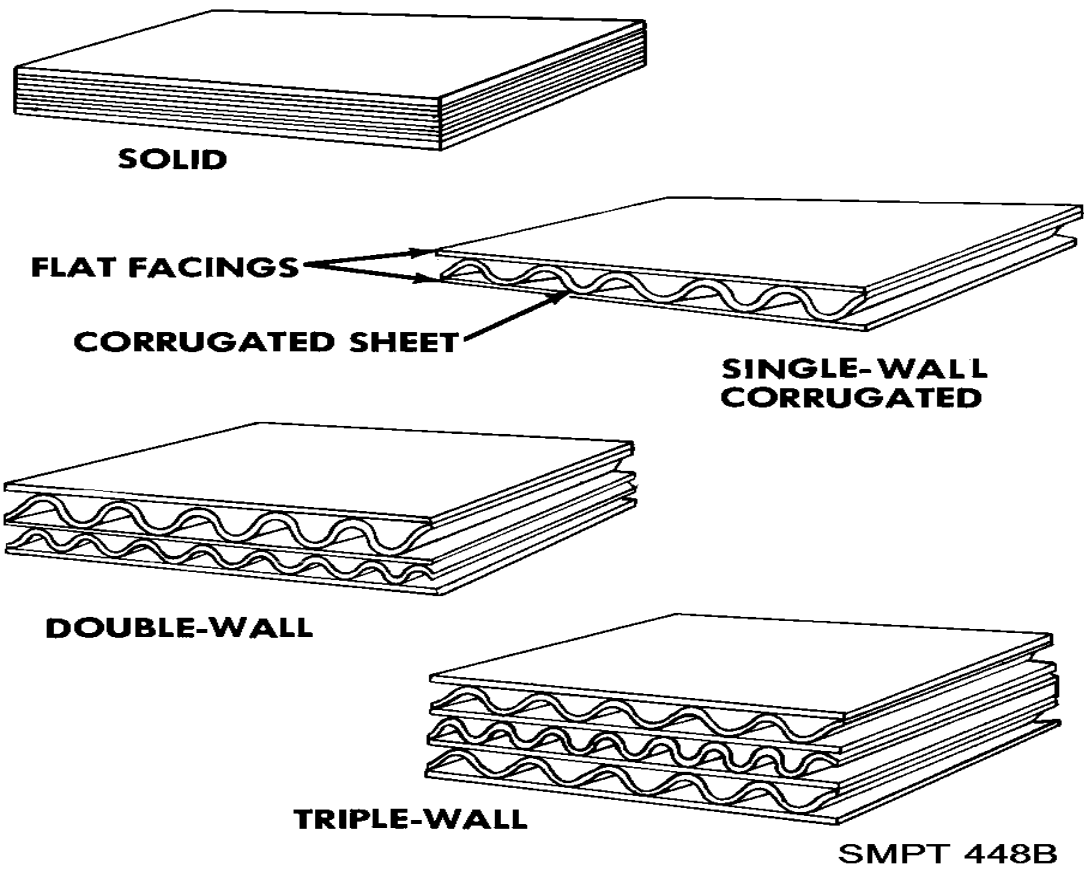


Figure 6-1. Types and varieties of fiberboard.

## FLUTE SIZES

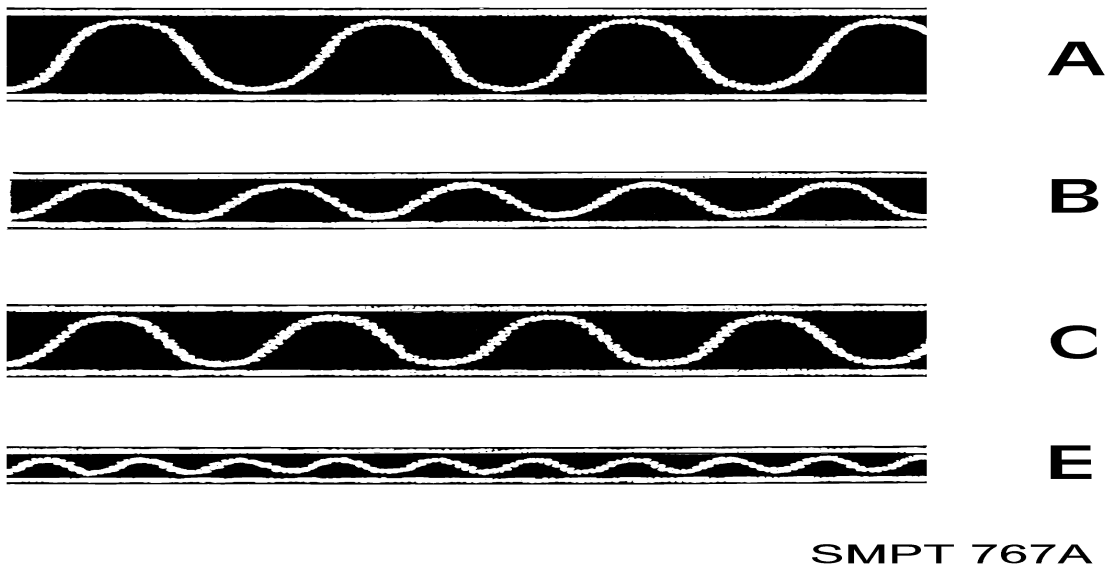


Figure 6-2. Corrugated fiberboard flutes.

**STYLES OF FIBERBOARD BOXES**

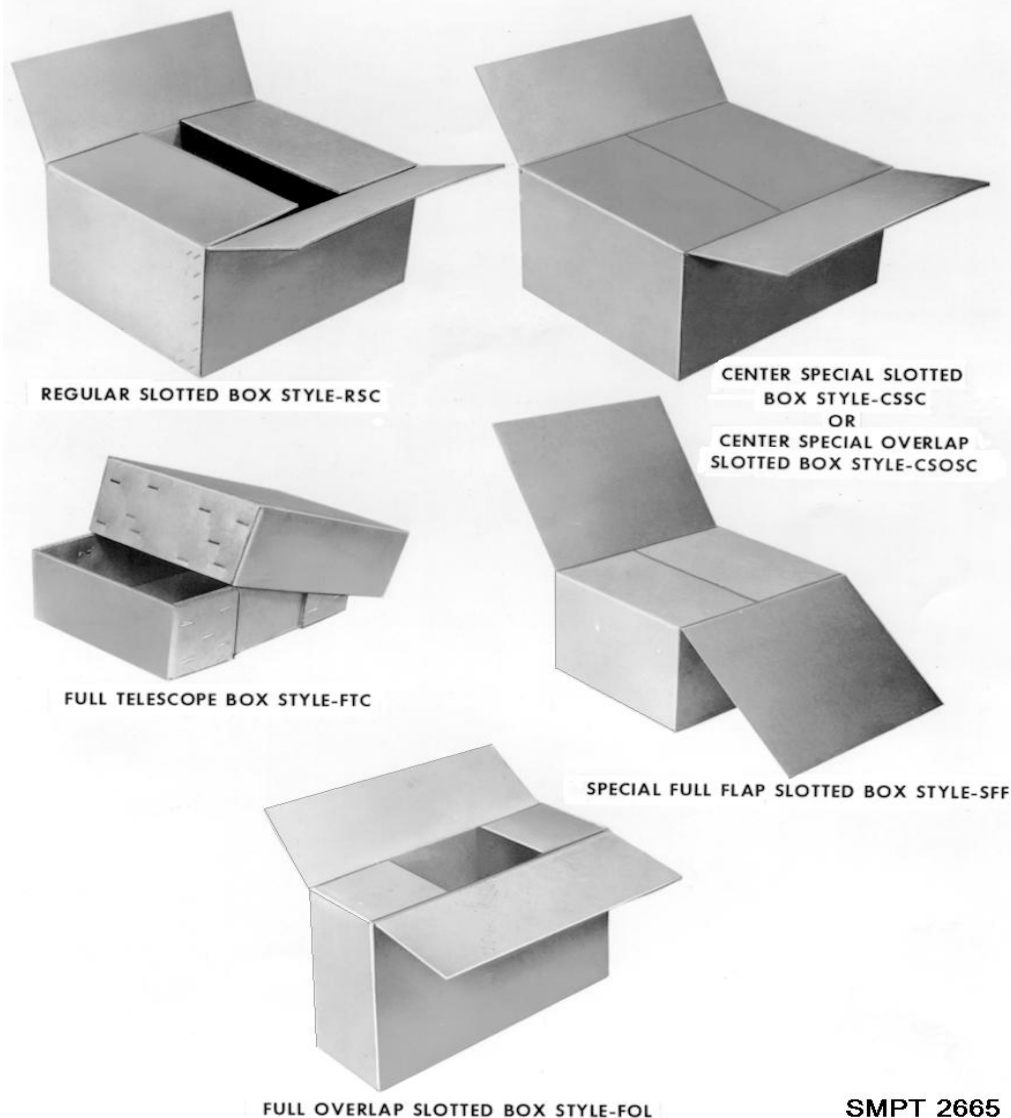
The styles shown in figures 6-3 and 6-4 are the basic styles of domestic and weather-resistant fiberboard shipping boxes. Additional styles may be found in ASTM D 5118.

**Regular Slotted Box (RSC)**

This box (the most commonly used style) is shown in figure 6-3. The box shall be scored and slotted to form a body piece having four flaps for closing each of two opposite faces. The flaps along the longer edge of the box openings are the outer flaps and those along the shorter edge are the inner flaps. Flaps shall not project beyond an edge of the box. All flaps shall be of equal length with the outer flaps meeting in the center of the width panel but not overlapping. The gap, not to exceed 1/4 inch, will be permitted unless otherwise specified.

**Center Special Slotted Box (CSSC)**

This box, shown in figure 6-3, shall be constructed the same as the RSC style, except that the length of the inner and outer flaps shall be such that they meet in the center of the box but do not overlap. A gap not to exceed 1/4 inch will be permitted.



SMPT 2665

Figure 6-3. Styles of fiberboard boxes (1).

**Full Telescope Box (FTC)**

This box is shown in figure 6-3. The box consists of a body and a cover, each constructed of one piece of fiberboard, scored and slotted. The box dimensions shall be the inside measurements of the assembled box body. The cover shall be a snug fit on the body. When specified, flaps shall be positioned inside the side panels of the body and outside the end panels of the cover. When set up, the flaps shall not overlap but shall be of sufficient length to allow them to be securely fastened to the adjoining walls. One method to fasten the flaps to the walls is with not less than five staples applied per flap as illustrated in figure 6-3. When specified in the order, the flaps shall be inside the side panels of the body and outside the end panels of the cover. Unless otherwise specified in the order, the body and cover shall be shipped unassembled.

**Overlap Slotted Box (OSC)**

This box shall be as shown in figure 6-4. This box shall be scored and slotted to form a body piece having four flaps for closing each of two opposite faces. When closed, the inner flaps shall not overlap and the outer flaps shall overlap the distance specified in the purchase order. Inner flaps shall be the same length as the outer flaps, except where the relation of width to length would cause the inner flaps to overlap, in which case, the inner flaps shall be cut so that, when in closed position, they shall meet.

**Special Full Flap Slotted Box (SFF)**

This box shall be as shown in figure 6-3. This box shall be constructed the same as style OSC, except that the length of the inner flaps in the closed position shall be such that they meet in the center of the box but do not overlap. A gap not to exceed 1/4 inch will be permitted.

**Full Overlap Slotted Box (FOL)**

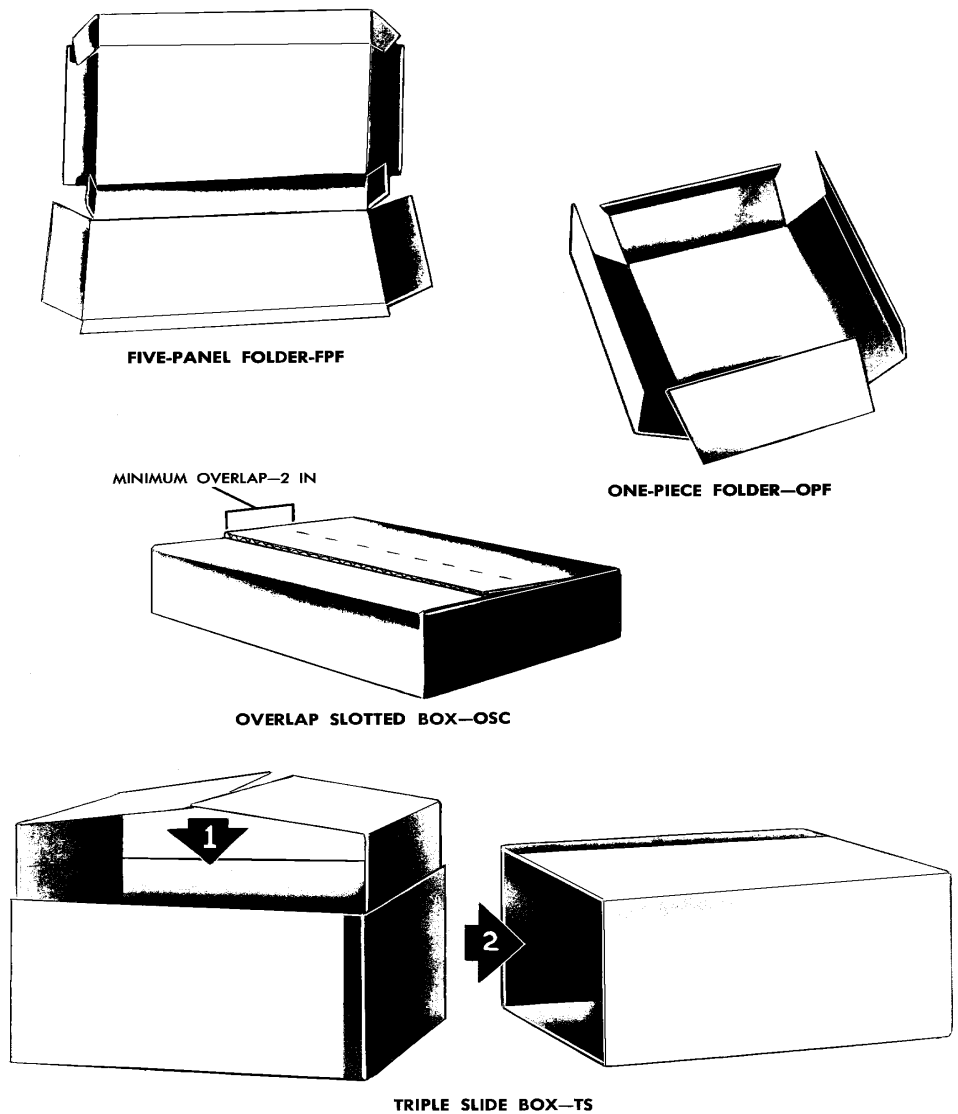
This box shall be as shown in figure 6-3. The box shall be constructed the same as style OSC, except that the length of the outer flaps shall be the full width of the box and shall not extend beyond the edge of the box by more than 1/8 inch.

**One Piece Folder (OPF)**

This folder shall meet the requirements shown in figure 6-4. The folder shall be constructed of one piece of fiberboard, scored and slotted as indicated in the referenced figure. When closed, outer flaps shall meet. A gap not to exceed 1/4 inch will be permitted. Unless otherwise specified, the inner flaps shall not be less than 2 inches long for folders under 18 inches in width and not less than 3 inches long for folders 18 inches and over in width.

**Triple Slide Box (TS)**

This box shall meet the requirements shown in figure 6-4. The box shall be constructed of three pieces of fiberboard scored to provide three tubes which, when assembled, completely cover six faces of the box. The inner tube shall be left open as illustrated. The middle tube shall be taped at the body joint and shall be a sliding fit on the assembled inner tube. The outer tube shall be taped at the body joint and shall be a sliding fit on the assembled inner and middle tubes. The box dimensions shall be the inside dimensions of the inner tube in the sequence of length, width, and depth and shall be as illustrated in the referenced figure. Corrugations shall be at right angles to the scoreline in each tube.



SMPT 450A

Figure 6-4. Styles of fiberboard boxes (2).

**Five Panel Folder(FPF)**

This folder shall meet the requirements shown in figure 6-4. The folder shall be scored and slotted as indicated in the referenced figure. When set up, outer flaps shall overlap (full overlap). The tuck flap (shown at the top and bottom of the box in figure 6-4) length shall be equal to the length of the side panel less 1/4 inch plus or minus 1/8 inch.

**REINFORCEMENTS**

**Sleeves**

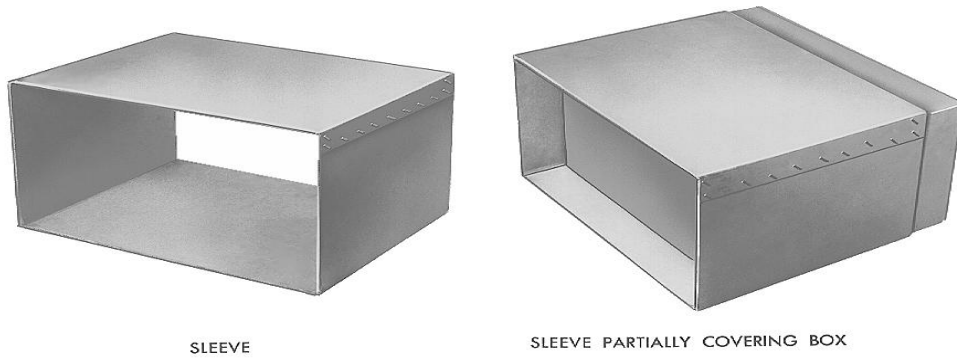
When specified in the order, sleeves shall be constructed from fiberboard as specified. If butt joint, it may be taped, or the overlap joint may be stapled, stitched or glued (see figure 6-5). Alternatively, the location of the body joint shall be in the center of the top or bottom panel, providing the joint does not interfere with the required marking. The sleeves shall fit closely over the top, bottom and end panels of the box for which it is intended. Space between the sleeve and box shall not



exceed 3/16 inch when opposite surfaces of sleeves and box are in direct contact with each other.

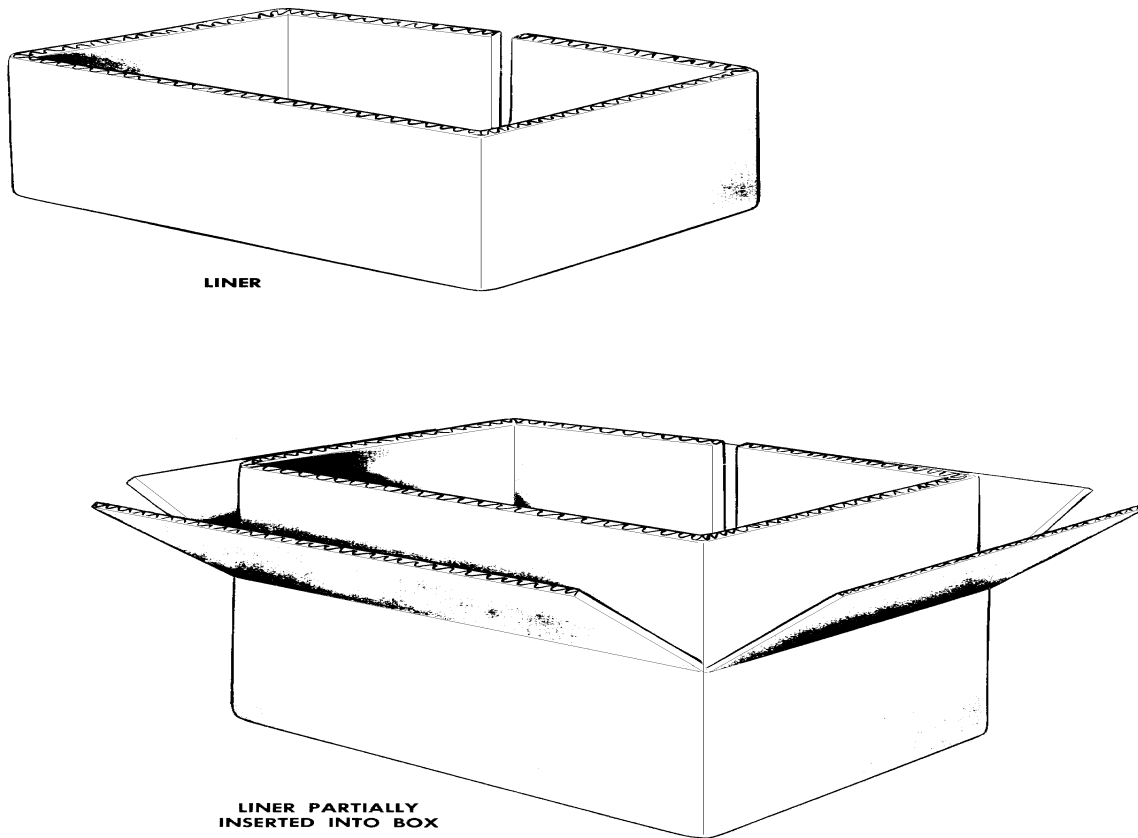
**Liners**

When specified in the order, liners shall be constructed from fiberboard as specified and as shown in figure 6-6. The liner shall be scored to cover the end and side panels of the box for which it is intended. The flutes of the liner shall be perpendicular to the top of the box. Unless otherwise specified in the order, the height of the liner shall be the full inside depth of the box for which intended, and the ends of the liner shall abut (gap not to exceed 1/8 inch) in the center of a side panel of the box.



SMPT 217

Figure 6-5. Use of a fiberboard sleeve.



SMPT 446

Figure 6-6. Use of a fiberboard liner.

## **FABRICATION OF BOXES**

### **Cutting, Scoring and Slotting**

Special machines are used to cut, score and slot the fiberboard material so that it can be made into a box.

### **Manufacturer's Joint**

Figure 6-7 illustrates several methods to fasten body joints of fiberboard boxes.

### **Class Weather-Resistant and WWVR Boxes**

The joint of type CF and SF boxes shall be a fiberboard overlap not less than 1.5 inches wide extending the full inside depth of the box. The joint shall be fastened either inside or outside the adjoining panel. The overlap joint shall be secured with metal fasteners (see figure 6-7) spaced not more than 2 inches apart, center to center, and the distance between the ends of the joint and the nearer end of the fastener shall not exceed 1 inch. When specified, the joint may be glued or butted (see ASTM D 5228 for instructions).

### **Class domestic boxes**

The joint of type CF, variety SW box shall be overlapped or butted. The joint of the type SF shall be overlapped. The joint of the type CF, variety DW box, shall be overlapped or butted. Large boxes may be fabricated with two joints positioned at diagonally opposite corners at the option of the supplier. The overlapped joint (joint tab) shall be made not less than 1.25 inches wide with the length of the overlap equal to the inside depth of the box. The joint tab shall be fastened either inside or outside the adjoining panel. Metal fasteners for the type CF and type SF boxes having a depth dimension of 18 inches or less shall be spaced not more than 3 inches apart, center to center. Metal fasteners for the SF box having a depth dimension greater than 18 inches shall be spaced not more than 2.5 inches apart, center to center. The distance between the ends of the joint and the nearer end of the nearest fastener shall not exceed 1 inch. For other means of fastening joints, see ASTM D 5118.

## **COMPLIANCE MARKING**

### **Types CF and SF, Class Weather-Resistant and WWVR Boxes.**

These boxes shall be imprinted with the following data (see figure 6-8):

- X Boxmaker's name or boxmaker's certificate.
- X Month and year of manufacturer (for example, "6-93").
- X Individual grade or identification symbols.
- X Specification compliance data, specification number, and minimum average bursting strength of \_\_\_psi.
- X For shipments to Government agencies the national stock number (NSN), inside dimensions, and outside cube shall be marked below the specification data on all exterior type boxes procured as an item of supply.

### **Type CF and SF, Class Domestic Boxes**

Each box shall be plainly marked with the appropriate boxmaker's certificate signifying compliance with the National Railroad Freight Classification rules and the National Motor Freight Classification rules, as applicable. The certificate may be located on the box wherever it is customarily placed; however, the preferred location is on the bottom panel or bottom outer flap.

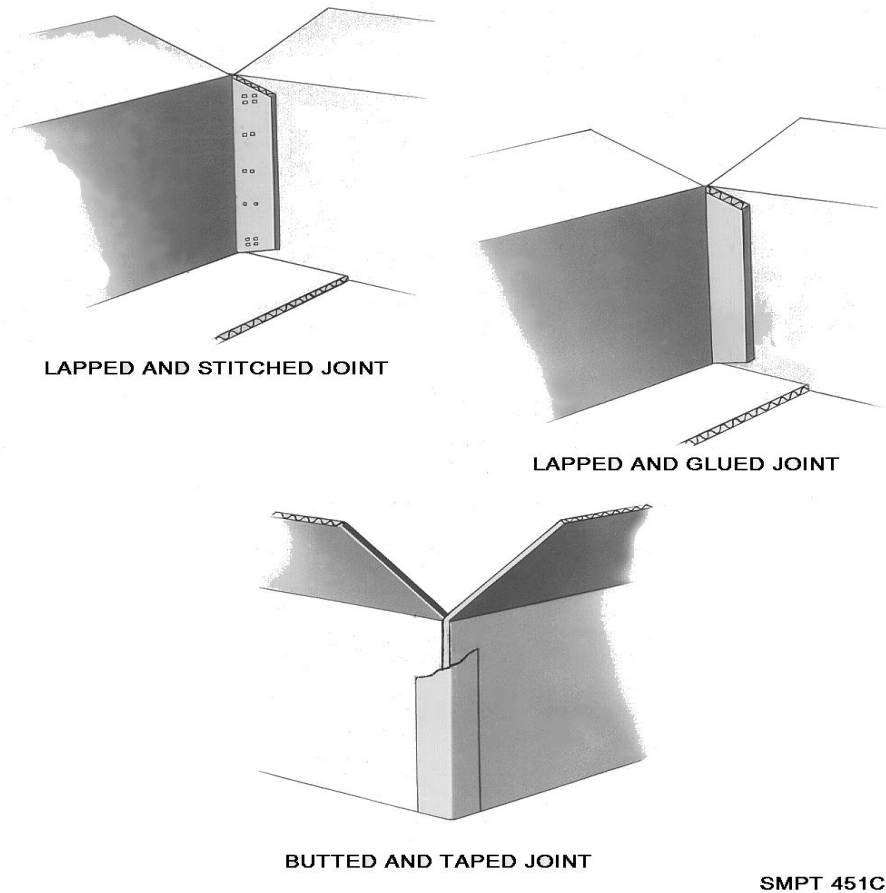


Figure 6-7. Body joints for fiberboard boxes.

**WORKMANSHIP**

The completed box shall be clean, free of frayed or torn edges, improperly aligned panels, improper scores and slots, and the marking shall be clear and legible. All dimensions of the boxmaker's blank shall be accurately cut, scored, and slotted so that the assembled box parts fit closely without binding. No flap shall project beyond an edge of a box by more than 1/8 inch when the box is set up and closed. All metal fasteners shall be well clinched, flush with or below the interior and exterior surfaces of the corrugated fiberboard joint, and shall be flush or slightly above the surfaces for solid fiberboard.

**CLOSURE**

ASTM D 1974, Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes, describes several methods for closing, sealing, and reinforcing fiberboard (solid or corrugated) boxes used for shipment. One of several methods listed in ASTM D 1974 may be referenced in regulations, specifications, or contracts.

Over one hundred closure methods for fiberboard boxes are described in ASTM D 1974. It is recommended that you obtain a copy of ASTM D 1974 for detailed information on the closure of fiberboard boxes.

Figure 6-9 illustrates fiberboard boxes closed with adhesives, tape, or stitches.

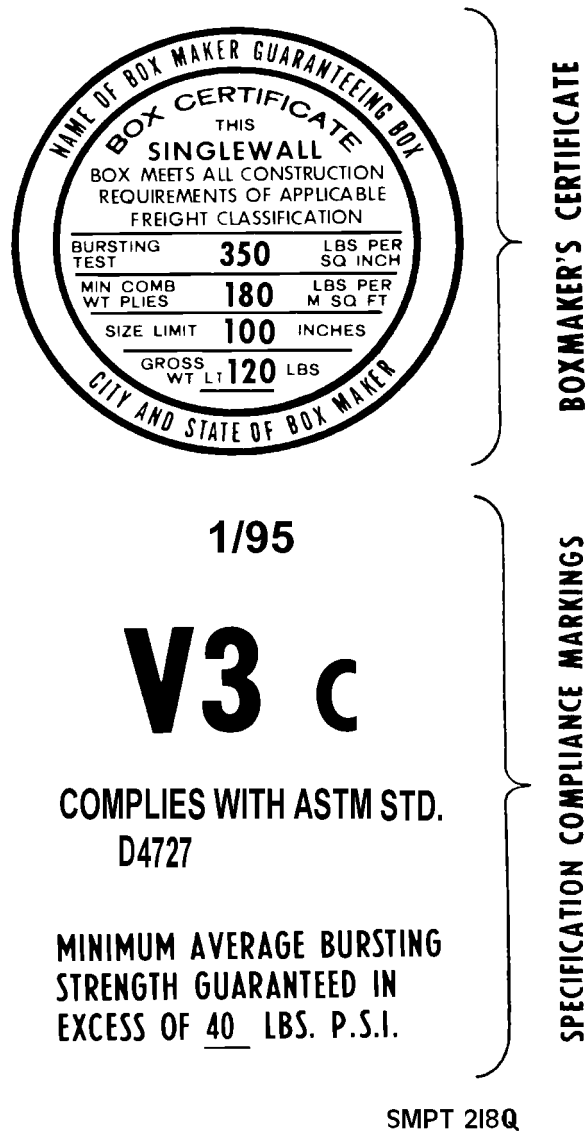


Figure 6-8. Sample (circular) box maker's certificate and compliance statement.

**Use of Adhesive**

Adhesive that meets the requirements of MMM-A-250, Adhesive, Water-resistant (for Closure of Fiberboard Boxes), is applied to both bottom and top flaps over the entire area of contact between the inner and outer flaps. Weights are usually necessary to keep the flaps down until the adhesive dries.

Semi-automatic and fully automatic box closure equipment is available for the application of adhesives. Hot melt adhesives are also applied by hand held "guns". Adhesives work best on clean, dry surfaces. It is important to have the box flaps held in place until the hot melt adhesive solidifies or the waterborne adhesive develops sufficient bond.

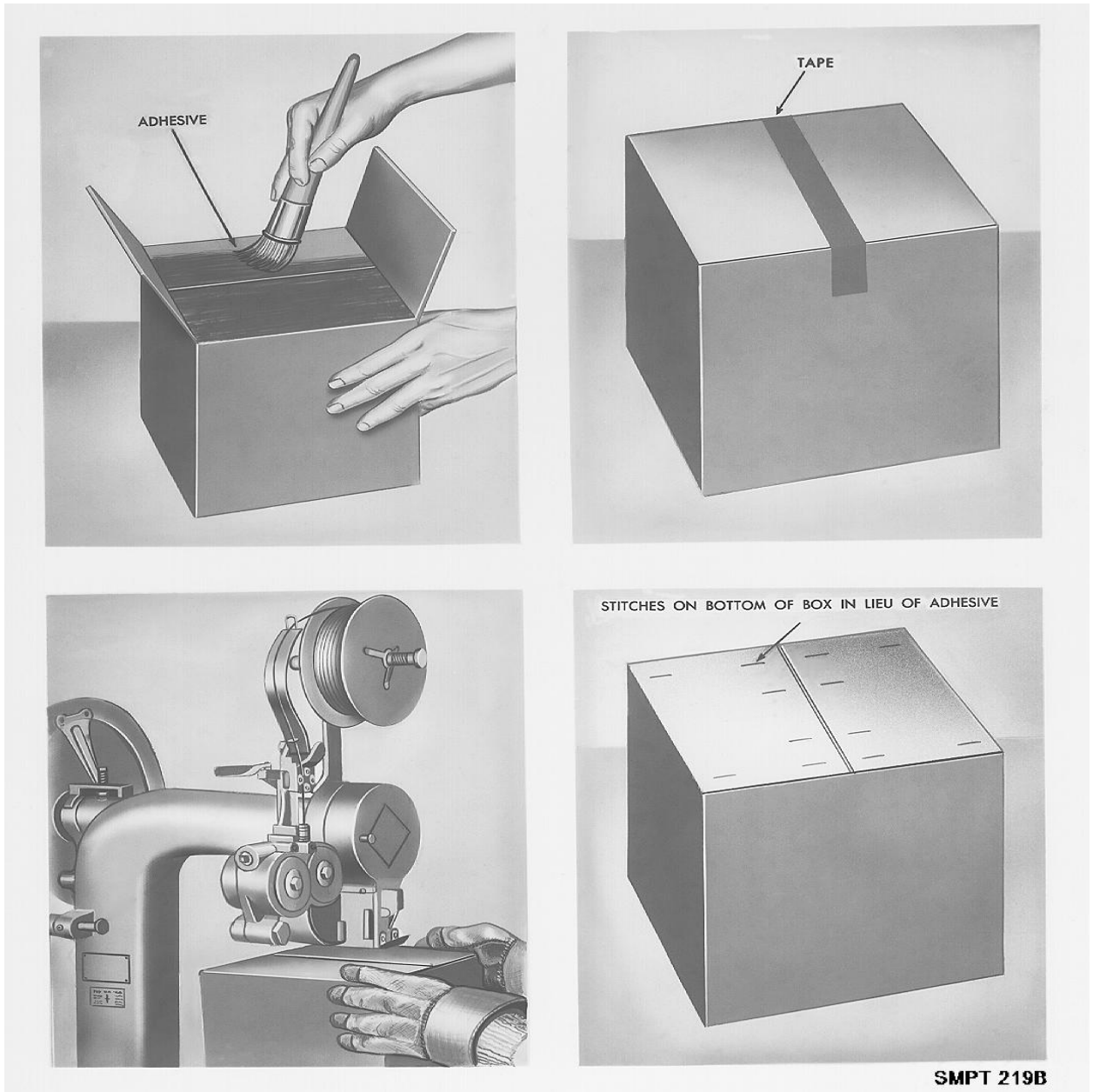


Figure 6-9. Closure of fiberboard boxes with adhesives, tapes or stitches.

### Combination of Stitches and Adhesive

The bottom set of flaps is stitched prior to packing. The number of stitches to be used is based upon the inside width of the box in inches. When stitching the bottom flaps, half of the stitches or staples will pass through each of the inner flaps and be distributed in such a manner as to fasten all flaps together over the entire area of contact between inner and outer flaps. This is to prevent the lifting of free edges and corners. After packing, the other set of flaps (top of the box) is sealed with MMM-A-250 adhesive in the same manner described in the preceding paragraph.

### Pressure-Sensitive Tape

Taping of RSC and similar styles, which are to be overpacked for shipment, may, when specified, have the box closed with 2-inch wide paper tape applied over the center seams of the box, continuing at least 2 inches onto the box ends. The tape

shall comply with CID A-A-1683; CID A-A-884 (tan); or CID A-A-1830 (transparent), Type III, Class 1 or 2; or 3-inch wide reinforced gummed tape applied over the center seams of the box, continuing at least 2.5 inches onto the box ends. The gummed tape shall comply with CID A-A-1671 (asphaltic) or CID A-A-1672 (nonasphaltic). Figure 6-9 shows a style RSC fiberboard box closed by this method. Figure 6-10 shows a nonslotted class weather-resistant fiberboard box closed with tape.

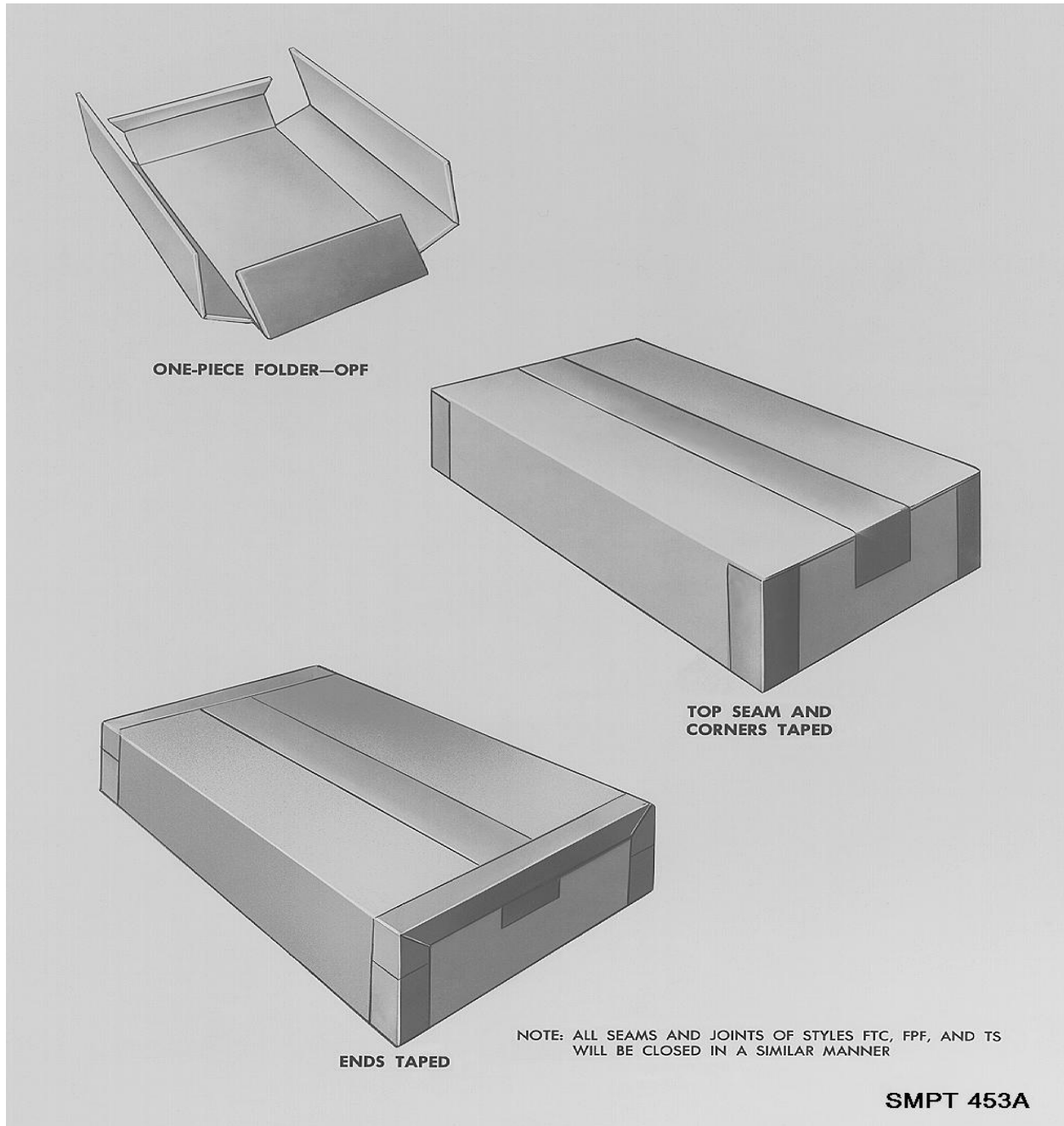


Figure 6-10. Closure of nonslotted class weather-resistant fiberboard box with tape.

**METHODS OF WATERPROOFING**

Although both V-board and W-board are highly water-resistant, boxes made from these materials will permit the entrance of water through the corners and joints. When packed items are of such a nature as to be damaged by water, waterproofing is provided by the use of individual wraps of material conforming to PPP-B-1055 or MIL-B-13239 (figure 6-11); by the use of caseliners conforming to MIL-L-10547; or by the use of waterproof, pressure-sensitive tape conforming to ASTM D 5486 (formerly PPP-T-60 or PPP-T-76), applied as shown in figure 6-12.

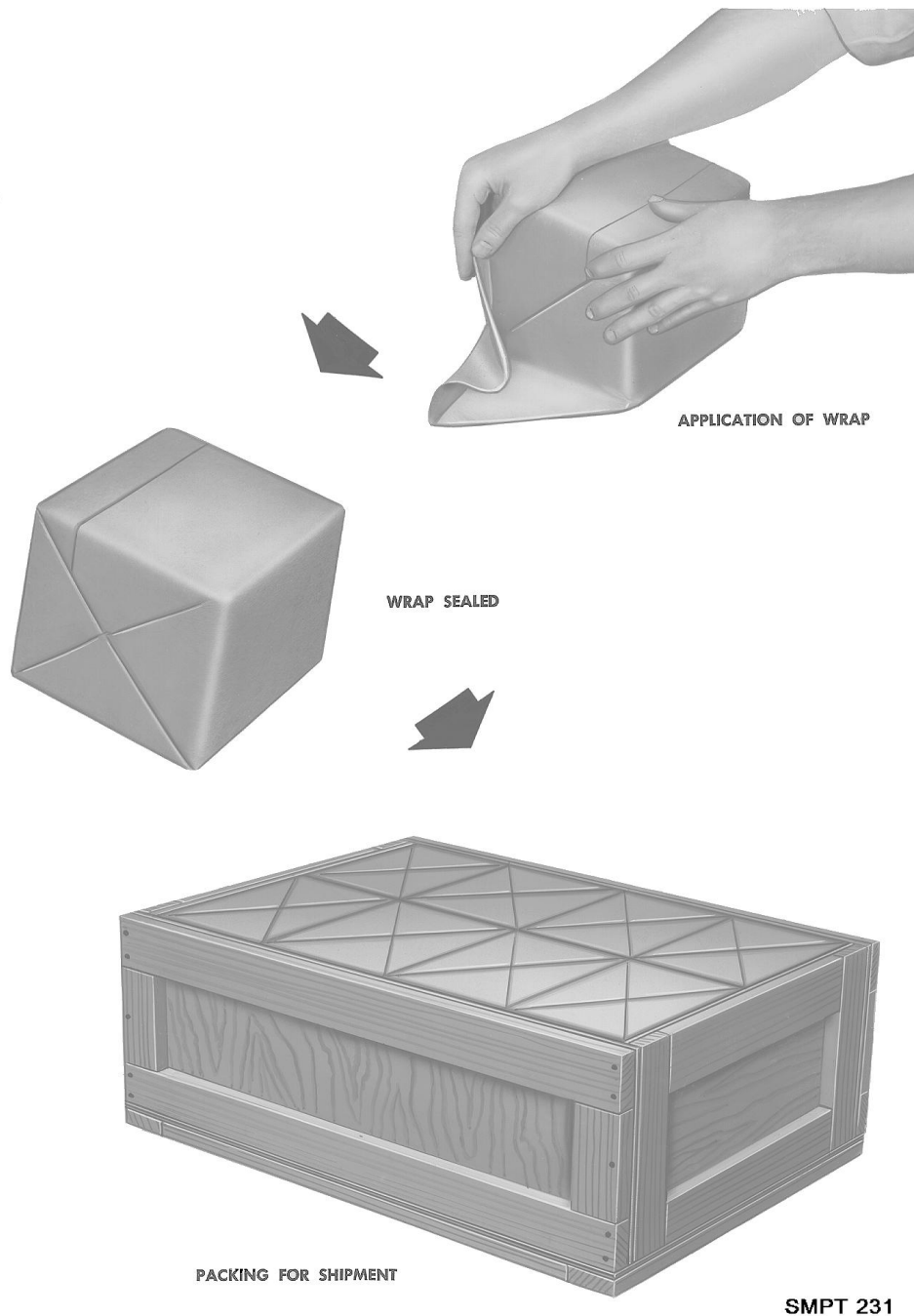


Figure 6-11. Waterproofing of individual packages.



Figure 6-12. Waterproofing fiberboard boxes with tape.

#### **SIZE AND WEIGHT LIMITS**

Size and weight limitations for fiberboard boxes are tabulated in ASTM D 5118.

#### **Weight Limitations for Types CF and SF Class Domestic Fiberboard Boxes**

The weight limit range (maximum weight of box and contents) for types CF and SF class domestic fiberboard boxes is 125 to 600 pounds, depending on the grade and size of the box. For example, grade 275 having inside dimensions (length + width + depth) of 90 inches would have a weight limit of 90 pounds.

#### **Weight Limitations for Class WR and WWVR Fiberboard Boxes Used as Exterior Containers**

The weight limit range (maximum weight of box and contents) for these boxes is 30 to 160 pounds, depending on the grade and size of the box. For example, grade W5s having inside dimensions (length + width + depth) of 75 inches would have a weight limit of 65 pounds.

### **PAPERBOARD CONTAINERS**

#### **DESCRIPTION**

Paperboard containers, in the form of folding or set-up boxes, are fabricated with automatic machines and delivered to the user in a flat, collapsed, or set-up form, ready for mechanical or hand assembling and use. Procurement of the boxes must be made from qualified manufacturers.



## **INTENDED USE**

The articles normally packed in folding or set up boxes are classed as supporting loads (type 1 load), semi-supporting loads (type 2 load), and nonsupporting loads (type 3 load). The maximum weight of the load should not exceed 10 pounds.

## **Supporting Load**

A supporting load is a rigid and rectangular product which completely fills and fully contacts and supports all the interior surfaces of the container. The following are examples of supporting loads:

- X A rectangular bar of soap.
- X Books and other printed matter.
- X One or more rectangular inner packs.

## **Semi-Supporting Load**

This load is a rigid or semirigid product which contacts and supports at least some portions of all the interior surfaces of the container. Examples of supporting loads are as follows:

- X One or more cylindrical cans, jars, or bottles.
- X Automotive or airplane parts.
- X Small arms ammunition.

## **Nonsupporting Load**

A nonsupporting load is a flexible, powdered, flaked, crystalline, or odd-shaped product which either results in a concentrated load or does not contact and support all interior surfaces of the container. The following are examples of products meeting the definition of nonsupporting loads:

- X Flour, sugar, soap powders, etc.
- X Odd-shaped parts.
- X Semisolids such as butter and lard.
- X Soft line clothing items, such as socks, underwear, etc.

## **FOLDING PAPERBOARD BOXES (PPP-B-566)**

### **GENERAL REQUIREMENTS**

Folding boxes will conform to the requirements of PPP-B-566. These boxes are made of good quality bending paperboard of a thickness between 0.012 to 0.045 inch. The paperboard, when scored, will withstand folding to 180 degrees without visible cracks or fractures on the outer surface. When greater than normal strength is required, the paperboard must possess specified bursting strength values.

### **CLASSIFICATION**

There are four varieties and many styles, types, and classes, as well as some subclasses of folding boxes suitable for unit packing or segregation of small items of supply. (See figures 6-13, 6-14, and 6-15).

### **Varieties and Processes**

Variety 1 and variety 2 consist of nonresistant paperboard and water resistant paperboard, respectively. Variety 3 is grease resistant, and variety 4 is water and grease resistant. The water resistant variety is available in the following processes:

- X Process I - Coated on one side, with the resistant surface on the inside.
- X Process II - Coated on both sides.

**Styles, Types, Classes and Subclasses**

Table 6-1 shows the breakdown of styles, types, classes and subclasses of PPP-B-566 boxes.

Table 6-1. Styles, types, and classes of PPP-B-566 boxes

Style I - Seal end (figure 6-13)	Type A - Outer flaps full overlap.	Class a - Inner flaps at random, but not overlapping. Class b - Inner flaps meeting minus 1/4 inch tolerance.
	Type B - Outer flaps meeting minus 1/16 inch tolerance.	Class a - Inner flaps at random, but not overlapping. Class b - Inner flaps meeting.
	Type C - Self-sealing.	Class c - single sealed ends. Class d - Double sealed ends.
Style II - Tuck end (figure 6-13)	Type D - Reserve tuck.	Class a - Inner flaps at random. Class e - Inner flaps specified
	Type E - Straight tuck.	Class a - Inner flaps at random. Class e - Inner flaps specified.
Style III -Brightwood blank (figure 6-13)	Type F - One piece with cover attached.	Class f - No dust flaps. Class g - Dust flaps on side panel. Class h - Dust flaps on cover.
	Type G - Two-piece.	Class l - Full telescope. Class j - Partial telescope. Subclass 1 - No turnover on sides or ends. Subclass 2 - With or without turnover on sides or ends. Depth of lid specified.
	Type H - One-piece tray.	Not applicable.
Style IV - Overlapping end wall (with or without double side walls) (figure 6-13)	Type I - Two-piece hardware lock.	Class l - Full telescope. Class j - Partial telescope. Class k - One-piece tray.
	Type J - Two-piece friction end.	Class l - Full telescope. Class j - Partial telescope. Class k - One-piece tray.
Style V - Cracker style lock end (figure 6-14)	Not applicable.	Not applicable.
Style VI - Tube and slide (figure 6-14)	Not applicable.	Not applicable.
Style VII - One-piece folders (figure 6-14)	Not applicable.	Not applicable.
Style VIII - Diagonal folds (figure 6-14)	Type F - One-piece cover attached	Class f - No dust flaps. Class g - Dust flaps on side panel. Class h - Dust flaps on cover.
	Type G - Two-piece.	Class l -Full telescope. Class j - Partial telescope.
	Type H - One-piece tray.	Not applicable.
Style IX - Double lock-end top and bottom (figure 6-15)	Not applicable.	Not applicable.
Style X - Snap lock bottom with tuck top (figure 6-15)	Not applicable.	Not applicable.
Style XI - Automatic fold, bottom and side glued (figure 6-15)	Not applicable.	Not applicable.
Style XII - Center support for rolls of tape (figure 6-15)	Type K - One-piece sleeve.	Class l - For widths of rolls up to and including 1 inch. Class m - For width of rolls up to and including 3 inches. Class n - For widths of rolls up to and including 4 inches.
Style XIII - Hinged, full depth cover with window	Not applicable.	Not applicable.
Style XIV - Double lock-end top and bottom	Not applicable.	Not applicable.

**CLOSURE**

Unless otherwise specified, the type of closure will be indicated by the style of the box. Locks provided for box closures will be carefully and securely assembled. When specified, telescopic styles will be closed by means of tape meeting the requirements of A-A-1492, A-A-1671, or ASTM D 5486. The tape is used to seal and strengthen the box. The amount of tape used and its application is dependent upon the nature of the contents. Under some conditions, it will be sufficient to apply a small piece of tape to overlap the closure by 1 inch. In other instances, where the contents are heavy, it may be necessary to run the tape entirely around the container.

**USE**

Only those articles which are not easily susceptible to damage which might be caused by ordinary distortion of the box, resulting from external forces during shipment, should be packed in folding paperboard boxes. These boxes are generally used for unit and intermediate packing. Normally, the weight of contents for these boxes is limited to 10 pounds. However, when in the judgement of the supervisor or other authority they are adequate for heavier loads, they may be so used. The resistant variety boxes are intended for use in packing items coated with oil or grease, for retaining the moisture content of the item packed, or for both, as applicable. Resistant variety boxes are not intended to be weatherproof.

**SETUP BOXES (PPP-B-676)**

**DESCRIPTION AND CLASSIFICATION**

Setup boxes are manufactured from nonbending paperboard. PPP-B-676 covers the requirements for new paperboard setup boxes and for closures of filled boxes. Setup boxes shall be of the types, varieties, classes, and styles as specified in table 6-2, as shown in 6-16 and 6-17.

<p><b>Table 6-2. Classification of setup boxes (PPP-B-676)</b></p> <p><b>Types (see figure 6-16)</b></p> <ul style="list-style-type: none"> <li>I - Full telescope.</li> <li>II - Partial telescope or shallow lid.</li> <li>III - Neck or shoulder.</li> <li>IV - Slide boxes.</li> </ul> <p><b>Varieties</b></p> <ul style="list-style-type: none"> <li>1 - Plain.</li> <li>2 - Water resistant.</li> <li>3 - Grease resistant.</li> <li>4 - Water and grease resistant.</li> <li>5 - Plain fire retardant.</li> <li>6 - Water resistant and fire retardant.</li> <li>7 - Grease resistant and fire retardant.</li> <li>8 - Water and grease resistant-fire retardant.</li> </ul> <p><b>Classes</b></p> <ul style="list-style-type: none"> <li>A - Blank, corner stayed.</li> <li>B - Blank, corners stitched or glued.</li> <li>C - Blank, corners cut without stays.</li> <li>D - Blank, end set.</li> <li>E - Blank, bottom set.</li> </ul> <p><b>Styles (see figure 6-17)</b></p> <ul style="list-style-type: none"> <li>1 - Banded or strip stayed.</li> <li>2 - Trimmed.</li> <li>3 - Strip covered.</li> <li>4 - Tight wrapped.</li> </ul>
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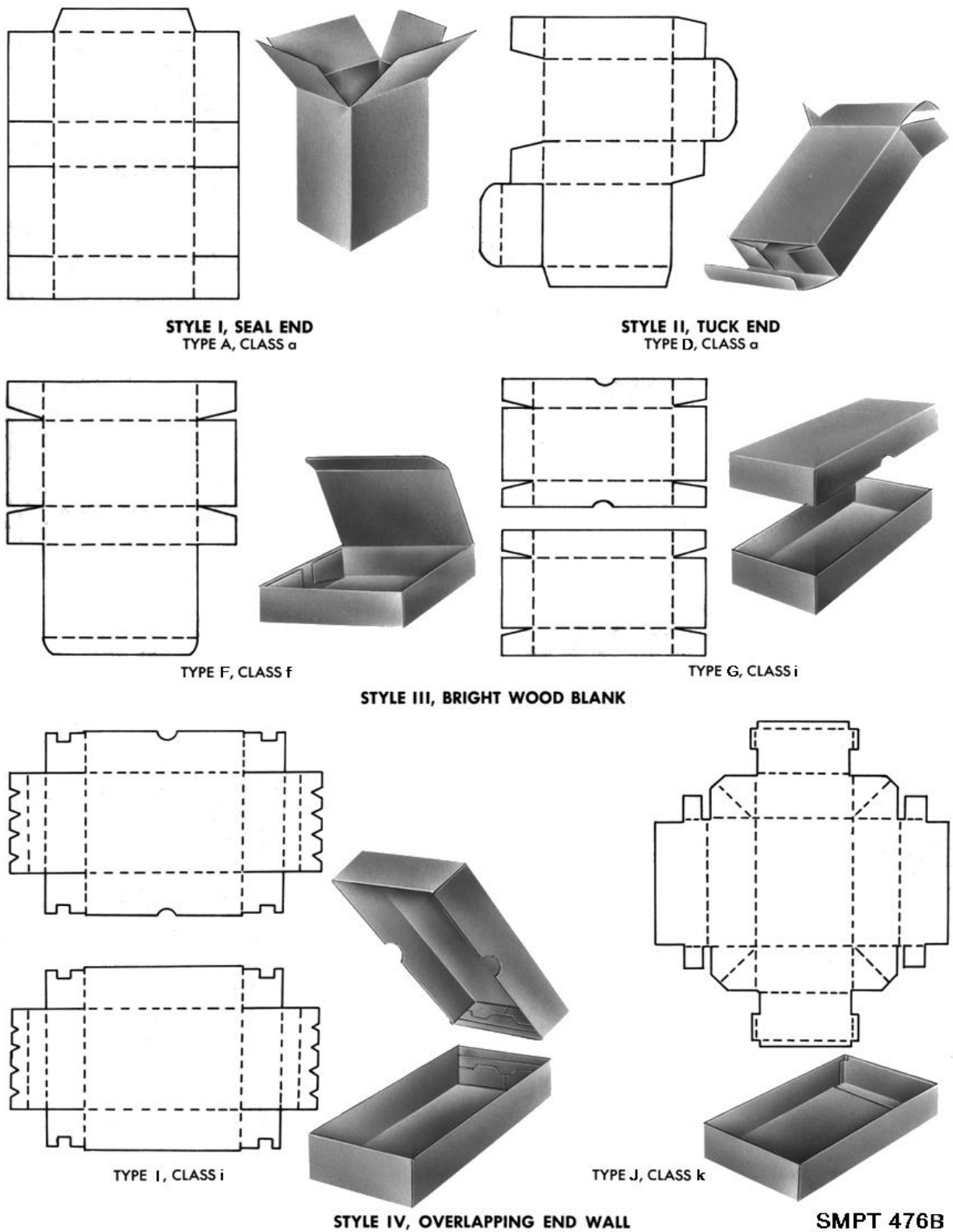


Figure 6-13. Styles I, II, III, and IV of folding paperboard boxes.

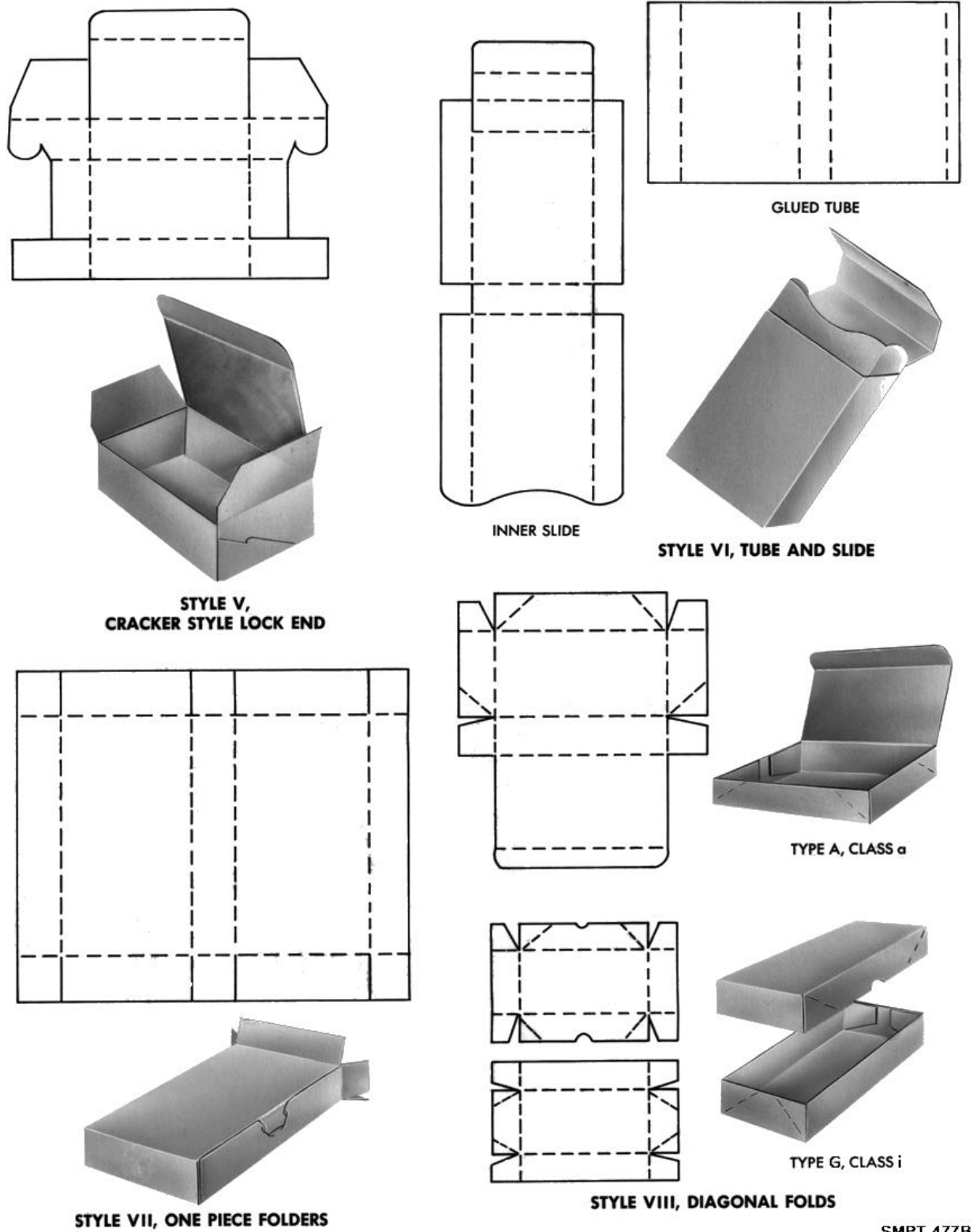
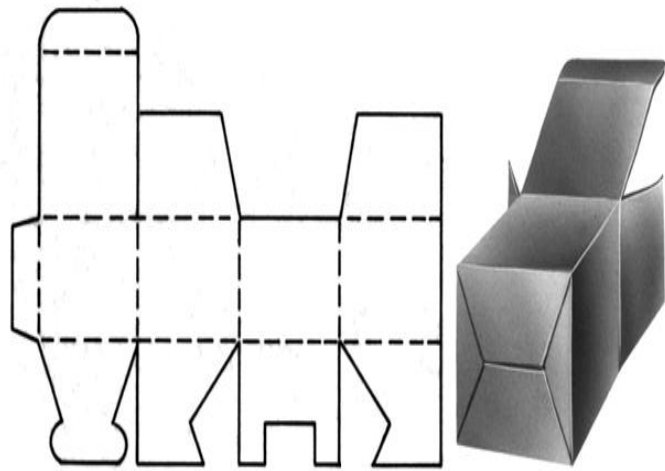
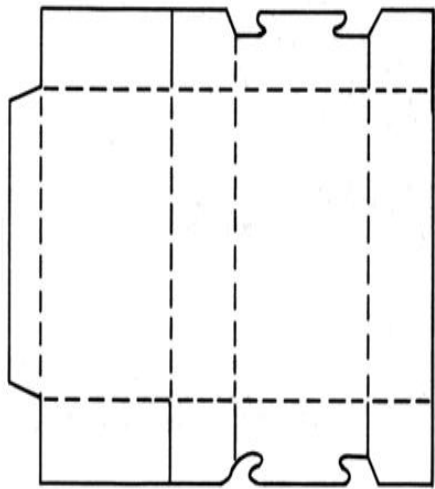
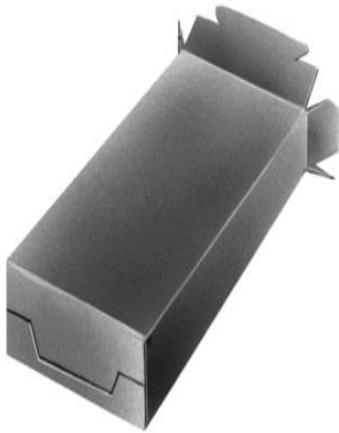


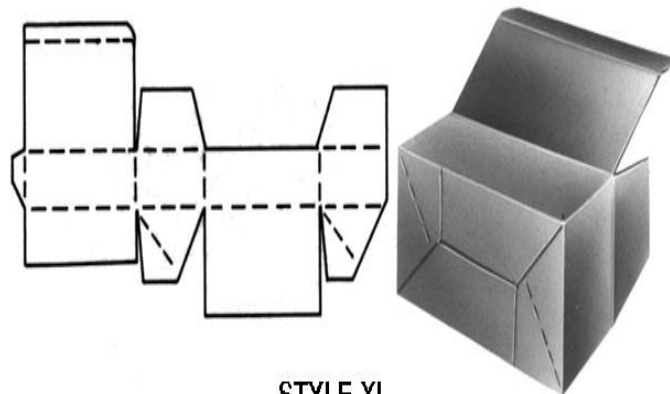
Figure 6-14. Styles V, VI, VII, and VIII of folding paperboard boxes.



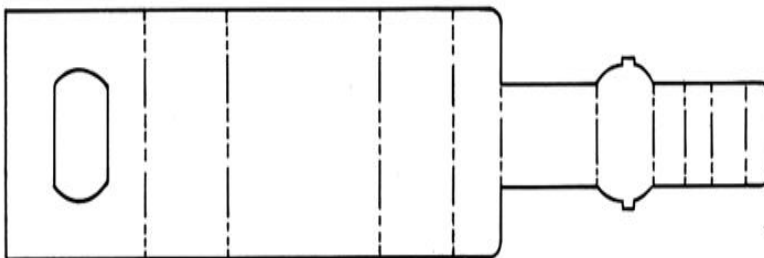
STYLE X,  
SNAP LOCK BOTTOM WITH TUCK TOP



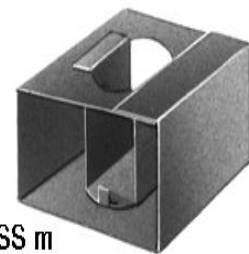
STYLE IX,  
DOUBLE LOCK - END TOP AND BOTTOM



STYLE XI,  
AUTOMATIC FOLD, BOTTOM AND SIDE GLUED



STYLE XII, CENTER SUPPORT FOR ROLLS OF TAPE



TYPE K, CLASS m

SMPT 478B

Figure 6-15. Styles IX, X, XI, and XII of folding paperboard boxes.

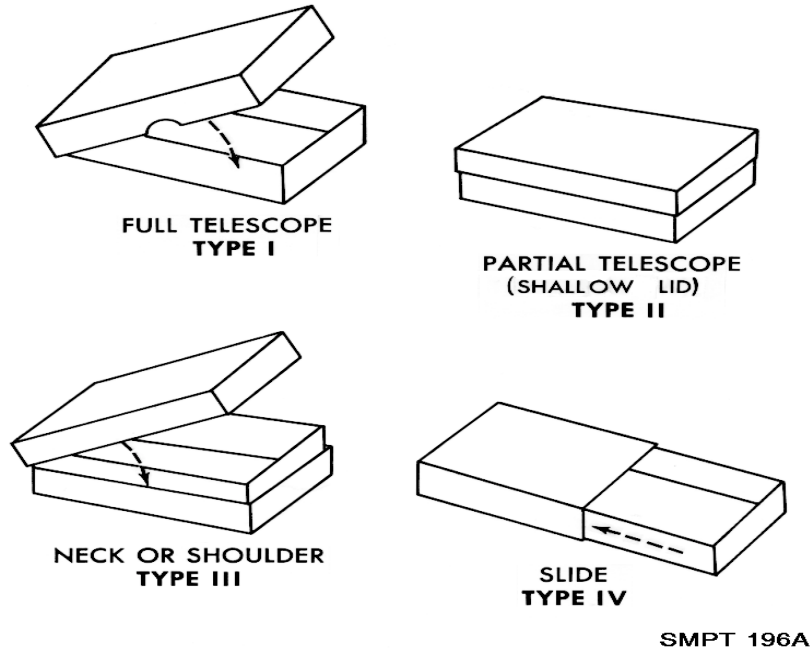


Figure 6-16. Types of paperboard setup boxes.

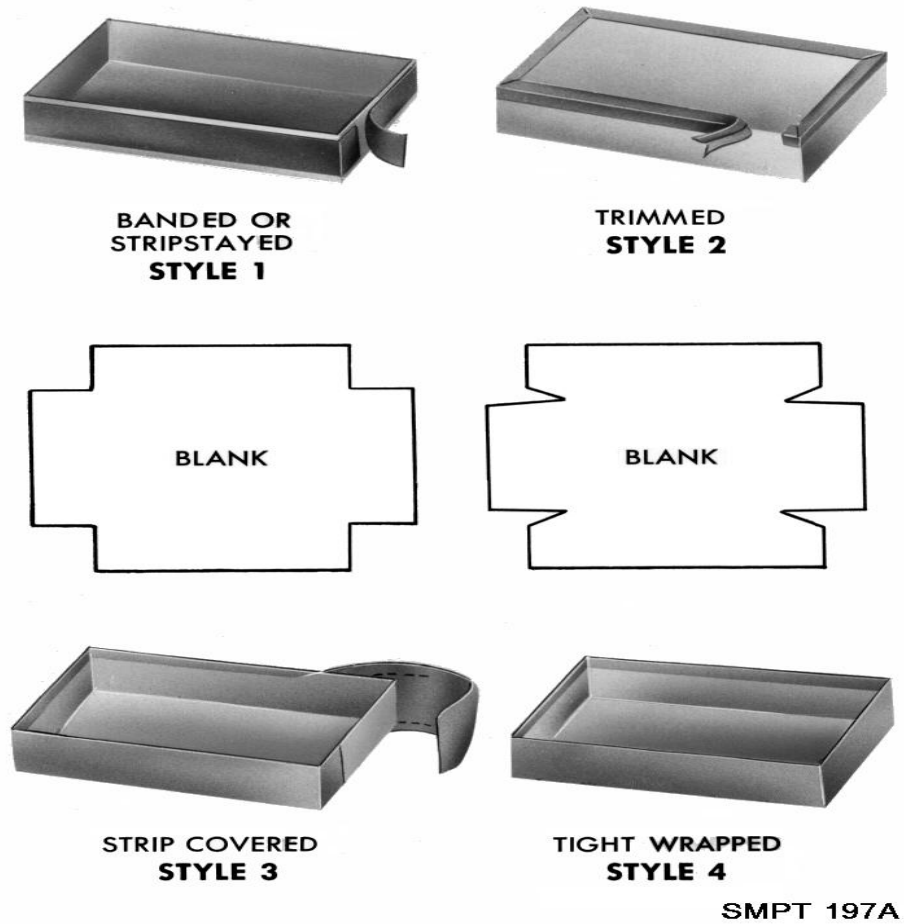


Figure 6-17. Styles of paperboard setup boxes.

## **INTENDED USES**

Setup paperboard boxes are used for interior packing and are used to give added protection to the article and for convenience in handling. Uses by varieties are as follows:

### **Varieties 1 and 5 Boxes**

Boxes that are not water or grease-resistant are intended for use in packaging dry items free from liquids or grease.

### **Varieties 2 and 6 Boxes**

Water-resistant boxes are intended for use in packaging items such as detergents, starch, flour or metal parts that can corrode. Water-resistant boxes are not weather-resistant since the water-resistant characteristic may be a thin continuous film or coating, and the remainder of the box will be absorbent and may require overpacking.

### **Varieties 3 and 7 Boxes**

Grease-resistant boxes are intended for use in packing items that are lightly coated with grease or oil as a corrosion protection. Varieties 3 and 7 boxes are not intended for use in packaging of items from which a large amount of free grease or oil will accumulate.

### **Varieties 4 and 8 Boxes**

Water-resistant and grease-resistant boxes are intended for use in the packaging of items that contain grease as an ingredient, and which will be affected if the item loses its moisture content, such as bakery goods and dog foods. The weatherproof limits are the same as those given above for varieties 2 and 6 boxes.

## **CLOSURE**

Unless otherwise specified, closure of setup boxes shall be secured by means of paper tape of 2-inch minimum width conforming to ASTM D 5486. Unless otherwise specified, telescoping type boxes shall be closed by applying a strip of tape girthwise around the center of the box and overlapping not less than 2 inches or, when specified, by applying a strip of tape that will securely cover the full perimeter seam of the box. Neck or shoulder type boxes shall be closed in the same manner as specified for the telescoping types. Slide type boxes shall be closed by applying a strip of tape centered lengthwise around the box and overlapping not less than 2 inches, or by applying strips of tape over each end of the slide (shell) on each end.

Alternatively, setup boxes may be securely closed with strips of 1/2 inch minimum width pressure sensitive, filament reinforced tape conforming to ASTM D 5330. A minimum of two strips of pressure sensitive tape shall be used. Each strip shall extend not less than 2 inches onto each box panel adjacent to the seams of the box.

## **METAL-EDGED PAPERBOARD BOXES (PPP-B-665)**

### **DESCRIPTION AND USES**

Metal-edged paperboard boxes consist of one or more paperboard flats assembled with metal edges. A great number of military depots are equipped with a machine known as "The Metal-Edge Box Stayer". The machine joins and reinforces box corners with a metal edging or stay. The metal-edged paperboard box may be used as a unit or intermediate container to provide protection to the contents or to facilitate handling and storage. Thicker and better grades of material are used in the metal-edged box than are generally used in loading and setup boxes. These factors, together with the metal-edged stiffeners, result in a more rigid box. The



boxes may be stabilized with interior blocks, forms, trays or partitions for additional protection to the contents. The weight limitation for these boxes is 40 pounds.

**CLASSIFICATION**

Table 6-3 lists two classes and nine styles of metal-edged paperboard boxes used as unit or intermediate containers to provide protection to the contents or for convenience in handling.

Styles A, C, D, and G boxes shall be provided with thumb notches. The neck or collar of style E boxes shall be made from the same board as the base, shall extend to the bottom surfaces of the box and shall be provided with metal stays at the four corners. The base and lid of style E boxes shall be of equal depth and the sum of their depths shall equal the depth of the neck or collar or the inside depth of the box.

When specified, style F boxes shall be provided with a pull hole or a pull string. Each box shall consist of one or more paperboard blanks or flat assembled with metal stays to comply to one of the box styles illustrated in figure 6-18. The paperboard shall consist primarily of unbleached kraft fiber and shall be of the thickness specified.

**CLOSURE**

Metal-edged paperboard boxes are closed by means of gummed tape, as required. Closure of the class 1 boxes may be made with 1- or 2-inch wide tape conforming to A-A-1492 and A-A-1671. Closure of class 2 boxes may be made with 1- or 2-inch wide tape conforming to ASTM D 5486.

Table 6-3. Classification of metal-edged paperboard boxes.

<p><b>Classes</b>                  1 - Domestic.                  2 - Weather-resistant.</p> <p><b>Styles (see figure 6-18)</b>                  A - Full telescope.                  B - Partial telescope or shallow lid.                  C - One piece, hinged lid.                  D - One piece, hinged lid, telescope.                  E - Neck or shoulder                  F - One piece, hinged lid, drop front.                  G - One piece, hinged lid, telescope, book style.                  H - Cut-away top case.                  J - Bin storage.</p>
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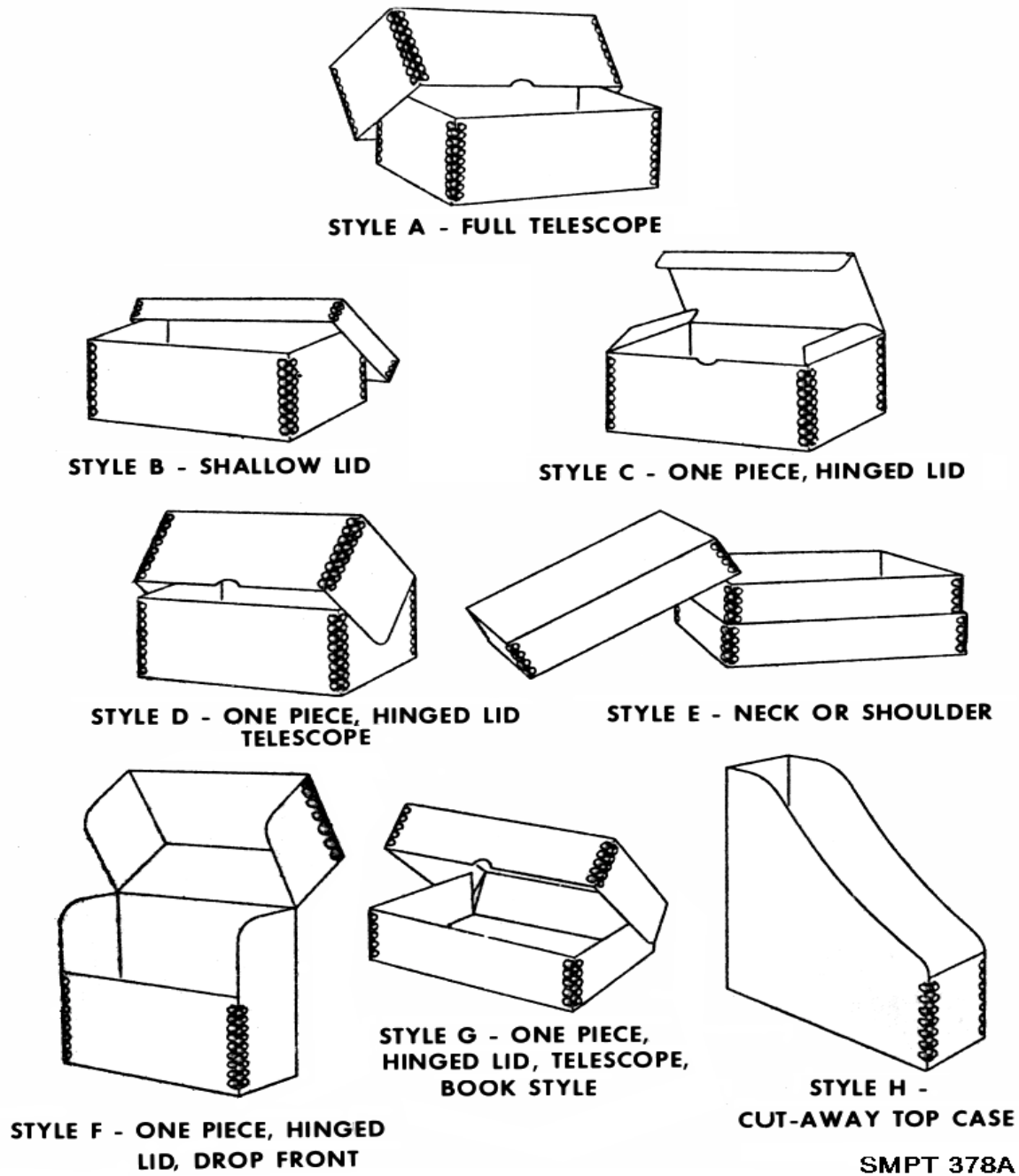


Figure 6-18. Styles of metal- edged paperboard boxes.

## TRIPLE-WALL CORRUGATED FIBERBOARD BOXES (ASTM D 5168)

### GENERAL

These boxes are made from triple-wall corrugated fiberboard (shown in figure 6-1) which makes them exceptionally good as packing containers. They are used occasionally as unit pack containers, such as for storage batteries.

## CHAPTER 7

# Cans And Drums

## DESCRIPTION, CLASSIFICATION AND SELECTION FACTORS

### DESCRIPTION

#### Cans

Cans are lightweight containers made of metal, paperboard, pulpboard, or a combination of metal and paperboard or pulpboard. Cans may be round, square, oval, oblong, or rectangular in shape. They have a variety of closures and may be used for vacuum or pressurized packaging. Most cans are used for interior packaging.

#### Drums

Drums are cylindrical, straight-walled containers made of metal, plastic, fiber or plywood, or a combination of metal and fiber, wood or plywood. Drums may be provided with rolling hoops. Rolling hoops may be pressed or expanded from the body of the drum or may be L-bars welded to the body. Drums may have removable or nonremovable heads.

### CLASSIFICATION

Cans and drums are broadly classified as to use, that is interior or exterior containers and reusable and nonreusable containers. They are also classified as to composition - metal and nonmetal.

#### Interior and Exterior Containers

##### *Interior*

Interior cans are usually 1 gallon or less in capacity, constructed of lightweight material, and are used for small items. These containers may be utilized for unit packing as specified in MIL-STD-2073-1C. Interior type containers are packed in exterior containers such as fiberboard boxes, cleated panel boxes, wirebound wood boxes, or nailed wood boxes for shipment.

##### **Exterior**

These containers consist of cans of larger capacity, pails, reusable type metal containers, and drums. Exterior containers are designed to withstand rougher usage. They may be palletized for convenience in handling.

#### Reusable and Nonreusable Containers

##### **Reusable**

Certain cans, metal containers, and drums are designed for reuse. The reusable type is very convenient for the return shipment of repairable items. This feature is particularly advantageous in cases where repairable instruments or accessories can be packed for shipment to the maintenance overhaul activity in the container in which the replacement item was received. Multiple trip drums may, under certain conditions, be refilled and reused for the shipment of liquid, powdered or granular commodities.

### **Nonreusable**

Single trip containers are usually discarded after their first use. One type, the strippable drum, is filled with a hot liquid which solidifies after cooling. At destination, the drum is torn away from the inclosed product. Other single trip containers, designed of light gauge materials, are discarded after the first trip because of requirements in Department of Transportation's hazardous materials regulation or because the general physical condition of the container would not warrant another trip.

### **Metal and Nonmetal**

Cans and drums are usually made from metal, although cans may be made from fiberboard or paperboard and drums may be made from fiber. The most common metal used in cans is steel, covered with a thin coating of tin or terneplate (lead-tin alloy coating). The most common metal used for drums is mild steel. Some drums, however, are made of aluminum, nickel, or stainless steel. Interior and exterior drums are also made of various plastic compositions.

## **USE AND SELECTION FACTORS**

### **Use**

A wide range of items and commodities are adaptable for shipping in cans and drums. Liquids, semiliquids, semisolids, granular, flakes, and powdered materials, and solids may be shipped in specified types of these containers. Fragile items and precision instruments may be given the high degree of protection they require by the use of cans or drums. Hazardous materials, including corrosives, flammable liquids, and solids must be shipped in containers specifically required or authorized by the Department of Transportation (49 CFR, Parts 170-179) or other regulatory agency.

### **Selection**

When selecting a can or drum, it must be remembered that these containers are structurally rigid in design and are dustproof. They are easy to mark and afford excellent physical protection to contents during shipment and storage. Drums may be less susceptible to pilferage than some other types of containers. Care must be taken when selecting containers. This is particularly true when selecting a container for shipment of dangerous items. For example, a square item packed in a cylindrical container takes about 1.5 times the cube required for the same item when packed in a square container. In addition to the loss of valuable cube, excess dunnage is required to fill the voids when a container of the wrong shape is used.

## **FIBER DRUMS (PPP-D-723)**

### **DESCRIPTION**

These drums are used for an assortment of material loading and shipping jobs throughout the U. S. and overseas. The materials used to construct the fiber drums shall be of the quality normally used by the manufacturer provided that the complete item complies with all provisions of PPP-D-723. For instance, the following facts about the drum shall be true:

- X The gage or thickness of the steel shall be as outlined in Table I of PPP-D-723.
- X Five (5) percent reclaimed fiber shall be used in construction of the drum, unless otherwise specified.

- X All materials used in the manufacture of fiber drums intended for contact with food and drugs for consumption must conform to rules and regulations set forth in 21 CFR, Parts 100-129.

#### CLASSIFICATION

Fiber cans under PPP-D-723 consist of 3 types, 5 grades, and 5 classes in the following manner:

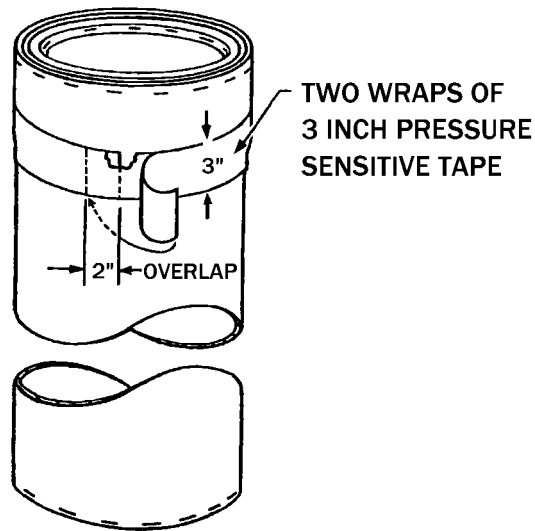
- X Type I – Domestic (nonweather resistant)
- X Type II – Overseas (nonweather resistant)
- X Type III – Overseas (weather resistant)
  - B Grade A – for dry and solid material (applicable to all types)
  - B Grade B – for semiliquid material (applicable to all types)
  - B Grade C – for hot poured materials that solidify on cooling applicable to types I and II only)
  - B Grade D – for rolled or cylindrical items (applicable to types I and II only)
  - B Grade E – for liquids or articles in liquid, nonregulated (applicable to all types)
    - Class 1 – regular construction (types I and II grade A drums)
    - Class 2 – foil laminated construction (types I and III grade A drums only)
    - Class 3 – integral plastic lining (applicable to types I and III grade A drums only)
    - Class 4 – semi-rigid plastic component (open head loose liner) applicable to grade E drums
    - Class 5 – molded rigid one-piece plastic component (closed head liner) applicable to grade E drums.

#### USE

These drums have various uses, as explained in the “Description” paragraph. Fiber cans are used in preservation Method 44 and are suitable for use as intermediate containers for small unit packs. They are also appropriate for use as shipping containers. Their content weight and volume capacities range from 60 lbs. for the 30 gallon capacity up to 700 lbs. for the 55 gallon capacity. For example:

- X Type I, grade A, class 1 is a non-weather resistant (domestic) drum, used for dry or solid materials (grade A), and has “regular” construction features (class 1). A “class 2” drum is a foil laminated one which is used for highly hygroscopic materials needing a barrier, such as desiccants.
- X Type II, grade E, class 4 or 5, are drums used for liquids or articles in liquids that are nonregulated shipments. These types and grades are for normal overseas cargo where handling and storage problems at the destination are not anticipated.

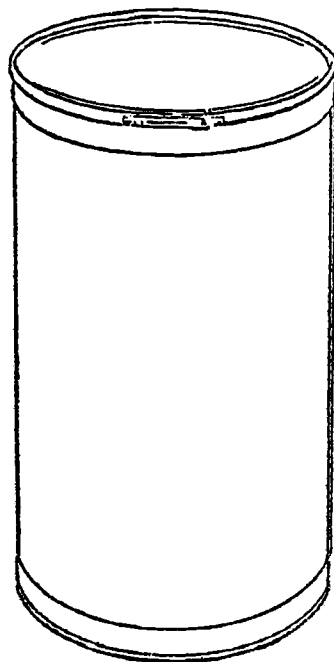
The complete list of specific types, grades, and classes of the drum, their construction, and intended uses may be found in PPP-D-723. Figure 7-1 illustrates a grade D fiber drum. Figure 7-2 illustrates a fiber drum with wood heading. Figure 7-3 shows a fiber drum with chime construction. Figure 7-4 shows the manufacturers marking requirements for the three types of fiber drums.



**METHOD OF CLOSURE**

**SMPT 156A**

Figure 7-1. Grade D fiber drums.



**METAL LOCKING BAND  
HOLDS REMOVABLE COVER  
IN PLACE.**

**CONVOLUTELY WOUND FIBER  
DRUM, HAVING COVER WITH  
TOP AND BOTTOM CHIME  
CONSTRUCTION.**

**SMPT 161B**

Figure 7-2. Fiber drum with wood heading.

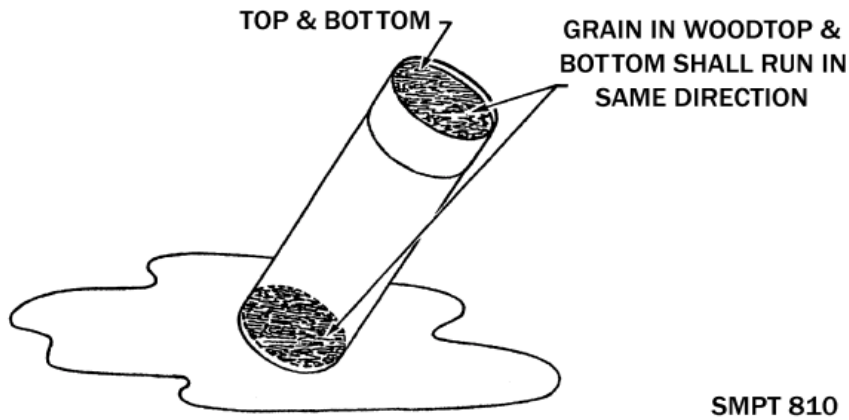


Figure 7-3. Fiber drum with chime construction.

**TYPE I**

**(DOMESTIC TYPE)**

**(NON-WEATHER RESISTANT)**

**COMPLIES WITH FED. SPEC PPP-D-723J  
FOR DOMESTIC SHIPMENT**

**GRADE\_\_\_\_\_ CLASS\_\_\_\_\_**

**MAX. WT. OF CONTENTS \_\_\_\_\_LBS.**

**MAX. CAPACITY CONTENTS \_\_\_\_\_GAL.**

**TYPE II**

**(OVERSEAS TYPE)**

**(NON-WEATHER RESISTANT)**

**COMPLIES WITH FED. SPEC PPP-D-723J  
FOR NORMAL OVERSEAS SHIPMENT**

**GRADE\_\_\_\_\_ CLASS\_\_\_\_\_**

**MAX. WT. OF CONTENTS \_\_\_\_\_LBS.**

**MAX. CAPACITY CONTENTS \_\_\_\_\_GAL.**

**TYPE III**

**(WEATHER RESISTANT OVERSEAS TYPE)**

**COMPLIES WITH FED. SPEC PPP-D-723J  
FOR MILITARY OVERSEAS SHIPMENT**

**GRADE\_\_\_\_\_ CLASS\_\_\_\_\_**

**MAX. WT. OF CONTENTS \_\_\_\_\_LBS.**

**MAX. CAPACITY CONTENTS \_\_\_\_\_GAL.**

Figure 7-4. Manufacturers marking requirements.

## **CANS, COMPOSITE, FOR DRY PRODUCTS (PPP-C-55)**

### **DESCRIPTION**

These cans are made of spirally or convolutely wound or lap seam construction. They may be lined with moisture-resistant, grease-resistant, or anticorrosive liners such as parchment, glassine, aluminum foil, polyethylene, etc., as required. The cans may be either round, square, rectangular, oval, or oblong with a variety of covers of either metal or paper .

### **CLASSIFICATION**

Fiberboard and paperboard cans are available in various types, styles, shapes and classes. The sizes of the containers are the sizes which are regularly supplied commercially.

### **USE**

These cans are suitable as containers for a wide range of supply items other than liquids. These include food, dry chemicals, drugs, small hardware, and small repair parts. These cans may be used for Method 10 preservation as established in MIL-STD-2073-1C.

## **METAL CANS, 28 GAGE AND LIGHTER (PPP-C-96)**

### **DESCRIPTION**

These cans are rigid containers made of 28-gage and lighter sheet metal plate. The metal may be either aluminum, tinplate, tinfree steel, blackplate, or any combination of these metals. The cans may be round, square, oblong, pear-shaped, open-top, or double seamed ends. They have a variety of closures, such as snap on caps, screwcaps, spout closures, and friction plugs. Several types may be provided with handles when specified. These cans are air-tight, dustproof, and watervaporproof .

### **CLASSIFICATION**

Cans procured under PPP-C-96 are available in several types and classes.

### **USE**

Depending upon the class and type, cans meeting the requirements of PPP-C-96 are capable of handling a wide range of contents. Types I, II, III, IV, and VII, Class 2, may be used for the methods of preservation 45 and 55 as prescribed by MIL-STD-2073-1C. In addition to items packaged for unit protection, other commodities such as foodstuffs, liquids, powders, pastes, and materials which are dispersed under pressure, may be canned also.

#### **CAUTION**

Food products, toilet articles, or medical products may not be placed in cans coated with terneplate. Such cans will be marked "CAUTION --- DO NOT USE OR REUSE AS A FOOD CONTAINER".



**CLOSURE**

Closure requirements vary with the type and class of can. Screw caps must be secured by automatic mechanical means or by cap wrenches and may not be hand tightened. Snap on closures are secured by full automatic, semiautomatic, or hand band closing or crimping tools. When specified, after filling the can with the product being packed, multiple friction plugs on 1-gallon and larger containers are spot soldered to the friction ring at three points equidistant from each other around the perimeter of the plug. Other methods of preventing the plug from coming loose will be accepted provided they will meet prescribed drop tests.

**SHIPPING AND STORAGE, REUSABLE METAL DRUMS (CAPACITY 88 TO 510 CUBIC INCHES) (MIL-D-6055)**

**DESCRIPTION**

These reusable metal shipping drums are constructed with a removable cover secured by a separate exterior locking ring and held in place by a removable nut and bolt. A rubber gasket is supplied to provide a barrier against watervapor. These drums may be fabricated from either aluminum or steel. They may be made from one piece of metal stamped and drawn to size and shape, or they may be formed of rolled metal with a side seam.

**CLASSIFICATION**

These metal containers are of two types. Type I drums are formed drums and Type II drums are drawn. They are furnished in either aluminum alloy, Class A, or steel, Class S. The drums are available in the sizes shown in table 7-1. Each container size and its corresponding cover and locking ring components are identified by a military standard part number as listed in the table.

Table 7-1. MIL-D-6055 Drums: Metal Reusable, Shipping and Storage

Steel containers					Nominal capacity (cu. in.)	Inside diameter	Inside depth
Container assembly	Military standard part number						
	Container body	Cover	Locking ring	Gasket			
MS-24347-1	MS24347-21	MS-24347-41	MS-24347-61	MS-24347-81	88	5	4.5
MS-24347-2	MS-24347-22	MS-24347-41	MS-24347-61	MS-24347-81	167	5	8.5
MS-24347-3	MS-24347-23	MS-24347-42	MS-24347-62	MS-24347-82	149	6.5	4.5
MS-24347-4	MS-24347-24	MS-24347-42	MS-24347-62	MS-24347-82	224	6.5	6.75
MS-24347-5	MS-24347-25	MS-24347-42	MS-24347-62	MS-24347-82	282	6.5	8.5
MS-24347-6	MS-24347-26	MS-24347-43	MS-24347-63	MS-24347-83	340	8.35	6.0
MS-24347-7	MS-24347-27	MS-24347-43	MS-24347-63	MS-24347-83	425	8.5	7.5
MS-24347-8	MS-24347-28	MS-24347-43	MS-24347-63	MS-24347-83	510	8.5	9.0

Note. Add D in place of dash in the part number of aluminum alloy.

**USE**

The use of these containers is limited to lightweight items. This type of container is used principally for the preservation and packing of such items as delicate instruments, expensive relays, and small electric motors which require inspection or lubrication during storage. These containers may also be used for preservation by Method 40 and Method 50, where the size or weight of the item is too great for the nonreusable sealed can.

**NOTE**

The US Postal Service has advised that reusable metal mailing containers with split-ring type closing devices are damaging mail bags and other mail when placed in parcel post channels. The projection of the split-ring and exposed end of the protruding screws cut the canvas or nylon fabric of the bags during handling and while in transit. When containers are handled as "outside" pieces, they damage other mail. Split-ring closure type reusable metal containers are nonmailable under the provisions of Section 123.2 of the U.S. Postal Service Manual, unless the projections of the split-ring and exposed end of the protruding screws are properly cushioned and wrapped to prevent injury to postal employees and damage to mail and equipment.

**CLOSURE**

Reusable metal containers are provided with gasketed, removable covers. The cover, or lid, is held in place by a circumferential locking ring that is secured by means of a nut and bolt. After installing the gasket in the cover groove with the flat surface of the gasket outermost, place the cover on the container. Assemble the locking ring to the cover and container. Insert the bolt and tension the nut to a minimum torque pressure of 4 foot-pounds plus or minus 1/2 foot pound. During the tightening of the nut and bolt, tap the locking ring repeatedly with a rubber, fiber, or plastic mallet to relieve the friction, thereby assuring a uniform and effective seal. In lieu of the specified torque-indicating device, closure of the container may be accomplished using a common screwdriver having an overall length of 12 inches. If this procedure is followed, a spot check of torque with a torque-indicating device should be made to assure tensioning of the nut and bolt.

**SEALING**

In order that opening or tampering can be readily detectable, seal each container of serviceable material with a wire and metal seal affixed to prevent opening of the container without destroying the seal. After the closure is completed, insert the sealing wire through the drilled head of the locking ring bolt and the rim of the metal container, draw the wire tight, twist the ends together and apply a metal seal so that the bolt cannot be loosened without breaking the wire or destroying the seal. Alternatively, the sealing wire should be placed underneath the bolt in the lower hold of the lugs of the locking ring and similarly tightened and sealed. The sealing wire should be tucked under to prevent injury to handling personnel.

**CONSERVATION, REUSE, AND REPAIR****Reusability**

As the reusability feature has been a factor in the general adoption of metal containers for preservation and packing military materiel, it is of major importance that attention be given to their conservation, repair, and reuse.

Special care should be taken to minimize loss of any integral parts of the empty containers. It is recommended that caution be exercised in the repair of reusable containers, since the overall cost of repair and materials should not exceed 65 percent of the purchase price of the container. In the event a minor repair is deemed economical, the information in the following paragraphs may be used as a guide. Immediately upon removal of material from metal containers, old markings and tags should be obliterated. The cover, gasket, exterior locking ring, bolt, and nut should be fastened together to prevent loss.

### **Damage to Body**

The reusable metal containers have bodies which are either soldered or deep drawn from a single piece of metal. Soldered bodies are more susceptible to damage from dents and abrasions incurred in rough handling. Dents in the body of the container affecting the soldered seam, joint, or lip will make the container unfit for further use (figure 7-5). Dents, other than the above, in the body of the container are considered repairable and can be removed by hammering, pressing, or other suitable means. The painted surfaces are to be retouched or repainted, where necessary, and the container returned to stock or reused.

### **Damaged to Cover**

Small dents in the cover or lid of a metal container are considered repairable provided they do not distort the cover or impair assembly of the cover to the gasket or container (figure 7-5). Such dents are removed and bare spots retouched, where necessary, in accordance with the preceding paragraphs. If the dent in the cover occurs in the rolled flange that holds the gasket in place, or is otherwise distorted, the cover should be condemned and replaced by a serviceable one from a drum from which a body has been scrapped (figure 7-5). If parts are not available from this source, spares should be requisitioned from stock. In the event that removal of an otherwise repairable dent in the cover results in distortion, the cover should be condemned.

### **Damage to Gasket**

Proper closure of MIL-D-6055 metal drums to obtain a watervaporproof seal is dependent upon the condition of the gasket. Consequently, the importance of ascertaining serviceability of the gasket by visual inspection cannot be overemphasized. If the gasket is torn, distorted, weather checked, or deformed due to stretching, it must be replaced by a serviceable one (figure 7-6). Reusability of the gasket, as well as effectiveness of the watervaporproof seal, depends upon proper assembly of the gasket to the cover and to the container. After assembly to the cover, the flat surface of the gasket must be in position to bear against the rolled lip of the container.

### **Damage to Locking Ring**

To insure proper sealing of the gasket to both the cover and the container, the locking ring must exert a uniform clamping pressure. Small dents in the locking ring will impair this function of the ring (figure 7-6). Any attempt to remove such dents is considered impracticable due to the possibility of creating further damage. Consequently, it is necessary to replace locking rings when they are damaged as previously described.

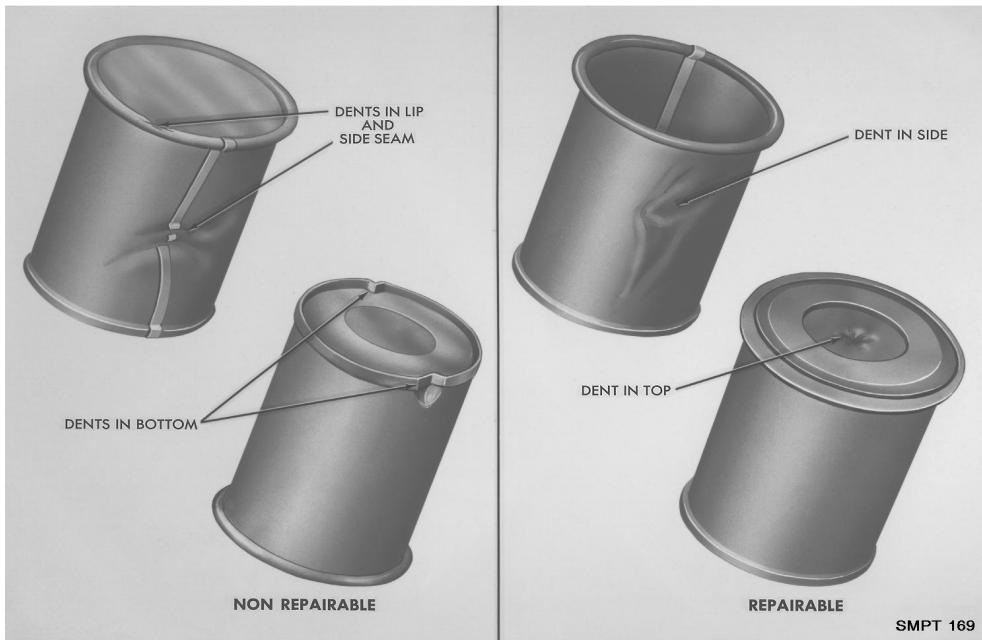


Figure 7-5. Nonrepairable and repairable dents in drums.

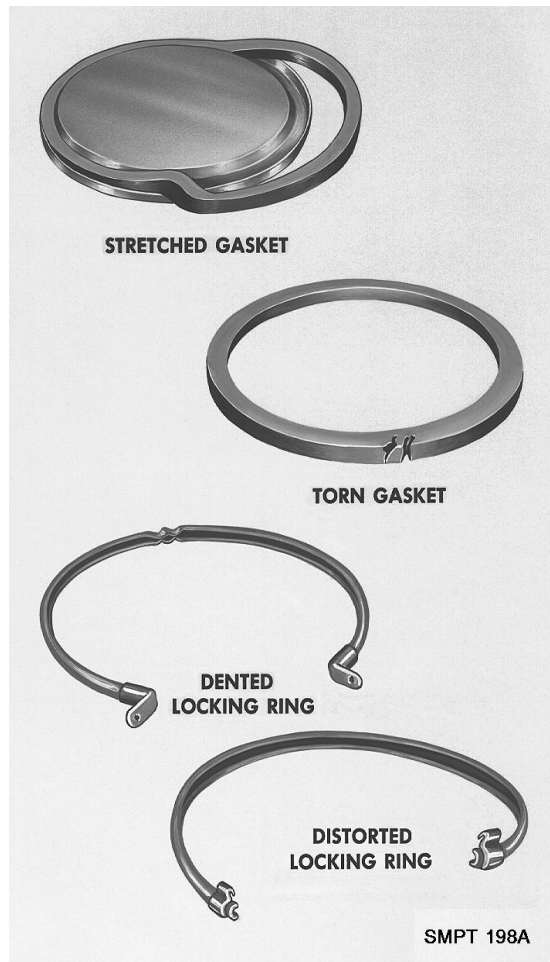


Figure 7-6. Nonrepairable gaskets and locking rings.

## Chapter 8

# Reusable Cushioned Containers

## INTRODUCTION

There are several systems of containers which were specifically designed as multiuse shipping containers. The Air Force developed a system which utilizes fiberboard boxes with a polyurethane cushioning medium. The Navy version utilizes molded plastic cases with either a polyurethane or suspension system cushioning medium.

The DOD packaging activity, contractor, subcontractor, or vendor shall select the appropriate multiapplication container for those depot repairable items which fall within the parameters of size (allowing for the wrapping material and barrier), weight, and fragility. Although these integral multiapplication containers are designed for the purpose of protecting fragile items, the pack reusability, versatility, and low labor costs of insertion and removal of the item make it cost effective for many less fragile and nonrepairable items.

## BOXES, SHIPPING, REUSABLE, WITH CUSHIONING (PPP-B-1672)

### GENERAL

This specification was developed to provide a source of containers to be used in the system, generically called "Fast Pack." We are referring to the shorter life, fiberboard and polyurethane containers. The longer life, plastic reusable containers will be specifically addressed later in this chapter.

Fast Pack is a system which utilizes a family of standard size cushioned shipping containers. These packs are made with polyurethane foam cushioning which in most cases is bonded to the container to assure the integrity of the complete pack. Due particularly to their construction and closure features, these boxes are designed and intended to be reusable.

The Fast Packs are especially useful for return of repairable components since each size and type is suitable for shipment of a large number of different items within certain limits of size, weight, and fragility.

Material for all Fast Pack boxes shall conform to ASTM D 4727, type CF, class WR. Boxes of types I, III, and IV packs shall be a variety SW, material grade V3c. Type II packs shall be a variety SW, material grade W5c. Cushioning material for types I, III, and IV packs shall meet the requirements of MIL-PRF-26514, type I, class 2, grade C. Cushioning for type II, style D packs shall conform to type III, class 2, grade A, B, or C.

### TYPES AND STYLES

The four types of packs used in the Fast Pack system are:

- X Type I, Vertical Star Pack.
- X Type II, Folding Convolute Pack.
- X Type III, Telescoping Encapsulated Pack.
- X Type IV, Horizontal Star Pack.

There are five styles in the Fast Pack system. They are described as follows:

- X Style A, Regular Slotted Container (RSC).
- X Style B, Double Cover Container (DBLCC) modified so that the covers extend to one-half the depth of the tube.
- X Style C, Modified DBLCC in that the joints for the covers and the single piece tube shall be butted and secured with metal fasteners and the covers shall extend to one-half the depth of the tube.
- X Style D, Modified Triple Slide (TS). The modification is that the middle box shall be omitted and the sleeve shall have the overlap stitched, stapled, or glued outside the side panel.
- X Style G, Modified Full Telescope Encapsulated box (FTC). It is the only type III container. It is modified in that the inside dimensions of the cover must be extended for ease in the installation and removal of the cover.

The various types and styles of Fast Packs are shown in figure 8-1.

Types I, III, and IV boxes shall be made of grade V3c material, except the two largest box sizes of Type III, which require V13c material because of dimensions. Type II boxes shall be made of grade W5c material.

#### **SPECIAL MARKING REQUIREMENTS**

For type I, type III, and type IV packs, the following markings shall be in characters of a size not less than 1/2 inch high, except that the NSN may not be less than 3/8 inch high. The markings shall be centered on the lower half of two opposite faces of the style A packs parallel to the closure seam formed by the outer flaps and style G pack covers. The markings shall be on two opposite faces of the bottom cap of the style B and style C packs. The markings format shall be as follows:

**REUSABLE  
FAST PACK - (proper pack code)  
(proper size and cube)  
(proper NSN)**

Type II packs require the following markings, in characters not less than 1/4 inch high. The markings shall be placed within approximately the right one-third of the two narrow sides of the pack. The marking format shall be as follows:

**REUSABLE - FAST PACK - (proper pack code)  
(proper size and cube)  
(proper NSN)**

Each end of the slide on a style D box shall be marked with the words:

**PUSH OPEN and ANTI STATIC**

The words "ANTI STATIC" shall be placed 1/4 inch below the words "PUSH OPEN."

The criteria listed above apply to depots that package or represerve and repack expendable items for shipment and/or storage.

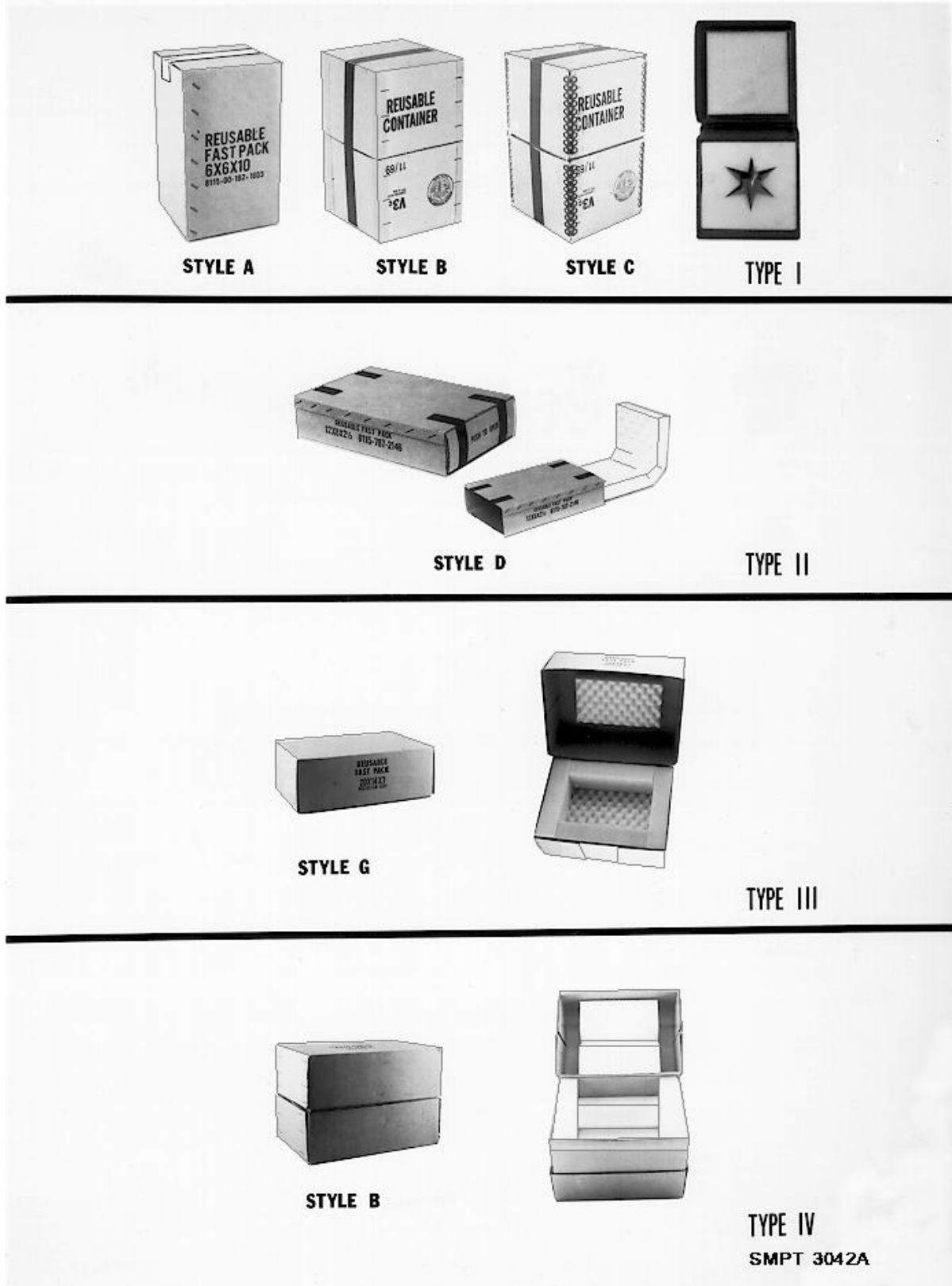


Figure 8-1. FAST PACK containers.

## **GUIDELINES**

Contractors and depots are encouraged to use advanced packaging technology, and innovative methods or materials for the purpose of effecting packaging economies.

## **OPENING AND REUSE OF FAST PACKS**

- X To open Fast Pack boxes, the closure and reinforcing tape(s) shall be cut with a shallow knife at a minimum number of seam locations which will permit opening and preclude any damage to the box. DO NOT remove totally adhered tape.
- X Surfaces to which the tape for closure or reinforcement is to be applied must be free of loose soil, oil and/or grease. These surfaces should be wiped clean prior to the application of tape.
- X Tape applied to reused containers should be applied directly over the existing tape.
- X Loose ends of existing tape should be cut off, not torn loose. Tearing the tape from the box damages the box surface and weakens the container walls.

## **CLOSURE AND MARKING REQUIREMENTS**

Closure of Fast Packs shall be performed after the item(s) are placed inside and packed for shipment and storage. Marking for military shipment and storage shall be done in accordance with MIL-STD-129. Marking of packs for civil agencies shall be in accordance with FED-STD-123.

The tape used for reinforcement and sealing shall be of the specification, type, and size as specified for each type and style of box and according to the desired level of packing.

As a rule, no preprinted markings, except container certification marking, shall be obscured by taping or reinforcement. Any obscured or obliterated markings that were on the boxes need not be remarked, except for the pack code.

Recommended closure procedures for each type and style of FAST PACK boxes have been developed to assure reusability to the maximum extent. Figures 8-2 and 8-3 depict closure and reinforcement procedures for Level B and Level C Fast Packs, respectively.

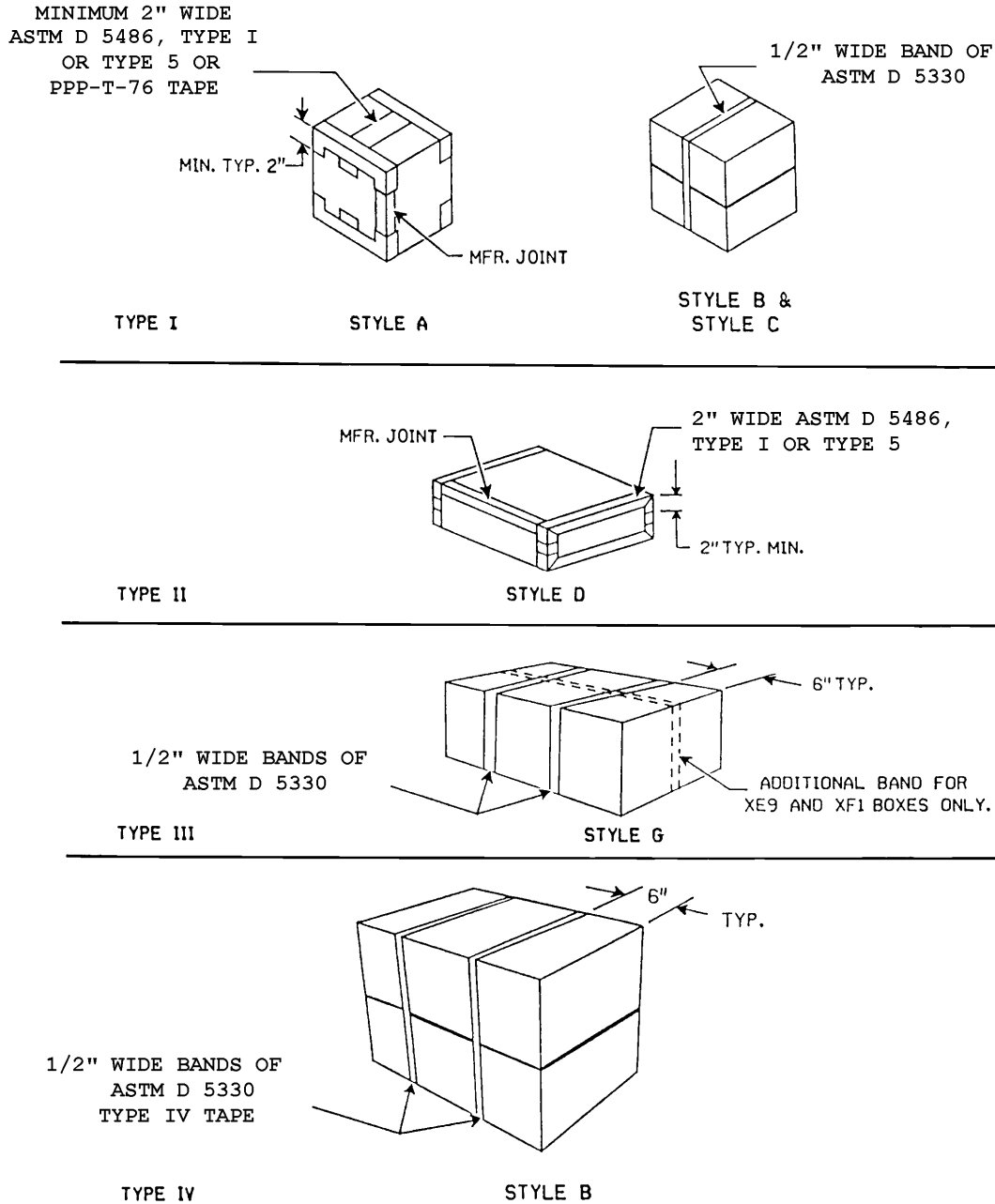
## **LEVEL B PACKING**

**(Note)** Level B packing is the highest level attainable in fiberboard containers, as compared with Level A in hard surfaced containers of wood, glass, metal, etc.

The following procedures are shown in figure 8-2, Level B Fast Pack closure and reinforcement.

Type I, style A packs shall be sealed with minimum 2-inch wide tape conforming to ASTM D 5486 (formerly PPP-T-60 and PPP-T-76) applied over all seams, corners, and manufacturer's joints. The tape shall be centered over the seams and joints and shall extend over all the corners and edges of the box a minimum of 2 inches onto the adjacent box panels. Tape shall be applied over the lengthwise seam of the outer flaps, sealing the opening of the box and over the manufacturer's joint prior to tape being applied to the edge seams of the box. The tape applied to the manufacturer's joint shall cover the joint but not extend over the corners of the box onto the adjacent panels. This method also serves as the closure.





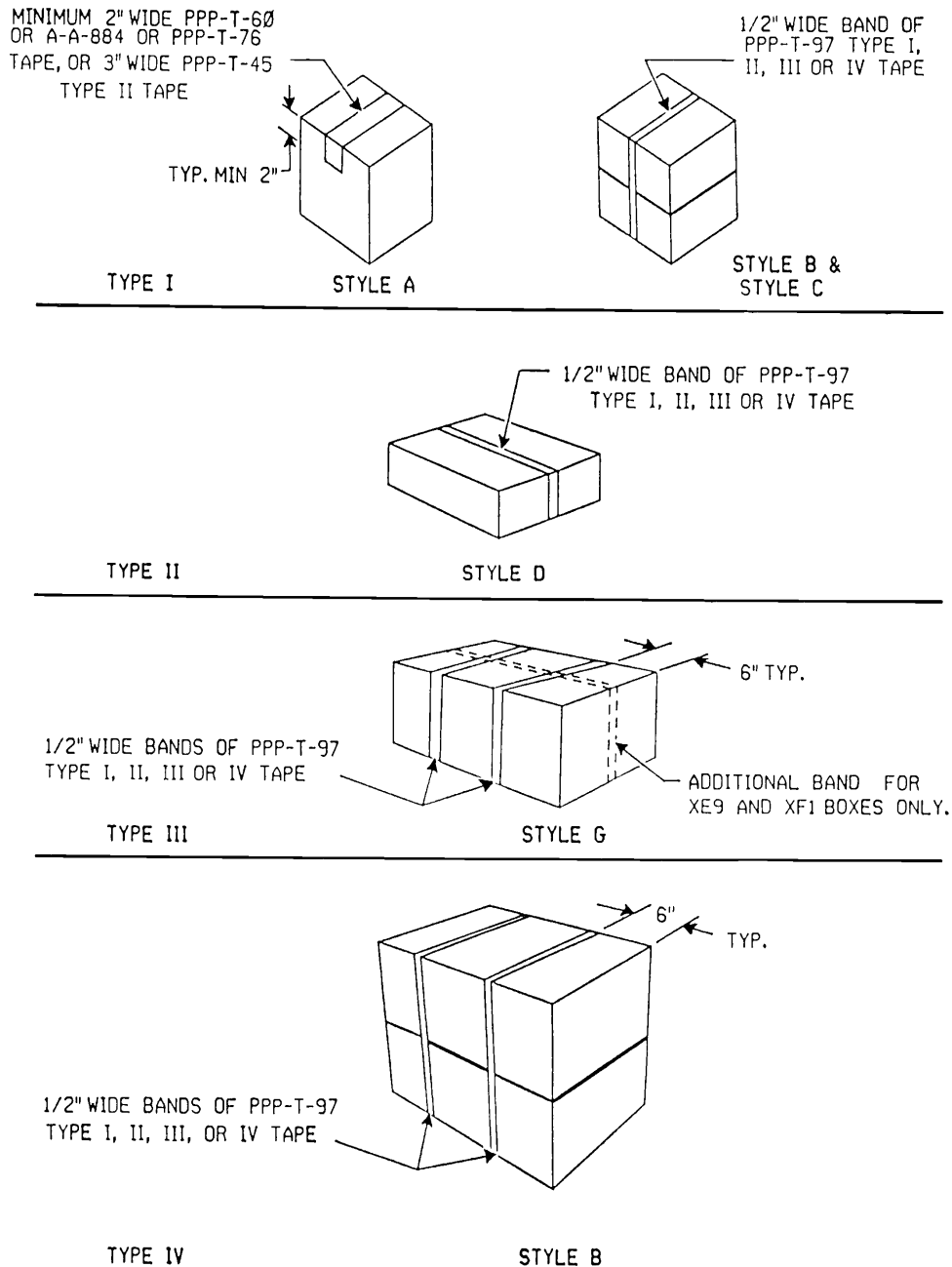
LEVEL B FAST PACK CLOSURE AND REINFORCEMENT

SMPT 3091A

Figure 8-2. Level B Fast Pack closure and reinforcement.

Type I, styles B and C packs shall be centrally reinforced with one fully encircling band of 2-inch wide tape conforming to ASTM D 5330 (formerly PPP-T-97), type IV. This method serves as closure. Sealing is not required.

Type II, style D packs shall be treated in the same manner specified for type I, style A containers, which is to seal all open seams and manufacturer's joint with 2-inch wide tape conforming to ASTM D 5486 (formerly PPP-T-60 and PPP-T-76), type III or IV. This method also serves as closure.



LEVEL C FAST PACK CLOSURE AND REINFORCEMENT

SMPT 3090

Figure 8-3. Level C Fast Pack closure and reinforcement.

Type III, style G shall be reinforced with fully encircling bands of 2-inch wide tape conforming to ASTM D 5330 (formerly PPP-T-97), type IV. Two bands shall be positioned six inches from the ends over the top, bottom, and sides. Add one lengthwise band over the top, bottom, and ends for XE9 and XF1 Fast Packs. This method serves as the closure. Sealing is not required.

Type IV, style B shall be reinforced as specified for type III, style G, except that the lengthwise band shall not apply. This method serves as the closure. Sealing is not required.

### **Level C Packing**

**(Note)** Level C packing is no longer a valid concept according to MIL-STD-2073-1C but is mentioned here due to the present status of PPP-B-1672. Level C is a lower protection level than Level B. See Figure 8-3, "Level C Fast Pack closure and reinforcement."

Type I, style A packs shall be closed with a minimum 2-inch wide tape conforming to ASTM D 5486 (formerly PPP-T-60 and PPP-T-76), type III or IV. The tape shall be centered over the seam formed by the closure of the outer flaps of the top and shall extend down over the end panels not less than two (2) inches.

Type I, styles B and C shall be centrally reinforced with one fully encircling band of 2-inch wide tape conforming to ASTM D 5330 (formerly PPP-T-97) types I, II, III, or IV. This method serves as the closure. Sealing is not required.

Type II, style D shall be reinforced with one fully encircling band of 2-inch wide tape conforming to ASTM D 5330 (formerly PPP-T-97) types I, II, III, or IV. The band shall be placed lengthwise and centered over the top, bottom and ends (between the words "PUSH" and "OPEN"). This method serves as the closure. Sealing is not required.

Type III, style G shall be reinforced as specified for level B, type III, style G. This method serves as the closure. Sealing is not required.

Type IV, style B reinforcement shall be as specified for level B, type III, style G, except that the ASTM D 5330 tape used may be type I, II, III or IV and the lengthwise band shall not apply. This method serves as the closure. Sealing is not required.

### **SHORT LIFE CONTAINERS**

Types I through IV. Construction details and materials requirements of the short life multiapplication containers shall conform to PPP-B-1672 (FAST PACK) for types I through IV. The container codes for types I through IV are contained in Table J.VII of MIL-STD-2073-1C. The container codes for types I through IV are NR, NS, NV, and NW, respectively. Table 8-1 presents the following information concerning Types I, II, III, and IV short life containers:

- X container size and National Stock Number (NSN).
- X recommended maximum bare item dimensions.
- X item weight range in pounds.
- X maximum shock (Gs) transmitted to the item.
- X packaged outside dimensions (inches)
- X packaged cube(cubic feet).

Type I consists of a polyurethane foam cushion insert with a diecut, star shaped, vertical cavity and top with bottom pads of the same material assembled in the container. This type is used for packaging fragile items, either rectangular or cylindrical in shape, such as meters, gauges, attitude and air speed indicators. Items packaged in this star pack type are inserted or loaded into the cavity from the top of the container prior to placing the top pad in place.

Type II consists of folded convoluted polyurethane foam cushion bonded to container board. Although the cushioning provides protection against shock, it essentially holds the item in place by precompression of the convoluted tips. This type is used for circuit boards and electronic modules. It is also used for packing glass envelope electronic tubes or other items whose depth does not exceed certain limits.

Type III consists of a telescoping container with bonded, convoluted (some end and side pads of which are flat sheet stock) polyurethane foam cushioning which forms an oblong cavity. This type is used to pack equipment such as receiver-transmitters, amplifiers, power supply units, and electronic indicators.

Type IV consists of a two piece (top and bottom) polyurethane foam-insert, which forms a star shaped cavity when the two pieces are mated in conjunction with end pads of flat sheet stock. The insert components and end pads are bonded in place within a half telescoping container conforming to ASTM D5118/ASTM D5118M, type CF, style DBLCC. The cushioning insert is similar to the type I star pack insert except that it is cut along (horizontal to) its greatest dimensional length to facilitate insertion (loading) and extraction of relatively long, rectangular or cylindrical items such as voltage regulators, electronic receivers, panels, transmitters, couplers and amplifiers.

When using these short life containers for items which do not completely fill the preformed cushion cavity, the item shall be immobilized by adding additional compatible cushioning material. Items whose dimensions slightly exceed the cushion can be carefully pressed into position.

TABLE 8-1. Multiapplication container selection.

PPP-B-1672, Type I, Vertical Star, (MIL-STD-2073-1C, Appendix C, CODE NR)

Container ID (inches) (National Stock Number)	Recommended max. bare item dimensions (in.)	Item weight range (lbs.)	*Maximum Shock (Gs) transmitted to item	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
6 x 6 x 10 (8115-00-192-1603)	3 Dia x 6	1.0 - 1.5 1.6 - 2.2	30 - 40 25 - 29	6.3 x 6.3 x 10.5	.242
	3 x 3 x 6	2.3 - 3.0 1.5 - 4.0	30 - 40 30 - 40		
8 x 8 x 12 (8115-00-192-1604)	3 x 3 x 8	1.5 - 4.0	30 - 40	8.3 x 8.3 x 12.5	.499
	4 Dia x 8	3.0 - 7.5	25 - 29		
	4 x 4 x 8	7.6 - 8.5	30 - 40		
	5 Dia x 8	3.0 - 5.0 5.1 - 7.0 3.5 - 5.5	25 - 29 30 - 40 30 - 40		
10 x 10 x 12 (8115-00-192-1604)	4 Dia x 6	2.0 - 3.0 3.1 - 4.5 4.6 - 5.0	30 - 40 25 - 29 30 - 40	10.5 x 10.5 x 12.5	.798
	5 Dia x 6	3.0 - 6.0	30 - 40		
	6 Dia x 6	4.5 - 7.0	30 - 40		
	5 x 5 x 6	4.0 - 9.0	30 - 40		
12 x 12 x 14 (8115-00-134-3655)	5 Dia x 8	3.5 - 4.5	25 - 29	12.5 x 12.5 x 14.5	1.312
	6 Dia x 8	4.6 - 8.5	20 - 24		
	5 x 5 x 8	5.0 - 7.0	25 - 29		
		7.1 - 13.0	20 - 24		
	6 x 6 x 8	3.0 - 5.0	30 - 40		
		5.1 - 7.0 7.1 - 11.0	25 - 29 20 - 24		
12 x 12 x 18 (8115-00-050-5237)	5 Dia x 10	4.0 - 5.0	25 - 29	12.5 x 12.5 x 18.5	1.673
	6 Dia x 10	5.1 - 11.0	20 - 24		
		6.0 - 8.0	25 - 29		
	5 x 5 x 10	8.1 - 16.0	20 - 24		
		4.0 - 6.0	30 - 40		
	6 x 6 x 10	6.1 - 8.0	25 - 29		
		8.1 - 13.0	20 - 24		
		8.0 - 10.0	30 - 40		
10.1 - 14.0 14.1 - 20.0		25 - 29 20 - 24			
14 x 14 x 16 (8115-00-134-3656)	6 Dia x 10	6.0 - 15.0	25 - 29	14.5 x 14.5 x 16.5	2.008
	7 Dia x 10	8.0 - 14.0	30 - 24		
		14.1 - 17.0	24 - 29		
		17.1 - 20.0	30 - 40		
	6 x 6 x 10	5.0 - 7.0	30 - 40		
		7.1 - 9.0	24 - 29		
	7 x 7 x 10	9.1 - 12.0	20 - 24		
		6.5 - 9.0	30 - 40		
		9.1 - 12.0	25 - 29		
		12.1 - 21.0	20 - 24		
		21.1 - 23.0	25 - 29		

\* Shock values in this Table were determined by instrumented free fall drop testing in accordance with Method 5007 of FED-STD-101.

TABLE 8-1. Multiapplication container selection. - continued

PPP-B-1672, Type II, folding convoluted (MIL-STD-2073-1C, Appendix C, CODE NS)

Container ID (inches) (National Stock Number)	Recommended max. bare item dimensions (in.)	Typical item weight range (lbs.)	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
6 x 5 x 2-1/2 (8115-00-787-2142)	5 x 4-1/2 x 1-1/4	0.5	6.3 x 5.3 x 3.0	.058
6 x 5 x 3-1/2 (8115-00-787-2147)	5 x 4-1/2 x 2-1/4	1.0	6.3 x 5.3 x 4.0	.078
9 x 6 x 2-1/2 (8115-00-101-7647)	8 x 5-1/2 x 1-1/4	0.9	9.3 x 6.3 x 3.0	.102
9 x 6 x 3-1/2 (8115-00-101-7638)	8 x 5-1/2 x 2-1/4	1.8	9.3 x 6.3 x 4.0	.136
10 x 10 x 3-1/2 (8115-01-057-1244)	9 x 9-1/2 x 2-1/4	1.8	10.5 x 10.5 x 4.0	.256
12 x 8 x 2-2/12 (8115-00-787-2146)	11 x 7-1/2 x 1-1/4	1.8	12.5 x 8.3 x 3.0	.181
12 x 8 x 3-2/12 (8115-00-787-2148)	11 x 7-1/2 x 2-1/4	3.6	12.5 x 8.3 x 4.0	.241
13 x 13 x 3-1/2 (8115-00-057-1243)	12 x 12-1/2 x 2-1/4	4.3	13.5 x 13.5 x 4.0	.422
16 x 16 x 3-1/2 (8115-01-057-1245)	15 x 15-1/2 x 2-1/4	8.6	16.5 x 16.5 x 4.0	.631
18 x 12 x 2-1/2 (8115-01-019-4085)	17 x 11-1/2 x 1-1/4	4.3	18.5 x 12.5 x 3.0	.402
18 x 12 x 3-1/2 (8115-01-019-4084)	17 x 11-1/2 x 2-1/4	8.6	18.5 x 12.5 x 4.0	.536
24 x 16 x 3-1/2 (8115-01-093-3730)	23 x 15 x 2-1/4	10.0	24.5 x 16.5 x 4.0	.936

Note: Because items assigned to these packs are not of extremely low fragility, dynamic cushioning values have not been determined.

TABLE 8-1. Multiapplication container selection. - continued

PPP-B-1672, Type III, telescoping encapsulated (MIL-STD-2073-1C Appendix C, CODE NV)

Container ID (inches) (National Stock Number)	Recommended max. bare item dimensions (in.)	Item weight range (lbs.)	Maximum Shock (Gs) transmitted to item	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
30 x 16 x 14 (8115-00-516-0242)	24 x 11 x 9	28 - 48 49 - 54	30 - 39 40 - 50	31.0 x 17.0 x 14.5	4.423
32 x 12 x 14 (8115-00-519-1825)	26 x 6 x 8	12 - 19 20 - 29 30 - 33	30 - 39 25 - 29 40 - 50	33.0 x 13.0 x 14.5	3.600
26 x 9 x 9 (8115-01-015-1313)	20 x 5 x 5	20(max)	50(max)	27.0 x 10.0 x 9.3	1.454
24 x 14 x 14 (8115-00-516-3558)	18 x 8 x 8	13 - 16 17 - 38	30 - 39 25 - 29	25.0 x 15.0 x 14.5	3.147
20 x 14 x 9 (8115-00-516-0251)	16 x 10 x 5	6 - 7 7 - 8	30 - 39 40 - 50	21.0 x 15.0 x 9.5	1.732
25 x 14 x 14 (8115-00-550-3574)	13 x 7 x 7	7 - 14 15 - 16 17 - 19	20 - 24 30 - 39 40 - 50	26.0 x 15.0 x 14.5	3.273
32 x 18 x 16 (8115-01-015-1315)	24 x 13 x 11	80 (max)	20 - 24	32.5 x 18.5 x 17.0	5.916
34 x 24 x 18 (8115-01-015-1314)	25 x 18 x 12	90 (max)	35 (max)	36.5 x 26.5 x 19.0	10.636
24 x 18 x 16 (8115-01-015-1312)	18 x 13 x 11	20 - 39 40 - 50	25 - 29 30 - 39	25.0 x 19.0 x 16.5	4.536
30 x 27 x 14 (8115-01-094-6520)	24 x 21 x 8	26 - 45 46 - 50	21 - 28 23 - 30	31.0 x 28.0 x 15.0	7.535

TABLE 8-1. Multiapplication container selection. - continued

PPP-B-1672, Type IV, horizontal star (MIL-STD-2073-1C, Appendix C, CODE NW)

Container ID (inches) (National Stock Number)	Recommended max. bare item dimensions (in.)	Item weight range (lbs.)	Maximum Shock (Gs) transmitted to item	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
20 x 14 x 14 (8115-00-010-8956)	14 x 5-1/8 x 5-3/8  14 x 7 x 7	6 - 14 15 - 18 19 - 21  10 - 14 15 - 19 20 - 23 24 - 26 27 - 29	25 - 29 30 - 39 40 - 50  30 - 39 20 - 24 25 - 29 30 - 39 40 - 50	20.5 x 14.5 x 14.5	2.495
22 x 16 x 16 (8115-01-006-7257)	16 x 6-3/8 x 6-3/8  16 x 7-1/4 x 7-1/4	8 - 20 21 - 27 28 - 31  11 - 16 17 - 21 22 - 24 25 - 27 28 - 31	25 - 29 30 - 39 40 - 50  25 - 29 20 - 24 25 - 29 30 - 39 40 - 50	22.5 x 16.5 x 16.5	3.545

## CONTAINERS, PLASTIC REUSABLE SHIPPING AND STORAGE

### LONG LIFE CONTAINERS

Long life containers, types VI through X are listed in table 8-2. All types shall be in accordance with the cognizant Government design activity requirements and construction of types VI through X shall conform to the following drawing numbers:

- X Type VI, Naval Inventory Control Point (NAVICP) drawing P069(code NY)
- X Type VII, NAVICP drawing 13414(code NZ)
- X Type VIII, NAVICP drawing 15024(code MY)
- X Type IX, Warner Robbins Air Logistics Center drawing numbers 11214-5002-100, 11214-5002-200, 11214-5002-300, or 11214-500-400 (code WY)
- X Type X, NAVICP drawing no. 15450 (code RC)

Table 8-2 presents the following information concerning types VI, VII, VIII, IX, and X long life containers:

- X container (size and NSN)
- X item Size
- X item weight range
- X packaged outside dimensions
- X packaged cube (cubic feet)

Type VI consists of two halves of polyethylene blow molded container with polyurethane cushioning and an electrostatic protective cushioned bag. This is used to ship circuit cards and similar type components. This container is shown in figure 8-4.

Type VII consists of a plastic type container with bonded, convoluted polyurethane foam cushioning which forms a cavity. This container is shown in figure 8-5.

Type VIII consists of plastic type container with a coiled steel cable shock mounted platform to which highly sensitive equipment is strapped. This container is shown in figure 8-6.

Type IX consists of two halves of a plastic container. A load platform suspended by elastomeric shock mounts is in one half. Strap tie-downs are used to hold items in place on the load platform. This type is made in four sizes and provides a 15G shock protection for shock sensitive avionics-type equipment in the 10 to 91 pound weight range.

Type X consists of two halves of a plastic container. A load platform suspended by elastomeric shock mounts is in the bottom half. Strap tie-downs are used to hold items in place on the load platform. Type X containers are made in seven sizes and provide 45 G shock protection for shock sensitive electronic-type equipment in the 3-75 pound weight range. This type container is primarily used to package depot level repairables. This container is shown in figure 8-7.

The multiapplication containers in types VI, VII, VIII, and X, were designed by the Navy Aviation Supply Office (ASO) for RIF (Reduction-in-Force) and retrograde shipment and storage repairables at the depot level anywhere in the world via any mode of transportation. They are now managed by the NAVICP.



These containers meet Air Transport Association (ATA) 300, Category I specifications and will withstand a minimum of 100 trips, thus providing life cycle, cost effective protection.

There are twenty nine (29) different sizes of plastic reusable containers with a total of more than 20,000 applications. Simplicity of item removal from the container makes these the easiest of all containers to use, thereby ensuring proper item protection and uniformity or standardization in packaging. Safety is improved at DoD field activities where knowledgeable packaging personnel are not always available.

A cushioning or suspension system is built into each container. These containers are the "state-of-the-art" in repairables management. A new series of containers has been developed for storage aboard ship. These containers are fabricated from flame resistant materials which are self extinguishing. Shock mounts that are incorporated provide a 45G shock protection.

The following illustrations are depictions of the hard modular containers which we have addressed:

- X **Figure 8-4. Container, Drawing No. P069 (Type VI, Code NY).** For circuit card assemblies and small, non-fragile modules.
- X **Figure 8-5. Container, Drawing No. 13414 (Type VII, Code NZ).** For major repairables. Protection to forty (40) G shock level.
- X **Figure 8-6. Container, Drawing No. 15024 (Type VIII, Code MY).** For gyroscopic instruments and other fragile/delicate repairables. Protection to fifteen (15) G's.
- X **Figure 8-7. Container, Drawing No. 15450 (Type X, Code RC).** For major repairables when major repairables are to be stored in non-flammable containers.

#### CLOSURE INFORMATION

- X P069 containers are banded with ASTM D 5330 tape with minimum one(1) inch overlap. Tape banding guides are molded into the container for easy placement.
- X Modular containers numbered 13414, 15024, and 15450 are closed with quarter-turn type fasteners which are permanently affixed to the containers.



Figure 8-4. Container, Drawing Number P069.

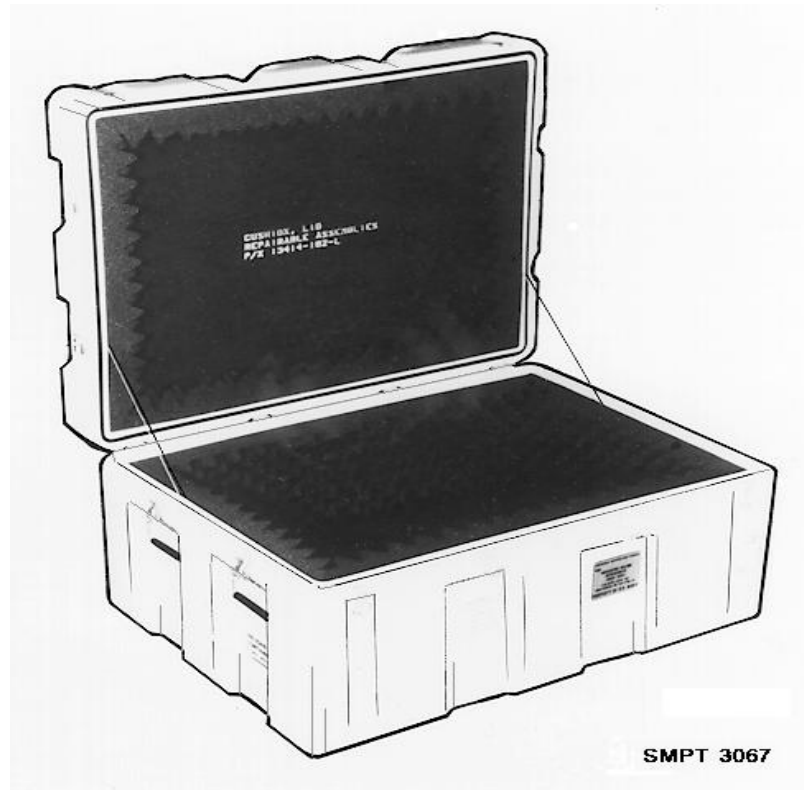


Figure 8-5. Container, Drawing Number 13414.

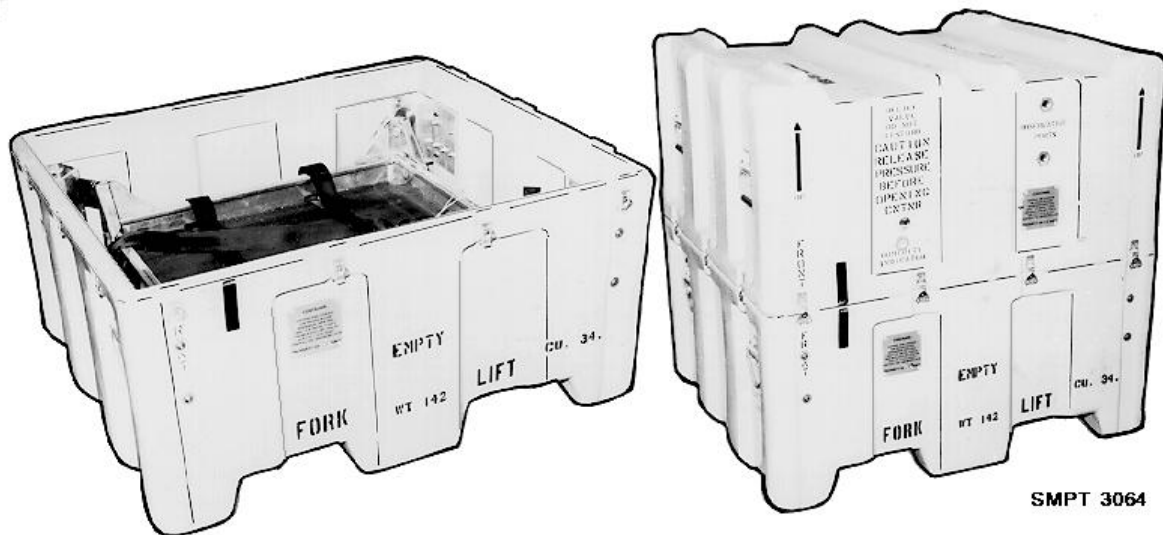


Figure 8-6. Container, Drawing Number 15024.

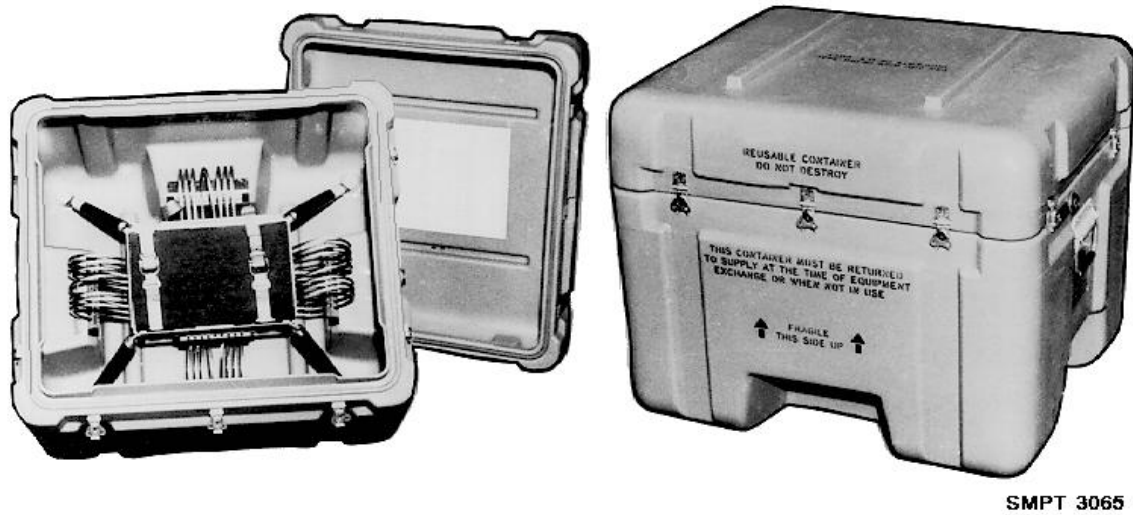


Figure 8-7. Container, Drawing Number 15450.

TABLE 8-2. Multiapplication container selection

PPP-B-1672, Type VI, Molded Reusable Container Assy for Circuit Cards and Modules: Naval Inventory Control Point (NAVICP) Drawing No. P069 (MIL-STD-2073-1C, Appendix C, Code NY)

Container ID (inches) (National Stock Number)	*Recommended max. load size (in.)	Item weight range (lbs.)	Maximum Shock (G's) transmitted to item	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
11.25 x 8.25 x 2.125 (8145-00-260-9556)	8.5 x 6.0 x 1.0	0 - 3	NOTE: Because items assigned to these packs are not of extremely low fragility, dynamic cushioning values have not been determined.	12.0 x 10.0 x 3.0	0.208
11.25 x 8.75 x 4.5 (8145-00-260-9548)	8.5 x 6.0 x 3.25	0 - 3		12.0 x 10.0 x 5.0	0.347
13.25 x 10.75 x 2.125 (8145-00-260-9559)	10.5 x 8.0 x 1.00	0 - 4		14.0 x 12.0 x 3.0	0.292
13.25 x 10.75 x 4.5 (8145-00-260-9562)	10.5 x 8.0 x 3.25	0 - 4		14.0 x 12.0 x 5.0	0.486
6.75 x 5.0 x 2.0 (8145-01-014-0440)	5.0 x 3.0 x 1.0	0 - 2		8.0 x 6.0 x 3.0	0.083
19.75 x 13.75 x 4.5 (8145-01-012-4088)	17.0x11.0x2.62	0 - 4		21.0 x 15.0 x 5.0	0.911
24.0 x 12.0 x 6.0 (8145-01-164-4073)	24.0 x 11.0 x 3.0	0 - 4			27.0 x 14.5 x 7.0

\* Includes wrap, barrier, bag, cushioned pouch and other packaging materials as required.

TABLE 8-2. Multiapplication container selection. - continued

PPP-B-1672, Type VII, Modular Reusable Containers for Packaging Major Repairables: NAVICP Drawing No. 13414 (MIL-STD-2073-1C, Appendix C, Code NZ)

Container ID (inches) (National Stock Number)	*Recommended max. bare item dimensions (in.)	Item weight range (lbs.)	Maximum Shock (Gs) transmitted to item	Packaged outside dimensions (inches)	Packaged Cube (cu. ft)
10 x 10 x 14 (8145-00-301-2987)	4 x 4 x 8	6.0	40 - 50	13.0 x 13.0 x 16.0	1.565
10 x 10 x 18 (8145-00-288-1396)	4 x 4 x 12	7.0	40 - 50	13.0 x 13.0 x 20.0	1.956
14.5 x 13 x 10 (8145-00-553-1539)	8.5 x 7 x 4	9.0	40 - 50	18.0 x 16.0 x 12.0	2.000
14 x 14 x 12 (8145-00-519-6384)	8 x 8 x 6	11.0	40 - 50	17.0 x 17.0 x 14.0	2.341
12 x 12 x 18 (8145-00-288-1397)	6 x 6 x 12	11.0	40 - 50	15.0 x 15.0 x 20.0	2.604
20 x 13 x 12 (8145-00-485-8256)	14 x 7 x 6	17.0	40 - 50	23.0 x 16.0 x 14.0	2.981
16 x 16 x 15 (8145-00-522-6907)	10 x 10 x 9	20.0	40 - 50	19.0 x 19.0 x 17.0	3.552
18 x 14.5 x 19 (8145-00-449-8424)	12 x 8.5 x 13	25.0	40 - 50	21.0 x 18.0 x 21.0	4.594
22.5 x 21 x 11.5 (8145-01-044-3289)	16.5 x 15 x 5.5	33.0	40 - 50	26.0 x 24.0 x 14.0	5.056
22 x 16 x 17 (8145-00-540-1762)	16 x 10 x 11	31.3	40 - 50	25.0 x 19.0 x 19.0	5.223
29 x 14.5 x 14 (8145-00-501-9138)	23 x 8.5 x 8	28.0	40 - 50	32.0 x 18.0 x 16.0	5.333
28 x 18 x 13 (8145-00-549-6647)	22 x 12 x 7	35.0	40 - 50	31.0 x 21.0 x 15.0	5.651
34 x 18 x 15 (8145-00-536-4925)	28 x 12 x 9	44	40 - 50	37.0 x 21.0 x 17.0	7.644
30 x 18 x 19 (8145-00-449-8427)	24 x 12 x 13	50	40 - 50	33.0 x 21.0 x 21.0	8.422
22.5 x 21 x 22.5 (8145-00-499-9808)	16.5 x 15 x 16.5	55	40 - 50	26.0 x 24.0 x 25.0	9.028
27 x 27 x 17 (8145-00-485-8250)	21 x 21 x 11	70	40 - 50	30.0 x 30.0 x 19.0	9.896
34 x 24 x 17 (8145-00-514-2798)	28 x 18 x 11	78	40 - 50	37.0 x 27.0 x 19.0	10.984
28 x 24.5 x 20.5 (8145-01-026-2369)	22 x 18.5 x 14.5	80	40 - 50	31.0 x 28.0 x 23.0	11.553
40 x 24 x 18 (8145-00-529-8585)	34 x 18 x 12	85	40 - 50	43.0 x 27.0 x 20.0	13.438
36 x 20 x 27 (8145-01-008-3683)	30 x 14 x 21	120	40 - 50	39.0 x 23.0 x 29.0	15.054
27 x 27 x 32 (8145-01-010-3776)	21 x 21 x 26	110	40 - 50	30.0 x 30.0 x 34.0	17.708

\*Includes interior carton and associated blocking and bracing when applicable.

TABLE 8-2. Multiapplication container selection. - continued

PPP-B-1672, Type VIII, Shipping and Storage Containers For Gyroscopic Instruments: NAVICP Drawing No. 15024 (MIL-STD-2073-1C, Appendix C, CODE MY)

Shipping Container ID (in.) (National Stock No.)	*Max. load size without handling case (in.)	Handling case. OD (National Stock No.)	Item size using handling case	Item weight range (lbs.)	Max shock (Gs) transmitted to item	Packaged outside dimensions (in.)	Packaged cube (cu. ft.)
30 x 26.38 x 25.5 (8145-01-016-3451)	13 x 9 x 8	10.38 x 6.5 x 6.5 (8145-01-016-3453)	Max Length - 8.38 Max Width - 4.5 Depth Min - 1.69 Max - 3.75	0.5 - 10.5	15	3.04 x 26.8 x 25.6	12.070
		12.5 x 7.25 x 8 (8145-01-016-3454)	Max Length - 10.5 Max Width - 5.25 Depth Min - 3.25 Max - 5.25				
		14 x 10.38 x 9.75 (8145-01-016-3455)	Max Length - 12 Max Width - 8.38 Depth Min - 5 Max - 7				
35 x 27 x 30 (8145-01-016-3452)	17.5 x 12.25 x 13	18 x 12.25 x 11.75 (8145-01-016-3456)	Max Length - 16 Max Width - 10.25 Depth Min - 6.9 Max - 9	8 - 40	15	35.4 x 29.0 x 30.4	18.061
		19 x 14 x 14.25 (8145-01-016-3445)	Max Length - 17 Max Width - 12 Depth Min - 9.5 Max - 11.5				

\*Includes wrap and cushioning as required to protect the barrier bag when applicable.

PPP-B-1672, Type IX, Shipping and Storage Containers for Avionics Instruments and Shock Sensitive Items: Warner Robbins Air Logistics Center Drawing Nos. 11214-5002-100, 11214-5002-200, 11214-5002-300, 11214-5002-400 (MIL-STD-2073-1C, Appendix C, Code WY)

Container 10 (inches) (National Stock No.)	Item Size Max/Min (inches)	Item Weight Range (lbs)	Maximum Shock (G's) Transmitted to Item	Packaged outside dimensions (inches)	Packaged cube (cu. ft.)
24.5 x 23.25 x 21.75 (8145-01-235-1113)	10.5 x 9.75 x 9.25/4 x 4 x 5	10 - 16.5	15	27.5 x 26 x 25	10.344
32.5 x 32.25 x 27 (8145-01-235-1112)	21 x 21 x 15.75/8 x 6 x 5	12 - 25	15	35.25 x 35.25 x 30.25	21.752
32.5 x 32.25 x 27 (8145-01-236-5003)	21 x 21 x 15.75/12 x 6 x 6.75	25 - 54	15	35.25 x 32.25 x 30.25	21.752
38.5 x 44 x 36 (8145-01-235-1114)	25 x 32 x 20.8/15 x 8.75 x 7.75	40 - 91	15	41.13 x 37 x 39.13	34.461

PPP-B-1672, Type X, Modular Reusable Containers for Packaging Depot Level Repairables: NAVICP Drawing No. 15450 (MIL-STD-2073-1C, Appendix C, Code RC)

Container NSN	Item Size (inches)	Item Weight Range (lbs)	Packaged Outside Dimensions (inches)	Packaged Cube (cubic feet)
8145-01-262-2982	Min. 8 x 4 x 4 Max. 12 x 8 x 8	3 – 10	19.0 x 15.0 x 12.0	1.979
8145-01-262-2983	Min. 12 x 8 x 6 Max. 14 x 12 x 9	10 – 20	21.0 x 19.0 x 15.0	3.464
8145-01-262-2984	Min. 14 x 12 x 7 Max. 16.5 x 15 x 10	15 – 30	23.5 x 22.0 x 16.0	4.787
8145-01-262-2985	Min. 14 x 12 x 9 Max. 28 x 13 x 12	20 – 40	35.0 x 20.0 x 18.0	7.292
8145-01-262-2986	Min. 14 x 14 x 10 Max. 16.5 x 16.5 x 15	30 – 60	23.5 x 23.5 x 21.0	6.711
8145-01-262-2987	Min. 14 x 14 x 10 Max. 28 x 21 x 14.5	30 – 60	35.0 x 28.0 x 20.5	11.626
8145-01-262-2988	Min. 25 x 14 x 10 Max. 34 x 21 x 14	45 – 75	41.0 x 28.0 x 20.0	13.287

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